The Visual Regime of Augmented Reality Art:

Space, Body, Technology, and the Real–Virtual Convergence

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Contents

Abstract

My research investigates the aesthetic and perceptual dimensions of Augmented Reality (AR), one of the most fertile fields of technological innovation and artistic exploration within post-desktop philosophy and practice. Although AR has seen rapid expansion and development, it remains largely undertheorized in the humanities. In this sense, my study contributes to the definition of AR, the identification of the most relevant artworks, and the systematization of a theoretical framework for the field.

AR is defined as a set of visualization and interaction systems that permit the perceptual overlay of virtual information (including photos, videos, 3D graphics, texts, sounds) on top of our material reality, in real time, site-specifically, and in an interactive manner. AR's capacity to articulate a hybrid space that seamlessly merges real and virtual elements is what I call *convergence*. AR artworks such as Jan Torpus' *Living-Room 2* (2007), Janet Cardiff and George Bures Miller's *Conspiracy Theory* (2003), Jeffrey Shaw's *The Golden Calf* (1994), Julian Oliver's *Artvertiser* (2008), John Craig Freeman and Will Pappenheimer's *Hans RichtAR* (2013), and recent AR mobile applications such as Layar and Wikitude are relevant examples of the way in which AR makes reality and virtuality not only adjacent but also perceptually convergent within the same space-image. Thus, the questions that arise and which are examined in this study are as follows: to what extent does reality–virtuality convergence particularly affect a user's experience of space? Can we see AR as a confirmation or challenge to the established models of visuality? Or does it amount to a perceptual and aesthetic paradigm change?

I contend that AR proposes a different visual regime as evident from the fact that it extends the traditional definition of the image (proposing instead a processual space-image that integrates reality and virtuality), redefines the role of the interface (transforming it into a context-aware, user-centric device), and reconsiders viewer's experience of space (by embedding virtual data into the everyday environment). A key element of my argument is that regardless of the technical form and artistic solutions employed, AR should be seen as a concept rather than a technology (hence the mixed methodological approach that includes art history, media studies, and computer science). My study concludes that, while grounded on historically validated artistic endeavors that aim at merging real and fictional worlds (such as installation art and Virtual Reality art), AR proposes a different spatial and media experience and therefore a different regime of visuality.

Sommaire

Le régime visuel de l'art de la réalité augmentée

L'espace, le corps, la technologie et la convergence réel-virtuel

Ma recherche porte sur les dimensions esthétiques et perceptives de la réalité augmentée (RA), l'un des champs les plus fertiles de l'innovation technologique et de l'exploration artistique à l'ère post-ordinateur personnel. Bien que la RA bénéficie d'une expansion et d'un développement rapides, la théorisation du phénomène reste encore précaire. En ce sens, mon étude est une contribution à la définition de la RA, à l'identification des œuvres d'art les plus représentatives du domaine et à la systématisation d'un cadre théorique pour le phénomène de la RA.

La RA est définie comme un ensemble de systèmes de visualisation et d'interactions qui permet la superposition perceptuelle de l'information virtuelle (incluant photographies, vidéos, animations 3D, textes, sons) sur l'image de la réalité matérielle en temps réel, et d'une façon interactive et localisée. La capacité de la RA à articuler un espace hybride dans lequel les éléments réels et virtuels sont fusionnés de manière homogène est ce que j'appelle la *convergence*. Des œuvres de RA telles que *Living-Room 2* de Jan Torpus (2007), *Théorie du complot* de Janet Cardiff et George Bures Miller (2003), *Le Veau d'Or* de Jeffrey Shaw (1994), *Artvertiser* de Julian Oliver (2008), *Hans RichtAR* de John Craig Freeman et Will Pappenheimer (2013), et les applications mobiles récentes comme Layar et Wikitude, sont des exemples pertinents de la manière dont la RA place réalité et virtualité non seulement à côté, mais « perceptuellement » de manière convergente, dans le même espace-image. Ainsi, les questions qui se posent, et qui sont examinées dans cette étude, sont les suivantes : dans quelle mesure la convergence entre la réalité et la virtualité a un impact particulier sur l'expérience de l'espace de l'utilisateur ? Pouvons-nous voir la RA comme une confirmation ou un défi pour les modèles établis de visualité ? Ou représente-t-elle plutôt un changement de paradigme perceptuel et esthétique ?

Je soutiens que la RA propose un régime visuel nouveau, évident dans le fait qu'elle étend la définition traditionnelle de l'image (proposant à la place un espace-image processuel qui intègre réalité et virtualité), redéfinit le rôle de l'interface (la transformant en un instrument contextuel, centré sur l'utilisateur) et reconsidère l'expérience spatiale du spectateur (par l'incorporation de données virtuelles dans l'environnement quotidien). Un argument essentiel dans ma recherche est que, quelles que soient la solution technique ou la forme artistique employées, les RA devraient être considérées comme un concept plutôt que comme une technologie (d'où l'approche méthodologique mixte qui comprend l'histoire de l'art, l'étude des médias et celle de l'informatique). La conclusion de mon étude est que, bien que fondée sur des efforts artistiques historiquement validés qui visent à la fusion des mondes réels et fictifs (tels que l'art de l'installation et de l'art de la réalité virtuelle), la RA propose une expérience spatiale différente et donc un régime différent de visualité.

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Introduction

One of the most persistent themes in the history of visual representation is the tension between what we perceive as reality and what we conceive as virtual. That is, between the material world and the non-material, illusionist representation. Plato's myth of the cave that narrates the story of the chained prisoners who were caught within the perceptual impossibility to tell what is real and what is illusion speaks precisely about this. Similarly, Pliny's account about the mythical origins of visual representation based on the virtual presence of the shadow (and hence on the absence of a real body) is nothing but a specific—although enduring and powerful—conceptualization of the same intricate conundrum. Viewed in this larger perspective, can we see augmented reality (AR) as a response—perhaps, a solution—to this tension, at least judging from its promise to "augment" the perception of this reality? Or should we see it as yet another myth regarding visuality, this time technologically upgraded? To put it another way, how much does AR rely on or challenge these established models of visuality? Or does it represent a different regime of visuality altogether?[1]

These questions are legitimate considering that AR's primary goal is to perceptually integrate virtual information as closely as possible into specific environments in the material world. One typical example of an AR application is Layar, a browser that layers information of public interest—delivered through an open-source content management system—over the actual

[1] The term "visual regime" is defined here as the set of phenomenological, aesthetic and technological characteristics of the image and the status it has in terms of individual experience, societal circulation and distribution of meaning. My understanding of the term is close to what Jacques Rancière calls "regime of the arts". For him, the latter is "a specific type of connection between ways of producing works of art or developing practices, forms of visibility that disclose them, and ways of conceptualizing the former and the latter." (Jacques Rancière, *The Politics of Aesthetics. The Distribution of the Sensible*. Translated by Gabriel Rockhill (London and New York: Continuum, 2004), 20. In my thesis, I will demonstrate how the perceptual and aesthetic paradigm change of AR produces a different type of connection between the forms of visibility (artistic or not, virtual and real) and the individual experience, networked circulation and distribution of meaning.

image of a real space, streamed live on a mobile phone display. As the user points the smartphone or tablet to a specific place, virtual 3D-modeled graphics or videos appear in real time, seamlessly inserted in the image of that location, according to the user's position and orientation. An increasing number of artists employ this type of mobile AR application to create artworks that consist of perceptually combining material reality and virtual data. One example of the way in which the Layar application is employed for artistic ends is *We AR in MoMA* by Mark Skwarek and Sander Veenhof (2010), a "guerilla" public intervention in the Museum of Modern Art in New York. The artists invited to take part in the project practically challenged the museum's institutional authority by "hijacking" its physical exhibition space that now hosts a virtual presentation of various digitally animated artworks overlaid in a plausible manner in certain places in the gallery spaces, as they are perceived by the visitor on the screen of a smartphone or tablet.

Taking these considerations as a point of departure I propose the following definition: *AR is a set of visualization and interaction systems that permits the perceptual overlay of virtual information (including photos, videos, 3D graphics, text, sounds) on top of our material reality, in real time, site-specifically and in an interactive manner*. The augmented scene is perceived through the use of different displays and interfaces, the most common being the AR glasses (Head-Mounted Display), video projections or monitors and, especially in the recent years, hand-held mobile devices (such as smartphones or tablets). As important as the interface are the other operations and apparatuses that permit the augmentation effect: tracking systems, markers, GPS, compass, image registration and calibration, occlusion procedures, etc.[2] Emerging mostly from the research efforts dedicated to virtual reality (VR) technologies, AR's goal, however, is to reject the segregation of the viewer into a completely artificial environment—as in VR

[2] These devices and operations will be described in more details in the following chapters as well as in the Annexes.

systems—proposing instead a visual solution that integrates informational elements within the physical space we live in.[3]

Born in the engineer's laboratories during the beginning of the 1990s, the concept of AR was at least initially defined by those involved in its development. One of the most comprehensive and oft-cited definitions is provided by computer engineers Paul Milgram and Fumio Kishino who explain the term AR as "all cases in which the display of an otherwise real environment is augmented by means of virtual (computer graphic) objects."[4] The two scholars include AR in a larger scheme entitled "reality–virtuality continuum" (described also as mixed reality (MR) continuum by the two authors). The scheme ranges from primarily real to purely virtual environments, with AR and what they call "augmented virtuality" (AV) located between the two ends of the spectrum, as situations in which real and virtual are merged in different proportions. Computer scientists Ronald Azuma et al. define AR along the same lines, although the term employed is not "continuum," but "coexistence." They state the following: "an AR system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world." [5] These objects, the authors indicate, are interactive, dynamic, and context-specific information added to the user's sensory perception of space—a crucial specification that points to the fact that *AR expands the experience of space and not the space per se*. Three characteristics are described by Azuma et al. as important for identifying

[3] See Horea Avram, "Augmented Reality," in *Encyclopedia of Aesthetics* Second edition, Editor in chief: Michael Kelly (Oxford and New York: Oxford University Press, 2014), 232-236, and "Visual Regime of Augmented Space", in *Theorizing Visual Studies: Writing Through the Discipline*, Ed. James Elkins (New York: Routledge, 2013), 88-91.

[4] Paul Milgram and Fumio Kishino, "A Taxonomy of Mixed Reality Visual Displays," *IEICE Transactions on Information Systems,* Vol E77-D, No.12 December, 1994.

[5] Ronald Azuma, Yohan Baillot, Reinhold Behringer, Steven Feiner, Simon Julier, Blair MacIntyre, "Recent Advances in Augmented Reality", *IEEE Computer Graphics and Applications* (vol. 21 no. 6), November/December 2001: 34.

AR: 1) it combines real and virtual; 2) it is interactive in real time; and 3) it is registered in 3D.[6] These considerations are extremely important as they support my own contention that AR should be seen *as a visual regime and not as a unique device or particular technology*. Media theorist Lev Manovich makes a crucial contribution in the same direction to define AR as a concept, by viewing it as a different experience of space. By embedding virtual data into the everyday environment, Manovich writes, AR transforms the physical space into a "data dense" space that thus contains many more dimensions than before (not only geometric ones).[7] This is what Manovich calls the "augmented space": "the physical space overlaid with dynamically changing information, multimedia in form and localized for each user."[8] Manovich's position is especially important for defining AR as a specific manifestation in the context of post-desktop technologies and in contradistinction with VR. In his book dedicated to the history and aesthetics of virtual art, media arts historian Oliver Grau clarifies from his perspective what distinguishes VR and AR, or rather what he calls mixed reality. The latter is a media practice that "connects real spaces, including their forms of cultural and social action, with image process of virtual environments."[9] The basic concept, he adds, is obtaining "a virtual space full of information, which is activated, revealed, reorganized and recombined, added to and transformed as the user navigates the real space."[10] In other words, this is about experiencing a virtual space activated in the real world. In the field of performative arts, media theorists Steve Benford and Gabriella Giannachi contribute to define the perceptual cohabitation and interaction between reality and virtual environments in terms of "mixed reality performance." The latter is, according to them,

[6] Ronald T. Azuma, "A Survey on Augmented Reality," *Presence: Teleoperators and Virtual Environments*, 6, 4 (August 1997): 355–385. Available from: Human Interface Technology Lab (HITLab), University of Washington. http://www.hitl.washington.edu/projects/knowledge_base/ARfinal.pdf (Accessed December 2015).
[7] Lev Manovich, "The Poetics of Augmented Space." *Visual Communication* 5, no. 2 (2006): 223.
[8] Ibid., 219.
[9] Oliver Grau, *Virtual Art: from Illusion to Immersion*. Translated by Gloria Custance (Cambridge, Massachusetts, London, England: The MIT Press, 2003), 245.
[10] Ibid., 247.

"hybrid forms that combine the real and virtual in multiple ways and through this, encourage multiple and shifting viewpoints."[11] Taking Milgram and Kishino's scheme of the virtuality continuum as the main framework of analysis, Benford and Giannachi consider that "mixed reality performances may simultaneously occupy multiple points along this continuum by combining many real, virtual, augmented reality, and augmented virtuality environments into complex hybrid and distributed performance stages."[12]

As can be remarked from the above, many authors use the terms AR and MR loosely, with no clear explanation for their choice, and provide no details regarding the difference between them, while employing them to describe basically the same type of experience. This suggests that the two terms are generally (although not always) understood as synonymous, but it also provides evidence for my argument that *AR is a concept rather than a technology*. In this study, I use the term AR instead of MR considering that the phrase AR (and the integrated idea of augmentation) is better suited to capturing the nature of the process and the effect of blending reality and virtuality. As I will demonstrate in this study, the process of augmentation is the result of an *enhancement* of the possibilities to perceive and understand the world—through adding data that *augment* the perception of reality—and not simply the product of a mix. Nevertheless, there is surely something "mixed" about this experience, at least for the fact that it combines different media, various senses, reality, and virtuality. The fact that there is no consistent definition of AR and that the experience of augmentation is described with either the phrase AR or MR, depending on the author, proves the lack of a unified and nuanced vocabulary of analysis dedicated to this specific artistic and mediatic manifestation. Moreover, many terms relevant in understanding the phenomenon of AR (reality, virtuality, space, site, location,

[11] Steve Benford and Gabriella Giannachi, *Performing Mixed Reality* (Cambridge, Massachusetts and London, England: The MIT Press, 2011), 4.
[12] Ibid., 3.

interactivity, etc.) are used in most circumstances unspecifically and without a proper definition, being often taken with their implied (i.e., traditional) meaning. Cultural theorist Ulrik Ekman is right to observe that "if you have had to explain to somebody what a 'mixed reality' is and what its cultural ramifications are likely to be, you will probably have met with certain difficulties—on both sides of the exchange."[13] That the term mixed reality to which Ekman makes reference can easily be replaced with AR demonstrates the remarkable ambiguity with which these terms are generally used, a situation noticed earlier also by Paul Milgram who complains about the lack of a "consistent definition" of AR.[14] Writings about AR grounded in other fields such as art history, visual studies, or media theory were (and still are) rather scarce. However, in the last years, important contributions were made in this respect, among others, by Lev Manovich, Christine Ross, Mette Ramsgard Thomsen, Vladimir Geroimenko, Steve Benford, Gabriella Giannachi, Jay David Bolter, Blair MacIntyre, Jason Farman, and others. Still, compared with other related domains, the field of AR remains largely undertheorized. Part of my effort in the present study is, therefore, to contribute to the definition of AR and the systematization of a theoretical framework for AR.

Real-virtual (dis)continuity

Besides the differences in views and vocabulary, the definitions quoted above have in common the idea that AR provides an effect of perceptual coexistence or continuity between the real material world and the virtual realm. "Coexist" was Azuma's term to describe AR

[13] Ulrik Ekman, ed., "Introduction," *Throughout: Art and Culture Emerging with Ubiquitous Computing* (Cambridge, Massachusetts: The MIT Press, 2013), 13.
[14] Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum", *SPIE* [The International Society for Optical Engineering] Proceedings: *Telemanipulator and Telepresence Technologies*, 2351 (1994): 283.

experience, while Manovich refers to the idea of continuity. The latter writes: "augmented space technologies (…) define dataspace—if not in practice, then at least in theory—as a *continuous* field that completely extends over, and fills in, *all of* physical space."[15] Artist and theorist Vladimir Geroimenko makes a similar point when he writes that AR "allows the artist to translocate the borders and constraints of the experience from physical to virtual, expressing the piece onto spaces independent of physical or locative constraint, yet still tethered to the real world."[16] Certainly, within the larger context of the post-desktop technological philosophy and practice, there are other efforts directed toward finding solutions for directly integrating virtual information into specific real environments; a short list of such endeavors include Wi-Fi connectivity, GPS-driven navigation, mobile phones, GIS (Geographic Information System), and various technological systems associated with what is loosely called locative, ubiquitous, and pervasive computing (that is, different modalities of integrating information processing tasks into everyday activities and ordinary objects). AR is directly related to these technologies, although its visualization capabilities and the experience it provides make it a particular visual system within this general trend. Indeed, AR stands out for its unique capacity (or ambition) to offer a seamless combination of the real scene perceived by the user with virtual information overlaid on that scene interactively and in real time.

This capacity is what I call *convergence*: the perceptual blending—and not only juxtaposing—of the elements in the real world with images in the virtual realm in real time and localized for each user. A crucial role in obtaining the convergence effect is played equally by illusionist representation (through manipulations of virtual images and occlusions of real objects according to the moving body of the user), interactivity (the human-machine communication that

[15] Lev Manovich, "The Poetics of Augmented Space," 228 (author's emphasis).
[16] Vladimir Geroimenko, "Preface" in *Augmented Reality Art: From an Emerging Technology to a Novel Creative Medium*, edited by Vladimir Geroimenko, (Heidelberg: Springer, 2014), x.

assures the very functioning of the AR system[17]), location-specificity and localization (the interpellation of the user according to his/her situatedness and the specificities of that place[18]), as well as spatial embodiment (the production of a bodily space through media interactions, material conditions, and social practices). It is true that this dialogical exercise that unifies two different phenomenal levels, real and virtual, is not a perfect superimposition; AR's convergence effect is as much continuous as it is discontinuous, and this fluctuation is actually part of the very condition of AR. Certainly, aiming to create a credible convergence effect is not about producing perfectly homogenous spaces (this is at least technically, if not perceptually impossible), but about finding the means and conditions to establish a dialogue and a contact point between reality and virtuality.

AR - A different aesthetic and perceptual paradigm

Regardless of the degree of "perfection" of the convergence process, what we can safely assume is that the complex nature of AR operations permits a closer integration of virtual images within real space, one that, I argue throughout this thesis, constitutes *a different aesthetic and perceptual paradigm*."[19] AR's novelty resides in the fact that *it extends the traditional definition of the image*, *redefines the role of the interface*, and *reconsiders the viewer's experience of*

[17] Art historian Christine Ross writes that "the key rule underlying AR sites is interactivity—they are the very site of affirmation of an *inter-agero ergo sum* ('I interact, therefore I am')." Christine Ross, "Augmented Reality Art: A Matter of (non)Destination," Proceedings of the Digital Arts and Culture Conference (2009), *After Media: Embodiment and Context*, University of California, Irvine. Online at http://escholarship.org/uc/item/6q71j0zh (accessed December 2015).

[18] Media theorist Jason Farman notes that AR is able to "transform our location into an information interface." Jason Farman, *Mobile Interface Theory. Embodied Space and Locative Media* (New York and London: Routledge, 2012), 13.

[19] Here I use the term paradigm, following philosopher Thomas Kuhn, in the sense of a set of particular beliefs and knowledge that are regarded as "established" and the paradigm shift as the moment when "one conceptual world view is replaced by another." Thomas Kuhn, *The Structure of Scientific Revolutions*, Second Edition, Enlarged (Chicago: The University of Chicago Press, 1970 (1962), 10.

space. More precisely, AR questions the role of the image as it was conventionally defined in visual arts—as a delimited locus of aesthetic experience, separated from the non-artistic world. AR rejects the idea of a framed, window-like representational regime (inherited from the Renaissance), proposing instead a perceptual experience that dissolves—through illusionism and bodily participation—the traditional borders between virtual image and the material world, and between image as a delegated reality (a re-presentation) and image as an immediate experience of reality (a presentation). An important role in this process is played by the screen, another element that is redefined by AR. Either portable or stationary, the AR screen tends to be frameless and phenomenologically "transparent," therefore better integrated into the real environment. Such transformations concern both the material level of the apparatus and its perceptual presence. For example, when the image on and off the screen of a mobile device coincide temporally and visually, the frame of the screen tends to be perceptually relative if not quite absent. Or in the case of a video projection mapped on the body of a building, the screen as a distinct presence disappears altogether within the morphology of the building. This leads also to a different experience of space: by embedding virtual data into the everyday environment, AR transforms the physical space into a perceptual liminal zone, a type of space-image that integrates (the image of) reality and virtuality. Abolishing the perceptual (but not ontological) differences between the two realms, AR proposes another way of thinking about media-permeated urban space: not as a seizure of a certain locality but as the confirmation of its possible existence as multiplicity and continuity between real and virtual. In other words, space should be seen not as a static environment simply overlaid with data, but as an expanded space-image activated within the media sphere by the subjective and mobile user. Augmented space-image is not something to simply look at, but also something to act in. It not only takes the place

but it also takes place. That is, it not only re-presents—in the sense philosopher Jean-Luc Nancy describes the image as something that "gives a presence that it lacks"[20]—but it also presents, in the sense that it creates an event of perceptual presence through the continual actualization of data in situ. In this sense, as media theorist Mark B.N. Hansen notes, the space-image becomes "a means for the new media user to intervene in the production of the 'real'."[21] Indeed, in AR what we call "reality" becomes a much more complex construction whose perceptual and semantic dimensions are essentially determined and expanded by virtual data. The same idea is shared by media theorist Jason Farman who claims that "the virtual is not the opposite of the real; instead it is a component of experiencing the real."[22] This is to say that, in the AR spaces of perception, the elements in the material reality and virtual data equally contribute toward producing a different experience and artistic discourse. Lev Manovich's suggestion about considering virtual information in AR as a concrete form, as a raw material for art is relevant in this sense. He states that "architects along with artists can take the next logical step to consider the 'invisible' space of electronic data flows as substance rather than just as void—something that needs a structure, a politics, and a poetics."[23] And here "poetics" should be understood as a new model of interpretation which, according to Manovich, "reconceptualizes augmentation as an idea and cultural and aesthetic practice rather than as technology."[24] As a means to interpreting the important transformations occurring at the aesthetic and experiential levels in

[20] Jean-Luc Nancy, *The Ground of the Image*, Translated by Jeff Fort (New York: Fordham University Press, 2005), 66.
[21] Mark B. N. Hansen, *New Philosophy for New Media* (Cambridge Massachusetts and London England: The MIT Press, 2004), 10.
[22] Jason Farman, *Mobile Interface Theory. Embodied Space and Locative Media* (New York and London: Routledge, 2012), 22.
[23] Lev Manovich, "The Poetics of Augmented Space," 237.
[24] Ibid., 220. The title of Manovich's essay echoes Gaston Bachelard's The Poetics of Space with the clear intention of legitimating one of the most under-theorized domains of technological visualization. But instead of a metaphorical examination of the superficial and subjective nature of objects and "spaces we love" (Bachelard 1994, xxxv), Manovich's "The Poetics of Augmented Space" discusses the complex dynamic interaction between spatial form and information in the computer culture. See, Gaston Bachelard, *The Poetics of Space*. Translated by Maria Jolas (Boston: Beacon Press, [1964] 1994).

AR, I propose the term "*convergent space*" to describe the type of spatial practice that seamlessly merges real and virtual elements in a specific visual regime. It is precisely this capacity to facilitate the meeting at different levels between location, information, and user that makes AR a different perceptual and aesthetic paradigm, and at the same time one of the "hottest" concepts in contemporary arts and media practice.

AR - Origins and affinities

If AR, as I will argue in the thesis, is the mark of a broader paradigm shift, it is hard to believe that AR has appeared in a void or that its emergence is strictly related to certain advances in technological research. Hence, before explaining how I will structure the thesis to show how AR materializes a different aesthetic and perceptual paradigm, a brief historical view is in order. Most often, AR is associated with a set of relatively recent technologies that took shape at the beginning of the nineties, but as an artistic practice and as a media communication means AR should be seen in a larger perspective. Indeed, AR is based on art forms, visualization strategies, interactivity models, and display solutions that have already been historically validated, before the term AR itself was invented. For example, in the 1960s, computer scientist Ivan Sutherland played a crucial role in the history of AR contributing to the development of display solutions and tracking systems that permit a better immersion within the digital image. Another important figure in the history of AR is computer artist Myron Krueger whose experiments with "responsive environments" are fundamental as they proposed a closer interaction between the participant's body and the digital object. More recently, architect and theorist Marcos Novak contributed to the development of the idea of AR by introducing the concept of "eversion," "the

counter-vector of the virtual leaking out into the actual."[25] If we further expand the historical perspective, we can find other moments in the history of visual culture that attest the same preoccupation for perceptually blending material elements and virtual images. A few examples, among many others, would possibly include the following: Filippo Brunelleschi's experiment with linear perspective, c. 1420, in front of the Baptistery in Florence; *Sala delle Prospettive* (architectural illusionism of Baldassare Peruzzi painted in 1515 in Villa Farnesina in Rome); Magic lanterns (an early type of image projector developed in the 17th century); Pepper's ghost shows (a special effects technique for creating transparent ghostly images through the use of lights and reflections, which was mentioned in the 16th century and popularized in 1862); *Uncle Josh at the Moving Picture Show* (film directed by Edwin S. Porter, 1902, an early example of a moving image that plays with the tension between reality (the world off-screen) and virtuality (the world on screen); Erwin Piscator's incorporation of film footage into theater performance (for example in Ernst Toller's *Hoppla, We're Alive!*, 1927); Morton Heilig's *Sensorama*, 1957–1962 (a machine that is one of the earliest known examples of immersive, multi-sensory technology); Filmstage (inter-media experiments undertaken during the mid 1960s that combine live actors with film); Haus-Rucker-Co (the Viennese group founded in 1967 that explored the potential of architecture through prosthetic devices that altered perceptions of space). Whether any of these examples could be seen as direct predecessors of AR is a question of nuance and interpretation. In my opinion, even if they are not AR manifestations per se, they contribute in an important manner to the crystallization of *the idea* of AR by cultivating a specific path of visual exploration focused on blending reality and virtuality within the same perceptual field.

[25] Marcos Novak, "Interview with Leo Gullbring." *Calimero journalistic och fotografi*, 2001. http://www.calimero.se/novak2.htm (accessed December 2015)

However, I argue that, as an artistic manifestation, AR is more directly informed by two specific forms of art preoccupied by merging real and fictional in a unitary perceptual entity, particularly by installation art and VR environments. On the one hand, I identify installation art as a predecessor of AR considering the way in which both establish temporary site-specific spaces, enhance them with material and virtual elements and invest them with meaning as to create a sort of fictional zones within reality, while both require the interactive presence of the viewer to complete the piece. Among many possible examples, I mention a few works, mostly video-based interactive installations, whose effect is based on blending virtual image and real space: Bruce Nauman, *Corridor* (1968–1970), Peter Campus, *Interface* (1972), Myron Krueger, *Videoplace* (1974), Nam June Paik, *TV-Buddha* (1974), Dan Graham, *Present, Continuous, Past(s)*, (1974), Jeffrey Shaw, *Viewpoint* (1975), Jeffrey Shaw, *Inventer La terre* (1986), Paul Sermon, *Telematic Dreaming* (1992), Camille Utterback and Romy Achituv, *Text Rain* (1999), and Carsten Höller, *Sliding Doors* (2003). Like AR, all these works rely on material and virtual spatial configurations designed as a subjective realm, as a discursive environment, a sort of *mise-en-scène* with various degrees of interactivity and mediality. Nevertheless, not all installations, especially those of the previous (pre-digital) decades, produce the same effects like AR. As art historian Christine Ross remarks, "While the projected images of the 1960s and 1970s partook of an aesthetics of self-criticality, distantiation, and reality-versus-illusion, AR art contributes to the shaping of an aesthetics of immersiveness, relationality, and real-virtual continuum."[26] To this distinction, believes Ross, AR adds its "binding impulse," that is, a spectatorial practice that is driven by the idea of collectivities formation, as opposed to "unbinding operations" of earlier works.

[26] Christine Ross, "The Projective Shift Between Installation Art and New Media Art: From Distantiation to Connectivity," in *Screen/Space: The Projected Image in Contemporary Art* ed. Tamara Trodd (Manchester: Manchester University Press, 2011), 185.

On the other hand, VR environments occupy an important place in the history of AR, since they share the same preoccupation for illusionist imagery and—at least in some projects—immersion in "expanded image spaces experienced polysensorily and interactively."[27] Examples of VR works can include the following: Monika Fleischmann and Wolfgang Strauss, *Home of the Brain* (1992), Jeffrey Shaw, *EVE (Extended Virtual Environment)* (1993), Knowbotic Research, *Dialogue with the Knowbotic South* (1994), Char Davies, *Osmose* (1995) and *Ephémère* (1998), Maurice Benayoun, *World Skin. A Photo Safari in the Land of War* (1997), Agnes Hegedüs, *Memory Theater VR* (1997), Luc Courchesne, *Where are You/ T'es où?* (2005), and Neil Brown, Dennis Del Favero, Jeffrey Shaw, and Peter Weibel, *T-Visionarium* (2003–2008). From VR works AR adopts the techniques of (re)locating the viewer in the image and the appearance of the "perfect" illusion of the tridimensional virtual objects. Like VR, AR works to replace the image's flatness with profoundness, and in certain cases, substitutes arm's length visual experience with immersion. In these conditions, the viewer seems to be literally inside the convergent space, among the objects and images (both real and virtual), and not in a detached, "cinematic" mode of perception.

We can see these transfers from previous forms of art (installation and VR) to AR as the expression of a process of remediation, in the sense given to the term by Jay David Bolter and Richard Grusin, as "the representation of one medium in another" an operation that is, according to the authors, a defining characteristic of the new digital media.[28] To what degree AR is a good example of remediation, is a question of debate. What is sure, however, is that despite any similarities and continuities, AR can be seen as a set of artistic practices that not only relies on

[27] Oliver Grau, *Virtual Art*, 9.
[28] Jay David Bolter and Richard Grusin, *Remediation: Understanding New Media*. (Cambridge Mass. And London England: The MIT Press, 1999), 45. In direct relationship with the process of remediation manifested in AR, I use the plural form *mediums* instead of *media*, in order to underline the multiplicity of means of expression in AR and to avoid confusion with the popular term mass media.

but also disrupts the aesthetic models represented by installation art and VR. Although aiming at creating more inclusive spaces of interaction, installation art in general, unlike AR, is unable to offer the experience of a convergent space, that is, of a different type of visuality that combines virtual and real within a continuum. Some installation artworks lack the media component; others are not viewer-inclusive and (with some exceptions) do not offer a real-virtual live experience. Their spatiality is at best a "space of interaction" that connects but does not *integrate* real and virtual elements. As I stated already, AR not only places the real and virtual spaces in an adjacent position (or replace one with another) but makes them perceptually convergent in an—ideally—seamless way. Moreover, unlike VR that isolates the viewer within the image-space (through the use of a CAVE, inverted domes, or other fully-immersive display solutions), in AR virtual image is coextensive with material reality. Regardless of the degree of immersion, in AR there is no such thing as dismissing the real in favor of an ideal view of a perfect and completely controllable artificial environment like in VR. The "redemptive" vision of a total virtual environment is replaced in AR with the open solution of sharing physical and digital realities in the same sensorial and spatial configuration. In AR, the real is not denounced but reflected; it is not excluded but integrated. As computer scientists Blair MacIntyre et al. explain, "the importance and uniqueness of personal AR as a medium is the result of three features that combine to distinguish it from earlier media"—and, I would add, from other related artistic endeavors—:"blending the virtual and physical worlds, continuous and implicit user control of the point of view, and interactivity. While none of these features is unique (except, to some extent, the blending of the virtual and physical worlds), the combination is."[29] It is precisely this mixture of features that makes AR a different—if not new—perceptual and aesthetic paradigm.

[29] Blair MacIntyre, Jay David Bolter, Emmanuel Moreno, and Brendan Hannigan, "Augmented Reality as a New Media Experience" Proceedings of the *International Symposium on Augmented Reality (ISAR'01)*, New York, NY,

A closer look at AR's most important features and operational strategies and their historical development, reveals not only the technological progress and conceptual diversification undergone by AR in the period from the early nineties to these days (progress refers to improved design solutions, better accessibility, reliability, and enhanced informational capabilities) but also attests the philosophical transformations that occur in the process of integrating virtual information within a physical environment in direct correlation with the active viewer. These changes reflect the gradual shift of the concept and process of augmentation from a "total" engagement with the space (through immersive, VR-type visualization systems) to an open and more flexible interaction with the material reality. In other words, from conceiving space as an absorbing illusionist medium to treating space as a mobile, open-sourced, and socially-aware communication and visualization platform. It is important to bear in mind that much of the AR technology was born from the VR research, and thus, it started as an enhancement of the VR paradigm. Even mobile AR was seen, in the first years of its development, as a natural complement to the stationary visualization systems based on VR technology, hence, the use of hardware setups and interfaces similar to non-mobile AR systems. For example, the first wearable prototypes (*Touring Machine*, *ARQuake*, and others[30]) have their hardware mounted to a large backpack, use heavy HMD, fragile connectors and cables, and necessitate heavy power supplies that are not usually designed for mobile use. Certainly, these technical solutions used in early mobile applications were able to offer a superior performance in terms of visual effects than the present pocket devices. However, their merit consisted mainly in their effectiveness in illustrating a concept, since, in practical terms, they were unable to provide a convenient form: their lack of robustness (not to mention their difficult maintenance and high

Oct 29–30, 2001. Online at Georgia Tech: Augmented Environments, http://ael.gatech.edu/lab/ (accessed December 2015).

[30] For more details, see Annex 1.

costs) prevented them for being reliable and feasible solutions for mobile AR experience. Given these major practical impediments plus the consumers' interest for small forms and ergonomic devices dramatically accelerated the AR research process and business development strategies toward building more accessible and more comfortable solutions for mobile AR technology. The instruments that support AR experience in the mobile mode today are not anymore the cumbersome harnesses of the early nineties but the tiny smart phones or tablets—all of them, discrete tools, handy devices equipped with cameras, locative technologies, wireless connectivity, and a user-friendly interface, plus the possibility of accessing online global resources and open, user-generated content. As a consequence, mobile AR is now a more common occurrence; being increasingly affordable and providing a new personal experience, mobile AR became a more popular and reliable option for augmenting the material world with virtual data. The introduction of Google Glass in 2014 (a device that provides the wearer access to Google's key cloud features, in situ and in real time), and of Microsoft's *HoloLens* in 2015 (an AR unit, with high-definition "holographic" 3D optical head-mounted display), the fast public acceptance of AR systems for Smart Watches, the growing popularity and availability of AR applications together with the increasing number of artists that engage with AR experiential possibilities on the mobile front indicate that mobile AR seems to be the main direction of development, at least in the near future.

Chapters outline

This study is organized in four chapters and a concluding section, each exploring the most pertinent theoretical, terminological, and historical aspects as well as the main experiential

dimensions of AR. A number of significant cases of AR artworks and applications are discussed while addressing the premises and the repercussions of the paradigmatic change proposed by AR. The main objective of this thesis is to analyze (and demonstrate through this analysis) the aesthetic and perceptual paradigmatic change made manifest and performed in AR as a different regime of visuality. The analysis is articulated along four main intersected axes that explain this different regime, one exploring the history and terminology surrounding AR, the second identifying the specificities of the interface, the third discussing the idea of space and reality, and the fourth analyzing the implications of virtuality in constructing the perceptual and aesthetic meaning of AR and its regime of visuality.

Chapter 1, entitled "Augmented Reality: The Spaces in Between," examines the particular (historical, aesthetic, and technological) conditions in which AR experiments have emerged, while establishing—via the definitions offered by some of the most important authors writing in the field—its main principles and defining features. One of the purposes of this chapter is to identify what relates and what distinguishes AR from other artistic endeavors and expressions of the post-desktop media practices of embedding artificial intelligence into the everyday environment. The chapter introduces some of the most representative AR artworks such as *Living-Room 2* (2007) by Jan Torpus, *Under Scan* (2005–2008) by Rafael Lozano-Hemmer, *Conspiracy Theory*/*Théorie du complot* (2003) by Janet Cardiff and George Bures Miller, and *The Golden Calf* (1994) by Jeffrey Shaw. They are commented within the conceptual framework of AR as it was formulated in fields as diverse as art history, media theory, philosophy, information technology design, and computer engineering. What connects the various artistic projects discussed here—quite different with regard to their technological functionality—is their common preoccupation for creating a continuous perceptual zone that

abolishes as much as possible the distance in both time and space between real and virtual. In this sense, they prove that, despite the fact that technological factors play a key role in every AR work, AR should be seen as an aesthetic problem rather than a strictly defined technology. I contend that by articulating a specific perceptual environment that seamlessly combines real space and virtual information into the same perceptual entity interactively and in real time, AR is able to propose a different spatial experience: this is what I call here "convergent space." However, as I will demonstrate, the realization of this presupposed continuum is somehow problematic—and this is one of the central arguments of this chapter and of the whole study—since AR's convergent space is neither spatially homogenous nor temporally continuous. Instead, AR can be seen as a hybrid entity, that is, as a visualization system that weaves (more or less coherently) the virtual into the physical, and which links (more or less directly) a global infrastructure to a particular site. The last section of this chapter discusses these internal (inherent?) tensions presupposed by the hybrid condition of the AR space (via authors such as Mark B. N. Hansen, Lev Manovich, Ron Burnett, Christine Ross, and Mette Ramsgard Thomsen[31]). The aim is therefore to see to what extent we can speak—if any at all—about AR as a different (or perhaps new?) perceptual paradigm of spatial imaging.

Chapter 2, entitled "The Aesthetics of the Interface: Display solutions as real-virtual convergence tools," analyzes the crucial role of the interface in experiencing AR and producing its perceptual effect. The term "interface" is understood here in a broader sense, "as a technological artifact optimized for seamless interaction and functionality,"[32] considering various technical, representational, and cultural dimensions. However, in order to explain the

[31] See the Bibliography for the complete references.
[32] Christian Ulrik Andersen and Søren Pold, "Manifesto for a Post-Digital Interface Criticism" in *The New Everyday: A MediaCommons Project*, 2014, http://mediacommons.futureofthebook.org/tne/ (accessed December 2015).

specificities of the interface (use) in AR, I will build my analysis taking the historical "basic unity" of the interface, the screen, as the main element, since the latter makes evident the whole spectrum of changes proposed and presupposed by the AR's different visual regime.

My investigation elaborates on the definitions and descriptions of AR outlined in the first chapter, while acknowledging and integrating the critical analysis by scholars such as Anne Friedberg[33] and Kate Mondloch.[34] These authors speak about the atypical function and morphology ascribed to the screen in media installations (that are similar to AR), one that refuses the virtual-window paradigm and the traditional modes of spectatorship. I argue that AR furthers even more the unconventional use of the screen proposed by other media installations. In AR, screen is not a phenomenologically "independent" visualization device, but an embodied, intuitive and mobile platform, a transparent surface that is better integrated in the real-world environment, if not confounded with it. I assess the defining character of AR display solutions, both technically and aesthetically, as they emerge from analyzing a few relevant examples of artworks and AR applications. Building on these considerations, I propose an AR typology based on the identification of three distinctive attributes of the convergent AR space and of the augmented experience (*integrativity*, *projectivity*, and *mobility*) in which each specific type of AR display can be positioned (head-attached, spatial displays, and hand-held). The "integrative type" is concerned with depth, immersion, and the perfect illusion (for example, Jan Torpus' group project *Living Room 2* (2005–2007), or *Exercise in Immersion 4.1*, a 2007 project by Marnix de Nijs). The "projective type" is about the screen as a spatial display. Artworks in this category use the actual site as a projection surface; images are adapted to fit the setting, (through

[33] Anne Friedberg, *The Virtual Window. From Alberti to Microsoft*, Cambridge, Massachusetts and London, England: The MIT Press, 2006.
[34] Kate Mondloch, *Screens: Viewing Media Installation Art* (Minneapolis and London: University of Minnesota Press, 2010).

mappings and adjustments) therefore dissolving the virtual image—and implicitly the screen—into the real environment (for instance, Adam Frank and Zack Booth Simpson's *Shadow* (2004) and Rafael Lozano-Hemmer's work *Under Scan*, (2005–2008)). The "nomadic type" represents the networked screen of the localized information accessed through the smartphone or the tablet, hooked up to the Internet and surveilled by GPS (examples include mobile AR applications such as Layar, Wikitude, Aurasma, MARA, Nearest Tube, HistoryPin, Streetmuseum, or mobile AR artworks such as Julian Oliver's *Artvertiser* from 2008, Sander Veenhof and Mark Skwarek's *We AR in MoMA*, 2008–2010, and John Craig Freeman and Will Pappenheimer's *Hans RichtAR*, 2013).

Chapter 3, "Species of Spaces in the real world," assesses the perceptual and aesthetic dimensions of "reality" in AR experience. Building on the previous chapter's discussion about *how* AR augments, this chapter explores *what* exactly does AR augment, considering that both material and virtual elements defining AR experience are, in their own ways, different expressions of a perceptual reality. In this sense, I demonstrate that what we call "reality" in AR is neither an a priori "natural" given, nor a simple empirical proposition. It is rather a specific condition of the material reality, a precise configuration of space and time that exists and acquires sense only through the virtual images' input and with the corporeal experience in situ. To explain this specific condition of reality in AR context, I propose the term *design(at)ed space*. The latter describes the real-world environment of an AR work or application that is either *designed* as a setting for the work or a *designated* area within the existing real-world configuration that serves as a matrix for the augmentation experience. For example, Jan Torpus' *Living-Room 2*, Jeffrey Shaw's *The Golden Calf*, or Workspace Unlimited's *Spac[E]scape*, are works that design (that is, conceive and build) their experiential context, while works such as

Conspiracy Theory/Théorie du complot (2003) by Janet Cardiff and George Bures Miller, *Artvertiser* by Julian Oliver, or *We AR in MoMA* by Sander Veenhof and Mark Skwarek are works that designate certain areas in the existing urban milieu that function as the background and as a discursive component of the work. Thus, the design(at)ed space of AR is as much a product as it is a practice. Being highly contingent and specific and "produced" by the user, design(at)ed space can be seen as an "installationist" entity. That is, a spatial configuration that—like installation art—constructs "fictional" areas within material reality, a sort of mise-en-scènes that are aesthetically and socially generated. It is from this perspective that installation art is considered and discussed as an important predecessor of AR. A significant part of this chapter is dedicated to examining the overlaps and divergences between design(at)ed space and related concepts of milieu, *Umwelt*, place, site, and location with the goal of establishing the defining perceptual parameters and the specific theoretical vocabulary of AR vis-à-vis other kindred spatial manifestations and theoretizations.

Chapter 4, "On the Other Side: Virtuality and Virtual Space," investigates the properties and principles underlying the ideas of "virtual" and "virtuality" in AR. If in the previous chapter I explained the aesthetic and philosophical dimensions of the terms "real" and "reality" in the specific framework of AR, this chapter aims to clarify what defines AR from "the other side," that is, from the perspective of what is generally quantified under the loose category of the virtual. This endeavor is necessary especially given that, like the terms "real" and "reality," "virtual" and "virtuality" are often either not defined or taken with their implicit meanings in most writings on AR.

I argue that AR does not ask for a "new" definition of the virtual. In many aspects, the terms virtual and virtuality stand in continuity with other and earlier definitions, although I will

explain them through the particular perceptual and aesthetic relationship the "virtual world" entertains with the material reality in the convergence process. In AR, virtual and material are mutually dependent, and AR's experience is directly related to this interdependence. Any explanation of these terms via strict technical specifications would be aesthetically misleading and methodologically unproductive, given that the term "virtual" is applied here to analyze extremely different manifestations: computer graphics, 3D digital models, video projections, and sound streams. An important operation in this chapter is to disentangle the term virtual from understanding it as a visual effect and as a digital occurrence. I demonstrate that the term "virtual" should be defined in its ontological dimension, more precisely, as the (im)materiality of an image, something that pertains to the representational order and not as the effect it conveys (illusionism and/or immersion), and even less as the techniques it implies (i.e. digitality). Nevertheless, illusionism, realism, and *trompe-l'oeil* are important elements in defining virtuality and they are implicitly central players in the visual rhetoric of AR and its convergence effect, as much as it is digital technology that marks most of AR history and its future developments. The chapter concludes with the observation that AR is able to expand a whole tradition of representationalist verisimilitude by including material reality in the experience and not only "quoting" it, by *producing* it, and not only reproducing it.

The concluding chapter, "AR—Even better than the real thing?" offers a summary of the arguments that run throughout the text and which explain AR as a different aesthetic and perceptual paradigm. Precisely, I explain that the difference brought about by the visual regime proposed by AR resides in the important changes AR makes with regard to a number of key aspects of visuality and visual culture: AR redefines the image, more precisely, the traditional notion of the image by expanding this notion to equally include material reality and virtual

representation; AR extends and complicates the role assigned to interface, by embodying the screen and making it not only site-specific but also an integral part of the real space; it facilitates a different spectatorial involvement, more precisely, a special experience of spatial sociality that takes place at the edge of material and virtual worlds; it reformulates the aesthetic premises that underlie installation art and virtual reality environments proposing a more inclusive, user-centric, and reality-friendly practice; it proposes a more comprehensive and consistent experience vis-à-vis other contemporary media manifestations that enter in the category of ubiquitous or pervasive computing or Web 2.0.; it transforms an elitist concept and restrictive device into a trendy and handy instrument; thus, it moves the interest from immersion to mobility, from laboratory and gallery to the streets. Important to note is that all these changes provided by AR, take place by proposing a convergent space of perceptual combination and interaction between real world and virtual images and between global network and localized user.

Chapter 1

Augmented Reality: The Spaces in Between

1.1. Notions in motion: defining AR

In his groundbreaking essay "The Poetics of Augmented Space" media theorist Lev Manovich identifies Augmented Reality (AR) as a different cultural and aesthetic expression within the larger context of practices preoccupied with integrating spatial form and information.[35] This wider trend includes, according to Manovich, practices as diverse as illusionist fresco paintings and various technological solutions that embed artificial intelligence into the ordinary human environment: screens and signs that cover the walls of shopping and entertainment areas, or spaces where subjects can access information wirelessly on their portable devices. He admits, though, that in the AR environments the general dynamic between spatial form and information functions differently. Certainly, where AR stands out, I argue, is in its specific capacity (or rather ambition) to offer *a perceptual (seamless) combination of the real scene perceived by the user with virtual information overlaid on that scene interactively and in real time*. The goal of AR is therefore to reject the segregation of the viewer into a completely artificial environment—as in Virtual Reality (VR) systems, for example—proposing instead a different experience that integrates virtual informational elements with the specific material

[35] Lev Manovich, "The Poetics of Augmented Space," *Visual Communication* 5, no. 2 (2006): 219. The essay is an updated version of "Poetics of Augmented Space: Learning from Prada", originally written in 2002, updated 2005. See Lev Manovich official website: http://www.manovich.net/TEXTS_07.HTM (accessed December 2015).

spaces we live in. The experiential result of the convergence process is what Manovich names "augmented space," which he defines as "the physical space overlaid with dynamically changing information, multimedia in form and localized for each user."[36] The author derives the term "augmented space" from the established term augmented reality (already employed in scientific literature[37]). Nevertheless he sees AR, and implicitly augmented space, not as a strictly defined technology, but as a model of visuality concerned with the intertwining of the real and virtual:

> If we assume that the overlaying of different spaces is a conceptual problem that is not connected to any particular technology, we may start to think about which architects and artists have already been working on this problem. To put it another way, the layering of dynamic and contextual data over physical space is a particular case of a general aesthetic paradigm: how to combine different spaces together. Of course, electronically augmented space is unique – since the information is personalized for every user, it can change dynamically over time, and it is delivered through an interactive multimedia interface, etc. Yet it is crucial to see this as a conceptual rather than just a technological issue – and therefore as something that in part has already been an element of other architectural and artistic paradigms.[38]

Indeed, it is hard to believe that AR appeared in a void or that its emergence is strictly related to certain advances in technological research. As I will later demonstrate, AR—at least as an artistic manifestation–is informed by other previous attempts to merge real, fictional, body and image in a unitary perceptual entity (especially by installation art and VR art). Moreover, as many authors have noticed, AR proves to have important connections with the larger post-desktop philosophy and practice of embedding artificial intelligence into the everyday

[36] Ibid., 219.
[37] For more details about the use of this term in scientific literature dedicated to AR, see the following sections.
[38] Lev Manovich, "The Poetics of Augmented Space," 225-6.

environment (examples include mobile technology, locative media, ubiquitous computing, biofeedback, GPS-based devices, and electronic billboards). However, while AR art is part of these larger typologies, its specific way of blending (and not only juxtaposing) reality and virtuality in real time and in a localized manner is unique and thus indicates the possibility of a different spatial practice. The legitimate question that follows is to what extent this reality-virtuality convergence has a particular impact on a user's experience of space? Is this the mark of a different visual regime? Or, in other words, does the process of consolidating different—and differently situated—fragments of real and virtual spaces into a single—although discontinuous—"multimedia" space-image amounts for a perceptual and aesthetic paradigm change?

It is the goal of this chapter to answer these questions by scrutinizing the conceptual and technological framework of AR through several key definitions offered by scientific literature and by analyzing some of the most representative artworks subsumable under the generic term of AR. I evaluate and comment on these definitions and examples using the term AR in a broad sense, beyond specific technological restrictions. It is my contention that AR is an aesthetic problem rather than a strictly defined technology—although the technological factors play a key role in every AR work. While the various artistic projects discussed here are quite different with regard to their technological functionality, they are connected by their common preoccupation for creating a convergent space. That is, these projects aim to abolish as much as possible the distance in both time and space between reality and virtual information. This is what I call here the *convergence process*. However, as I will demonstrate in this thesis, the realization of this supposed continuum is somehow problematic since AR is never perfectly continuous spatially or temporally. AR space arguably remains in part spatiotemporally heterogeneous. It is not and

should not be seen as a "space of interaction" that simply connects but does not *integrate* real and virtual elements. Unlike other non-AR media projects, AR does not simply place the real and virtual spaces in an adjacent position (or replace one with another), but makes them perceptually convergent. Thus, defined by the coexistence and superimposition of real and virtual, a way to understand the convergence process is to see the AR and the perceptual spaces it produces as a hybrid form.

In spite of its overuse in recent art, media, social science, and communications literature, the term hybridity remains significant. In the present context, it explains AR's capacity to link various media and to blend forms, meaning, author, and audience within a framework of what media theoretician Edmond Couchot calls a "transversal aesthetic," understood by him as "a technological process specific to interactivity" and to subject-machine interaction.[39] Articulated in these parameters, as the following examples will demonstrate, AR's intricate topology reveals it to be not only the place of integration, but also of possible tensions. These tensions emerge between AR's material and virtual components, between stability and change, between temporal actualization and delay, and between perceptual continuity and discontinuity of space. It is in this double sense that the concept of hybridity should be read here: as an oscillation between a disjunctive and heterogeneous fragmentation and a synthesizing homogenization of the perceived space. The convergence effect is therefore the momentary appearance of continuity that will never take full effect for the viewer, given the internal (perhaps inherent?) tensions between the ideal of seamlessness and the mostly technical inconsistencies in the visual construction of the pieces.

[39] Edmond Couchot, "Digital Hybridisation: A Technique, an Aesthetic," *Convergence: The International Journal of Research into New Media Technologies* 8, no. 4 (2002): 19.

The goal of this chapter is to give substance to these assumptions through discussion of a few representative AR examples. The aim is to see to what extent we can speak—if any at all—about AR as a different perceptual and aesthetic paradigm of spatial imaging.

I begin with a review of several definitions of AR proposed by engineers and computer scientists, since it is in the technological and scientific literature where some of the foundational assumptions about AR were made. These definitions will open the way toward describing and analyzing some of the most representative AR artworks as they can provide a more comprehensive indication of AR's defining perceptual and aesthetic characteristics. Introducing AR in "two steps," one more technical, seen from the perspective of IT development and prospective technical research and one more artistic as it unfolds in a number of media artworks, is not meant to frame AR as a phenomenon developed dialectically or deterministically. If a certain discrepancy persists between the historical account of AR in information design circles and its account in the new media art world, this shows that no easy conjunctions and identifications can be made with regard to AR. What is needed for our analysis is not a simple technological evaluation, but indeed a "transversal aesthetic" reading of AR—where AR is seen as a perceptual paradigm, as a set of technologies, and as a process of interaction. This explains my use of a mixed methodological approach—one that includes computer science, media studies, and a phenomenologically inspired aesthetics. However, I consider it important to keep a constant eye on the idea of spatiality as it is conceived and negotiated equally by technologists and artists and to observe how technology, technique, and technicity participate in the definition of space in the practice and theoretical envisioning of both groups of researchers. It is useful to specify, on the other hand, that the scope of the present chapter remains anchored in the concreteness of the media objects given as example (artworks or not), thus leaving for the

following chapters a more thorough exploration of: the phenomenal appearance of continuity, aesthetic experience, and essential concepts such as reality and virtuality. For the moment, let me simply state that the terms real and reality (and their derivations "real space" and "real world") are used here with reference to the material or so called physical world we live in. The terms virtual and virtuality refer to physical entities too, but of a different nature; more precisely, they are used here in connection with the video streams and/or digital images or pieces of information that enter into the composition of an AR system.

1.2. From replacing to augmenting reality: computer scientists and designers' viewpoint

The term "augmented reality" was used for the first time in 1992 by a Boeing researcher, Tom Caudell, with reference to a see-through, head-mounted display system that allowed the viewer to perceive a computer-produced diagram superimposed and stabilized onto physical reality.[40] The term soon became widely used in scientific literature and popular media, being applied to various computer and mobile technology systems that were capable of overlapping real and virtual images. Certainly, some of AR's functional solutions and key concepts were outlined several decades before by technologists whose research findings and theorizations announced AR's principles and played an important role in the future development of this field. Nevertheless, it was the turn of the twenty-first century that witnessed the advancement of AR technologies and the consolidation of a specific vocabulary. In recent years, AR has become an

[40] See David Mizell, "Boeing's Wire Bundle Assembly Project", in: Woodrow Barfield and Thomas Caudell, eds., *Fundamentals of Wearable Computers and Augmented Reality* (Mahwah, NJ: Lawrence Erlbaum Associates Publishers, 2001): 452. The article Mizell makes reference to is: T.P. Caudell and D.W. Mizell, "Augmented reality: an application of heads-up display technology to manual manufacturing processes," 659-69, in: *Proceedings of The Twenty-Fifth IEEE Hawaii International Conference on Systems Sciences, 1992*, IEEE Press, vol. 2 (January 1992).

important set of research and visualization tools, with applications in many domains of activity, although its potential has yet to be fully explored.[41]

One of the first applications of AR technologies was in the development of display solutions for the flight simulators used for military training and spatial exploration. This development demonstrated AR's capacity to articulate a convergent perceptual space between reality and virtuality. Initially designed to provide total immersion in a virtual environment, flight simulators have found AR technology to offer a more efficient solution given its ability to combine physical space and three-dimensional computer graphics within a "live" experience. In the domain of medical imaging technology, AR is most often used for image-guided surgery. AR can help the surgical team to visualize the pre-operative imaging studies—such as Computed Tomography or the Magnetic Resonance Imaging scans—registered directly and correctly on the patient's body during the operation process, therefore enhancing the performance of the surgical intervention. Other scientific and business sectors such as manufacturing, maintenance industry, engineering design, and robotics use AR for special activities or interventions. For instance, when building a prototype or maintaining an unfamiliar piece of equipment, the technician can be assisted by an AR display instead of using a plan sheet or a repair manual. In the AR display, the image of the equipment is augmented with annotations and information pertinent to the specific intervention such as the location of different elements or inside views of the equipment. But AR is equally a viable option for non-scientific domains such as the entertainment industry and museums. One example of AR application for entertainment is *ARToolKit*.[42] This is a

[41] A short overview of the domains in which AR is applied is provided by Jim Vallino in "Introduction to Augmented Reality," *Department of Software Engineering Rochester Institute of Technology, Research and Professional Development: Augmented Reality*, http://www.se.rit.edu/~jrv/ (accessed December 2015).

[42] Introduced in 1999 by Hirokazu Kato and Mark Billinghurst, *ARToolKit* is made available freely as open source under the General Public License and is one of the most popular software library in the AR community. See Human Interface Technology Laboratory at the University of Washington, *ARToolKit*, http://www.hitl.washington.edu/artoolkit/ (accessed December 2015).

software library available for different applications (most of them games) that permits overlaying virtual imagery on the physical world in real time according to camera position and orientation relative to graphical square markers. Another major field where AR technology is frequently applied is museum information systems. A visitor to a museum may use AR equipment to retrieve computer-generated data, like curatorial information about the exhibition and the exhibited objects or touring instructions, in direct relationship with the configuration of the real space and the position of the mobile visitor. A relevant example is the Handheld Augmented Reality Project team's research dedicated to developing an electronic tour guide for museums based on a self-contained, inexpensive Personal Digital Assistant (PDA) that delivers fully interactive 3D AR information to visitors.[43] In recent years, researchers as well as industry and independent developers became increasingly interested in applying AR in the field of mobile communication technology. Affordable and efficient, mobile AR applications now seem to be the main direction of research in this area and the increasing number of applications available (commercially or shareware) for download for general use is a clear illustration of this development. Let us consider, for example, the "world browsers" Layar, Wikitude and Junaio.[44] Although based on different technologies these applications offer practically the same experience: as the user points a smartphone or a tablet towards a certain place in the real world, AR adds layers of digital information (videos, photos, sounds, graphics) directly on top of items in the world according to viewer's position and orientation. Two applications that use mobile AR potential should be mentioned at this point. One is *Historypin* (launched in 2011), a digital, user-generated archive of historical photos, videos, audio recordings and personal recollections made

[43] See Daniel Wagner et al, "The Handheld Augmented Reality Project," *Christian Doppler Laboratory, Graz University of Technology*, 2005-2007, http://studierstube.icg.tu-graz.ac.at/handheld_ar/marq.php (accessed December 2015).

[44] See Layar: https://www.layar.com/; Wikitude augmented reality SDK, http://www.wikitude.com/; The Junaio AR browser App, http://www.junaio.com/ (all sites accessed December 2015).

available via Google Street View.[45] The user is able to see historical images juxtaposed (or "pinned") on the exact location where they were taken, following the precise angle and scale. Thus, the user is able to make a comparison between how a location looked in the past and how it looks today. Even more interesting is that the user can experience the historical image in situ. As the user holds the Smartphone camera towards a location, the GPS finds the place and inserts a historical image according to the position and orientation of the camera. Other historical information is made available through the interface (accessible through buttons and links). Another similar application is *Streetmuseum* (2010). It functions in the same way as Historypin, with the difference that the application was conceived specifically and exclusively for London. The app guides users to various sites across London where hundreds of images of the city from the Museum of London's art and photographic collections, can be viewed in-situ, essentially offering the user a window through time. Similarly to Historypin, each image comes with bits of information about the scene to give users some historical content.

Fig. 1.1. *Historypin*: A global community collaborating around history. 2011. Application view.

[45] Historypin: A global community collaborating around history. http://www.historypin.com (accessed December 2015).

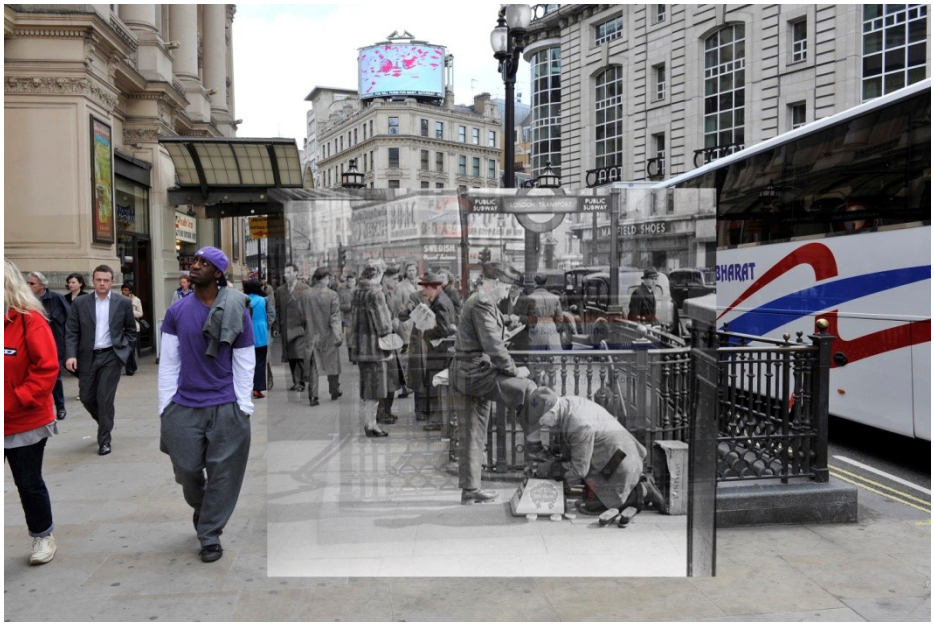

Fig. 1.2. *Streetmuseum*. 2010. Application for smartphone by The Museum of London.

Another spectacular mobile AR application is Google Glass: a wearable computer with an optical head-mounted display (OHMD) that is being developed by the search-engine company Google (the project was launched publicly in 2014). Google Glass displays information in a smartphone-like hands-free format, via a small transparent screen, and can communicate with the internet through natural language voice commands. Although the idea of AR glasses is not new, the great attention given to Google's device is primarily due to the great popularity of the company. Of course, this is an important benefit for AR, since this wide circulation effectively and efficiently pushes AR into the popular culture and public consciousness.

Artists have responded with enthusiasm and imaginative insight to the visual potential offered by AR, particularly to the advancements in the mobile AR field. The following chapters will discuss in more detail these developments. However, artists' approaches to AR technologies conceived and developed in laboratory environments are—despite their fertile potential—rather limited. Given the high costs implied and the sizable technical arsenal and human labour

required by most of these systems, the number of artistic AR projects developed so far in this area remains small.

Until recently, AR was for the most part defined as a concept, as a technological process and as a functional tool by the scientific literature. No doubt, it is in the engineers' labs and scientific research departments where crucial advances are made regarding AR technologies, both functionally and semantically. Thus, it is important to understand the technological apparatus of AR and the related terminology, as they give important insights into the organization and functionality of AR. But in order to have a complete image of the perceptual differences and artistic innovations proposed by AR we have to go beyond the strict technical provisions. AR should be understood from a larger perspective, one that includes its artistic expression, modus operandi and meaning; its role in visual (re)presentation and the ways it involves the viewer; its reception and effectiveness at the individual and social level; and its capacity to possibly lay the grounds for a different artistic medium.

Significantly, finding a comprehensive definition of AR—one that would encompass equally technical, aesthetic and experiential aspects—is not an easy task, given that AR is still a "work in-progress" project which, consequently, maintains around it an unstable terminology. AR is quite a problematic term since it is used "without what could reasonably be considered a consistent definition," as Paul Milgram *et al*. have previously observed—an observation that is still valid today.[46] This is largely because AR is an ongoing subject of technological and artistic research, a domain in full expansion, especially on the mobility "front," but which lacks full mainstream recognition and which still enjoys a certain underground status, *pour les connoisseurs*.

[46] Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum", *SPIE* [The International Society for Optical Engineering] Proceedings, Vol. 2351: *Telemanipulator and Telepresence Technologies* (1994): 283.

In the engineering and IT design fields, one of the first researchers to articulate a coherent conceptualization of AR is Ronald Azuma, who published in 1997 a seminal paper entitled "A Survey on Augmented Reality."[47] Its usefulness resides mainly in its speculation on potential directions of exploration, its gathering from many sources the most important information relative to AR technologies existing at the date of publication, and its comprehensive bibliography. His definition points to the essentials of AR:

> *Augmented Reality* (AR) is a variation of *Virtual Environments* (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it. Ideally, it would appear to the user that the virtual and real objects coexisted in the same space […]. *Augmented Reality enhances a user's perception of and interaction with the real world*. [my emphasis] [48]

It is important to remark that Azuma considers AR not as a specific technology, but as a set of technological operations that have three particular characteristics: they combine real and virtual, they are interactive in real time and they are able to execute registrations in 3D. Thus, one of the fundamental accomplishments of AR is the rejection of any visual solution that segregates the viewer into a completely artificial environment—no matter how credible that environment is—as in is the case of immersive VR. As the authors of a widely cited book on VR Ken Pimentel and Kevin Teixeira have written, "VR is more than a computer technology that

[47] Ronald T. Azuma, "A Survey on Augmented Reality," *Presence: Teleoperators and Virtual Environments* 6, no. 4 (August 1997): 355-385. Available from: Human Interface Technology Lab (HITLab), University of Washington. http://www.hitl.washington.edu/projects/knowledge_base/ARfinal.pdf (Accessed December 2015).
[48] Ibid.

places the user inside a 3D world; it's the artificial world itself and a new kind of experience. It's also a method of communicating ideas. Inside a virtual world, everything is potentially alive because the laws of reality are up to the designer."[49] Developing the same idea, the two authors write: "Virtual reality is all about illusion. It's about computer graphics in the theatre of mind. It's about the use of high technology to convince yourself that you're in another reality, experiencing some event that doesn't physically exist in the world in front of you."[50] It is this total abandonment to another reality that AR tries to surpass and which is critically addressed by Ronald Azuma and by most researchers in the field of AR. Nonetheless, illusion plays a key role in AR too, although the means and the effects are different from VR as the latter point to converging not disjoining the two orders of perceptual reality.[51]

Another important contributor to the foundation of AR as a concept and as a technological research field is industrial engineer Paul Milgram. He proposes a comprehensive and frequently cited definition of "Mixed Reality" (MR) via a schema that includes the entire spectrum of situations that span the continuum between actual reality and virtual reality, with "augmented reality" and "augmented virtuality" between the two poles.[52] His *Reality-Virtuality (RV) continuum* is illustrated as follows:

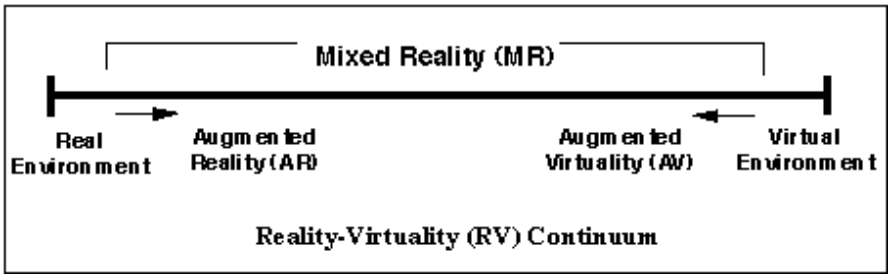

Fig. 1.3. Paul Milgram, Reality-Virtuality (RV) continuum.

[49] Ken Pimentel and Kevin Teixeira, *Virtual Reality. Through the New Looking Glass*, second edition (Blue Ridge Summit, PA: Windcrest/McGraw-Hill, 1995), xxi.
[50] Ibid., 7.
[51] These aspects will be discussed in more detail in Chapter four.
[52] Paul Milgram et al., "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum," 283.

The two reference points at the extremes of this schema are considered less equivocal, so Milgram explains them in these general terms:

> The commonly held view of a VR environment is one in which the participant-observer is totally immersed in a completely synthetic world, which may or may not mimic the properties of a real-world environment, either existing or fictional, but which may also exceed the bounds of physical reality by creating a world in which the physical laws governing gravity, time and material properties no longer hold. In contrast, a strictly real-world environment clearly must be constrained by the laws of physics.[53]

As the author concedes, the major challenge in this schema is to distinguish between AR and Augmented Virtuality (AV). The main criteria for establishing this difference could be the display solutions (in Milgram's examples, either "see-through" or "monitor-based" displays). Milgram believes these criteria to be insufficient and proposes that a better way to support such distinction is to consider a parallel continuum, one that refers to the "Extent of World Knowledge (EWK)." This is the extent of knowledge present within the computer about the world being presented (as the author explains in a later version of the 1994 article[54]): the presence and the extent of meaning and information attributed to the world objects by the computer—their location in space, the position and viewpoint of the observer within that area, or, when relevant, the viewer's attempts to manipulate objects within that space. Therefore, the extended schema proposed by Milgram looks as follows:

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[53] Ibid.

[54] Paul Milgram and Herman Colquhoun Jr., "A Taxonomy of Real and Virtual World Display Integration," 1-16, in *Mixed Reality - Merging Real and Virtual Worlds*, eds. Yuichi Ohta and Hideyuchi Tamura (Tokyo: Ohmsha; Berlin: Springer Verlag, 1999). Online at Ergonomics in Teleoperation and Control Laboratory (ETC) at the University of Toronto, "Publications": Milgram, P. and Colquhoun, H (1999), 2: http://etclab.mie.utoronto.ca/publication/1999/Milgram_Colquhoun_ISMR1999.pdf (accessed December 2015).

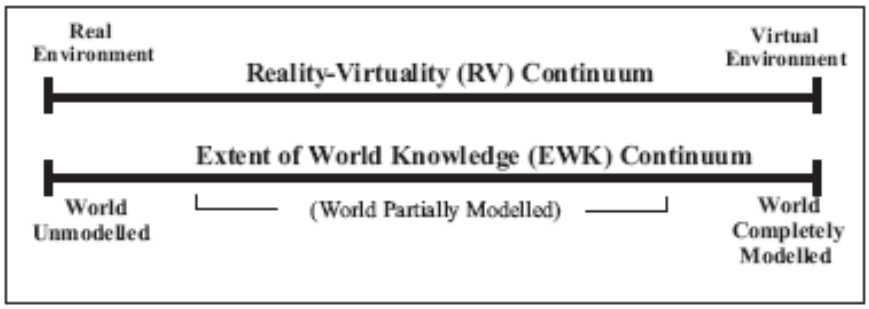

Fig. 1.4. Extent of World Knowledge (EWK) Continuum.

The practical importance of this second criterion for constructing the continuum is to establish the defining "substratum," as Milgram calls it. The substratum is the principal scene on which the augmentation is built: either the real environment augmented with computer-generated enhancements (AR) or the principally virtual environment augmented through the use of real (i.e. unmodelled) imaging data (AV). Increasing the knowledge of the substratum through consistent measurements will permit the system to make the graphical image appear in its proper place – not as an arbitrary projection on the real world, but as an integrated visual element superimposed on top of a corresponding real-world object within an acceptable margin of error.

The principal merit of the taxonomy proposed by Milgram is that it articulates a coherent general framework of discussion about environments that propose to converge the real world and virtual information, while underlining the essential role played by the interface in this perceptual spatial convergence. However, Milgram's "reality-virtuality continuum" schema has limitations when employed as a tool for theoretical analysis in fields other than those that are strictly related to computer research. So, two persisting questions remain: how can we define AR and AV more precisely? And how can we understand the differences between them and between these and MR in the absence of rigorous technical specifications and computational interpretations like the kind Milgram et al. discuss in their article? As I stated from the beginning, to define AR in strict

technological terms is a non-productive endeavor for a study—the present study—that proposes the exploration of AR as a perceptual phenomenon and not as a technology.

This technological identification process leads to the terminological problem implied by Milgram et al.'s schema. If Milgram and colleagues affirm that their approach of MR is motivated by the need for a more encompassing term to supplement the existing definition of AR, it is not entirely clear—again, beyond strictly technical details—which term encompasses what. Whether AR and AV are part of the broader field of MR remains an open question and possibly also a fertile terrain for exploration within a framework that includes aesthetic, visual, and media studies discussions (although such a taxonomic endeavour is beyond the scope of this study). It is important to highlight that with regard to questions of terminology in non-scientific literature, authors do not always explain a preference for either MR or AR. This suggests that the two terms are understood as synonymous, but it also provides evidence for my argument that, outside of the technical literature, AR is more of a concept than a technology. Here, I use the term AR instead of MR insofar as "AR" (and the integrated idea of augmentation) is better suited to capturing the convergence effect. As I will demonstrate in the following lines, the process of augmentation (i.e. the convergence effect) is the result of an *enhancement* of the possibilities to perceive and understand the world—through adding data that *augment* the perception of reality—and not simply the product of a mix. Nevertheless, there is surely something "mixed" about this experience, at least for the fact that it combines reality and virtuality, an aspect connected to the notion of hybridity.

All the same, it should be emphasized that the most important aspect of Milgram's contribution is the acknowledgment of the fact that AR is both an environment and a perceptual event placed along a *continuum* between real and virtual worlds. Azuma also discusses these

features, which he has formulated in terms of "*coexistence in the same space*" of the real and virtual.[55] As we have noticed above and as we will see below, the idea of continuum is the foundational assumption of any AR research and practice in information technology and of any theoretical interpretations that addresses AR within the same field—despite the problematic nature of this assumption. Milgram is actually quite clear about this: "AR can be regarded in terms of a continuum relating purely virtual environments to purely real environments."[56] Indeed, in AR virtual information is coextensive with reality; there is no such thing as dismissing the real in favour of an ideal view of a perfect and completely controllable artificial environment as in VR, for instance. The "redemptive" vision of a total virtual environment is replaced in AR with the open solution of sharing physical and digital realities in the same sensorial and spatial configuration. My interpretation of both scientific definitions and artistic contributions suggests that in AR the real is not denounced but reflected; it is not excluded, but integrated.

The research conducted by computer scientist Jim Vallino represents another pivotal contribution to the early development of the concept of AR and its supporting technologies. He writes:

> An augmented reality system generates a *composite* view for the user. It is a combination of the real scene viewed by the user and a virtual scene generated by the computer that augments the scene with additional information. […] The augmented reality presented to the user enhances that person's performance in and perception of the world. The ultimate goal is to create a system such that the user cannot tell the difference between the real world and the virtual augmentation of it. To the user of this ultimate system it would appear that he is looking at *a single real scene*.[57]
>
> [emphasis added]

[55] Ronald T. Azuma, "A Survey on Augmented Reality," Ibid.
[56] Paul Milgram *et al*., "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum," Ibid., 282.
[57] Jim Vallino, "Introduction to Augmented Reality," Ibid.

Two important aspects mentioned by Vallino should be emphasized: the idea of a composite view and that of a single real scene experienced by the user. Indeed, AR should be seen against any technological specificity as a means to enhance a person's performance in and perception of the world—a process in which the idea of continuum, however precarious its realization might be, is necessarily implied. Thus, unlike other simple exercises of media-based interaction (presupposed by non-AR installationist practices for example), in AR we are presented, as Vallino remarks, with a composite space that consists of continuous exchanges between two orders of reality, with the goal and subsequent effect of creating a single perceptual scene. As already noted here, such a process is not exempt from certain technical as well as aesthetic deficiencies. So, we should regard with caution Vallino's statement which asserts that the outcome of AR systems is the perfect integration of the real and virtual "such that the user cannot tell the difference between the real world and the virtual augmentation of it."[58] AR should be seen, in my understanding, not so much as the accomplishment of a technological development that provides a faultless assimilation of the virtual into the real or of the real into the virtual, but rather as a way to reinvent the perceptual experience by creating environments in which the two components are ingeniously and persuasively aligned; in other words, to conceive a convergent space of coexistence and of creative synthesis, however imperfect, between material reality and virtual information.

1.3. The effect is in the details: tracking, registration, and visualization systems

To have a comprehensive understanding of the *idea* of AR and of *how* it functions as a different perceptual paradigm, a few technical details are needed. Therefore, the goal of this

[58] Ibid.

section is twofold: first to sketch a short historical map of the AR technical developments and second to present the process of spatial convergence in a more technical light—that is, to understand the convergence process also from the perspective of the apparatus itself and its internal mechanisms. To understand means to have a glimpse into the extremely vast and intricate domain of AR technological research and design. Momentarily putting the spotlight on the technical aspects neither displaces the focus of my argument—the aesthetic dimensions of the process of spatial convergence in AR—nor subscribes to a technological determinist explanation of the AR experience strictly through the parameters of the apparatus. Certainly, AR's apparatus—platforms, display solutions, tracking systems, registration, occlusions, etc.—plays a central role in determining the forms and outcomes of the user's experience and consequently informs in a certain measure the aesthetic and socio-cultural interpretative discourse surrounding AR. But equally, the concept, destination, artistic intent, theme, and users' subjective ways of engaging AR inform and determine the evolution of technological research, commercial availability and shared accessibility—in short the development—of AR systems or platforms.

Take for example the display solutions: their evolving role within the AR domain and the preference given for some solutions over others illustrates precisely this dynamic. What is offered by developers is then modeled and improved by users. There are three main categories of interfaces used for AR experience: head-attached, spatial displays, and handheld.[59] In the first category are the HMDs—head-mounted-displays. These are complex visualization devices which, given their body-adapted features and optical or video "see-through" capability, permit

[59] For more details concerning the types and subcategories of AR display solutions, see: Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality. Merging Real and Virtual Worlds* (Wellesley, Massachusetts: AK Peters, 2005), 71-92; and Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum." Ibid.

the perceptual convergence of the real space and digital information with a great degree of accuracy.[60] In the second category are the projection-based or monitor-based solutions. In this case, the user does not wear the display device, but the combination of real space (or video image of real space) with virtual images is displayed on a monitor or video projection situated in front of the user or integrated into the setting.[61] In the third category are the mobile devices such as smart phones, tablets, laptops, or other personal digital assistants (including the recent experiments in AR eye-glasses or AR wristwatches) that provide the experience of a convergent real-virtual space using one or a combination of several options such as image recognition (or pattern) support, Global Positioning Systems (GPS), Internet access and wireless network (WiFi) connectivity.[62]

Often display solutions are equated—rhetorically and conceptually—with the idea of the interface. We should note that if display solutions are essential parts of the interactive experience, they are not the only elements that function as an interface for the AR experience. Other elements help to construct the AR experience, including the tracking devices, the material setup, the speakers, the joystick, the camera, the mechanical instruments, hardware, and the software. These components can play the role of an interface, as in the devices and equipments required for the good functioning of the medical, manufacturing, or flight simulator AR applications described above. This is to say that I take the concept of the interface in a larger sense, one that echoes the definition presented by media researchers Christa Sommerer et al. as the element that "defines the communication boundary between two entities;" an interface is the operational instrument that "provides the interconnection between the internal and the external

[60] See Ronald T. Azuma, "A Survey of Augmented Reality," *Presence: Teleoperators and Virtual Environments* 6, no. 4 (August 1997): 355-85. See especially the section "Optical vs. video."
[61] Ibid.
[62] For a more in-depth discussion of the aesthetic and phenomenological dimensions of the different types of display solutions, see Chapter 2 of the present study.

operation."[63] And, I would add, the interface provides an interconnection between reality and virtuality, locality and personalized information, intimacy and public interaction.

In the early nineties AR research privileged the use of the HMD, and to a lesser extent the projection-based interfaces for the development of mainly indoor systems. Once the mobile technology started to flourish by the end of the millennium, designers, computer scientists, and open-source contributors began to explore the possibilities of expanding AR experience with outdoor, mobile applications. Significantly, it is in the area of mobile technology where much of the recent AR research and implementation efforts are now focusing. Most of these efforts are directed at perfecting the display and/or the interface design and performativity—a trend that both generates and responds to users' needs, expectations, and effective contributions to content development. This change of development direction (reflected equally in industry, media communications, and art) brought a shift in preoccupations from prioritizing illusionism and immersion to privileging mobility and affordability. Of course, the main challenges and goals initially formulated (such as immersion, illusionism, and seamless integration) were not abandoned, but the possibilities of augmenting reality through wearable machines started to be considered as a more efficient way to "take [reality] into possession." In doing so, developers have assumed even greater variability concerning location, distances, web accessibility, timing, and number of users involved. As a consequence, new interface devices and new tracking and orientation systems considered to be better adapted to the mobile user have entered the scene: cell/smart phones, tablets, laptops, PDAs, GPS, gyroscopes, accelerometers, and image

[63] Christa Sommerer, Lakhmi C. Jain and Laurent Mignoneau, eds. *The Art and Science of Interface and Interaction Design* Vol. 1, (Berlin: Springer, 2010), viii.

recognition support. AR became, therefore, a specific expression within a larger trend of location-aware computational practice.[64]

In order to make virtual information visible in the real environment through the intermediary of an interface and to assign that piece of information to the right place, AR technologies use different tracking and registration systems. Along with displays and interfaces improvement, this is the other biggest challenge faced by computer scientists and designers. In AR, the tracking systems' role is to register a viewer's position in space as well as the physical features of the environment and then to instruct the system to render an augmented view from the user's new position while fitting the graphical elements as accurately as possible within the changing reality.

If we look back to the history of tracking technology, we find the work of computer scientist and AR pioneer Ivan Sutherland and his visionary ideas about the necessity of a closer connection between human movements, direction of view, and the digital output. Sutherland published in 1965 an influential essay, "The Ultimate Display," in connection with his research in immersive technologies, where he writes:

> The computer can easily sense the positions of almost any of our body muscles. So far only the muscles of the hands and arms have been used for computer control. There is no reason why these should be the only ones, although our dexterity with them is so high that they are a natural choice. Our eye dexterity is very high also. Machines to sense and interpret eye motion data can and will be built. It remains to be seen if we can use a language of glances to control a computer. An interesting experiment will be to make the display presentation depend on where we look.[65]

[64] For a short historical overview of mobile AR developments see Annex 1, "Historical landmarks in the development of mobile AR."

[65] Ivan E. Sutherland, "The Ultimate Display," *Proceedings of the International Federation of Information Processing Societies (IFIPS) Congress*, vol. 2 (New York, May 1965), 506-8.

The experiment Sutherland dreamed of has actually become reality; certain systems and applications that use the vast range of tracking techniques available today (in both VR and AR fields) are able to display the image depending on where one looks. If they are not yet ready to elaborate a "language of glances," as Sutherland envisioned, these systems nevertheless permit a closer connection between material space, human body, and digital image. Tracking technologies were initially developed in relation to VR experiments, and they remain a significant feature in this field. Building upon the achievements in the area of VR, AR research expanded the capabilities and the connective dimensions of the tracking systems to address the more unstable and dimensionally larger environments in the real world. Consequently, the technical challenges became considerably greater. The difference consists mainly in the fact that in VR the completely artificial environment is easier to control and adapt to the approximate position and orientation of the user's body. The possible errors are less discernible and better corrected when there are no fixed, material reference points. On the other hand, since virtual objects supplement rather than supplant the real world in AR, maintaining the illusion of the two worlds coexisting in the same visual field requires a more thorough registration and alignment of the virtual images to the real world. Any error in registration or calibration is more easily detected by the viewing subject. Besides tracking the viewer's position, an effective AR visualization system also requires the precise knowledge and careful mapping of the environment in which the augmentation takes place, whether this is a geometrically limited space (especially the case with indoor applications) or a geographically extended area (as in the mobile, mainly outdoor, applications).

So, to overcome these complex challenges a great array of tracking and registration systems—operating on very different technical principles, and having various performance

results—were experimented and implemented in the last two decades. Amongst the numerous solutions, mechanical, electromagnetic, and optical tracking systems are considered by many authors the most typical, especially for indoor applications. For the outdoor mobile applications, GPS became in the recent years the prominent tracking technology.[66] But, like the display solutions, tracking systems of any type have their qualities and downsides regarding efficiency, accuracy, optical quality, and responsive capabilities. As explained in Annex 2, GPS-based systems are able to cover large geographical areas, but their disadvantage consists in GPS's limited accuracy—10 to 30 meters. While acceptable for general use, this limitation is a problem for a system that needs accuracy and close control. Another example would be the marker-based tracking systems which are very effective in delivering a rigorous augmentation, but which are unproductive for outdoor, nomadic applications. Therefore AR frequently uses hybrid tracking systems that combine two or more solutions in order to compensate for the weaknesses of individual tracking technologies, consequently strengthening the visual effect.

This brief excursus through the technical features of augmentation instruments reveals one important aspect, namely, that AR—as technology and as experience—is a twofold process. Augmenting reality means equally adding information to the perceptual field *and* extracting data from the user's environment and the body's interaction with that environment. As Lev Manovich explains in his essay "The Poetics of Augmented Space," the real space is transformed in data space by "extracting data from it (surveillance) or augmenting it with data (cellspace, computer displays)."[67] Thus, image display, data rendering, tracking, registration, and occlusion are

[66] See Siyka Zlatanova, "Augmented Reality Technology," *GISt Report No. 17*, Delft University of Technology, Section GIS technology, Faculty of Civil Engineering and Geosciences. Delft, December 2002. www.gdmc.nl/zlatanova/thesis/html/refer/ps/GIST17.pdf (accessed December 2015).
[67] Lev Manovich, "The Poetics of Augmented Space," 222.

various methods, instruments, and solutions to control and manipulate both real materials and virtual resources.

1.4. Converging spaces in the artistic mode: between continuum and dis-continuum

One common opinion shared by all the scientists and computer designers discussed above is that AR's main feature is the ambition or the capacity to establish a perceptual intertwining of the real and virtual worlds into a *single* scene. The technological developments described here and the artwork examples discussed below reflect precisely this ambition. This opinion actually confirms my assumption that convergence is the basic principle of any AR experience, and its outcome is negotiated in the user-machine encounter with various degrees of success and sustainability, fluctuating between continuity and discontinuity. Again, we should consider the idea of convergence as a guiding principle beyond its pure instrumentality and technicality (if not commerciality)—that is, beyond the vision of performative details and interface "solutions" animating the imaginary of the engineers and designers of the '80s and '90s. The short review of scientific literature above has first and foremost a historiographic value. Whether artists share the same vision of AR as the engineers and computer scientists, and, consequently, whether these two groups share an envisioning of AR as a different perceptual paradigm is a question to be addressed throughout this study.

The following artworks are representative for AR precisely for their capacity to illustrate across various technologies and techniques the idea of a perceptual convergence between real and virtual spaces: *Living-Room 2* (2007) by Jan Torpus, *Under Scan* (2005-2008) by Rafael Lozano-Hemmer, *Conspiracy Theory* / *Théorie du complot* (2003) by Janet Cardiff and George Bures Miller, and *The Golden Calf* (1994) by Jeffrey Shaw.

Fig. 1.5. Jan Torpus, *Living-Room 2*. 2007. Immersive AR installation. General view and screen capture.

Living-Room 2 (2007), is an immersive AR installation realized by a collective under the coordination of Jan Torpus.[68] The work consists of a built "living-room" with pieces of furniture and domestic objects that are perceptually augmented by means of a "see-through" Head Mounted Display (HMD) that permits the viewer to perceive both worlds at the same time.[69] Particular attention is paid to the participant's position in the room: a tracking device measures the coordinates of the participant's location and direction of view and performs occlusions of real space and then congruent superimpositions of 3D images upon it.[70] The user can select different augmenting "scenarios" by interacting with both the physical interfaces (the real furniture and objects) and the graphical interfaces (provided as virtual images and text panels positioned in the visual field of the viewer, and activated via a handheld device). For example, in one of the

[68] Jan Torpus: project management, research and design. University of Applied Sciences Northwestern Switzerland (FHNW), Academy of Art and Design (HGK), Institute for Research in Art and Design (IDK), Basel, Switzerland, 2007. See: *Living Room 2*, http://www.torpus.com/ (accessed December 2015).

[69] An HMD is basically a helmet-like device with two small binocular displays positioned right in front of the wearer's eyes. The three-dimensional augmented perspective offered is based on two different technologies: *video see through* (which makes use of video-mixing and which displays captured real images mixed in the computer with virtual images) and *optical see-through* (which make use of optical combiners – essentially half-silvered mirrors or transparent LCD displays). See Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality. Merging Real and Virtual Worlds* (Wellesley, Massachusetts: AK Peters, 2005), 74.

[70] For more details regarding the work's tracking systems, spatial calculations, occlusions, shadow perception, light position, objects and user positioning information, calibration and real-time rendering, see "Research topics" and "Content development and design process" in *Living Room 2*, http://livingroom.idk.ch/ (accessed December 2015).

scenarios proposed, the user is prompted to design his/her own extended living room, by augmenting the content and the context of the given real space with different "spatial dramaturgies" or "AR décors." These are different "natural" environments, with grass fields, trees, stones, etc. selected by the user and integrated into the real space of the living-room to create an illusionistic, though imperfect, augmented spatial environment. Another scenario offers the possibility of creating an "Ecosystem"—a real-digital world perceived through the HMD in which strange creatures virtually invade the living-room intertwining with the physical configuration of the set design and with the user's viewing direction, body movement, and gestures. The user's interaction with these pseudo-creatures—correlated with physical areas and objects (wardrobe drawers, ventilator, lamps) and prompted into the visual field by sensors installed on these objects—produces a fantastic symbiosis between the real living room and the virtual "living" things. In this sense, the title of the work acquires a double meaning: "living" is both descriptive and metaphoric. As Torpus explains, *Living-Room* is an ambiguous phrase: it can be both a living-room and a room that actually lives; his observation suggests the idea of continuum and immersion in an environment where there are no apparent ruptures between reality and virtuality. Torpus goes on to note that, "in 'Living-room2' the [real] space itself becomes the object of transformation. In the virtual layer, the room can be visually transformed, reconstructed, extended, etc. Thus, the user becomes part of an immersive environment."[71] Of course, the idea and the practice of immersion are in these circumstances not about the creation of a purely artificial secluded space of experience like that of the VR environments, but rather about a dialogical exercise that unifies two different phenomenal levels, real and virtual, within a (dis)continuous environment (with the prefix "dis" as a necessary provision). Ron Burnett's observations about the instability of the dividing line between different levels of experience—

[71] Jan Torpus, "Context/Content, The Project," *Living Room 2*. http://livingroom.idk.ch/ (accessed December 2015).

more exactly, of the real-virtual continuum—in what he calls immersive "image-worlds" have a particular relevance in this context:

> These experiments with immersion bring the questions of direct interaction with virtual and real worlds into question and raise important issues of where the dividing line is between different levels of experience in image-worlds. Rather than thinking about oppositions here, virtual images need to be approached as one of many *levels* of experience for viewers. Viewing or being immersed in images extend the control humans have over mediated spaces and is part of a perceptual and psychological continuum of struggle for meaning within image-worlds. Thinking in terms of continuums lessens the distinctions between subjects and objects and makes it possible to examine modes of influence among a variety of connected experiences.[72]

It is precisely this preoccupation to lessen any (or most) distinctions between subjects and objects, and between real and virtual spaces, that lies at the core of every artistic experiment under the AR rubric. The fact that this distinction is never entirely erased—as *Living-Room 2* proves—is part of the very condition of AR. The ambition to create a continuum is after all not about producing perfectly homogenous spaces, but, as Ron Burnett points out, "about *modalities* of interaction and dialogue" between real worlds and virtual images.[73]

Another modality of creating a spatial continuum between reality and virtuality—but this time in a non-immersive fashion, occurs in Rafael Lozano-Hemmer's *Under Scan* (2005-2008). The work, part of the larger series *Relational Architecture*,[74] is an interactive video installation conceived for outdoor and indoor environments and presented in public spaces in London, Leicester, Northampton, Nottingham, and the 2007 Venice Biennale. It is a complex system comprised of a powerful light source, video projectors, computers, and a tracking device. The

[72] Ron Burnett, *How Images Think* (Cambridge and London: The MIT Press, 2004): 113.
[73] Ibid.
[74] Rafael Lozano-Hemmer, *Under Scan* (2005-2008), http://www.lozano-hemmer.com/ (accessed December 2015).

powerful light casts shadows of passers-by within the dark environment of the work's setting. A tracking device indicates where viewers are positioned and allows the system to project various video sequences onto their shadows. Shot in advance by local videographers and producers, the video sequences show full images of ordinary people acting freely, but watching the camera. As they appear within pedestrians' shadows, the figurants interact with the viewers, moving and establishing eye contact. When a viewer moves away, the video-character reacts accordingly by seemingly losing interest and looking away, then disappearing. Every seven minutes, the installation reveals its structure (technical components and modus operandi) by projecting over the public space a graphical, "explanatory" grid.

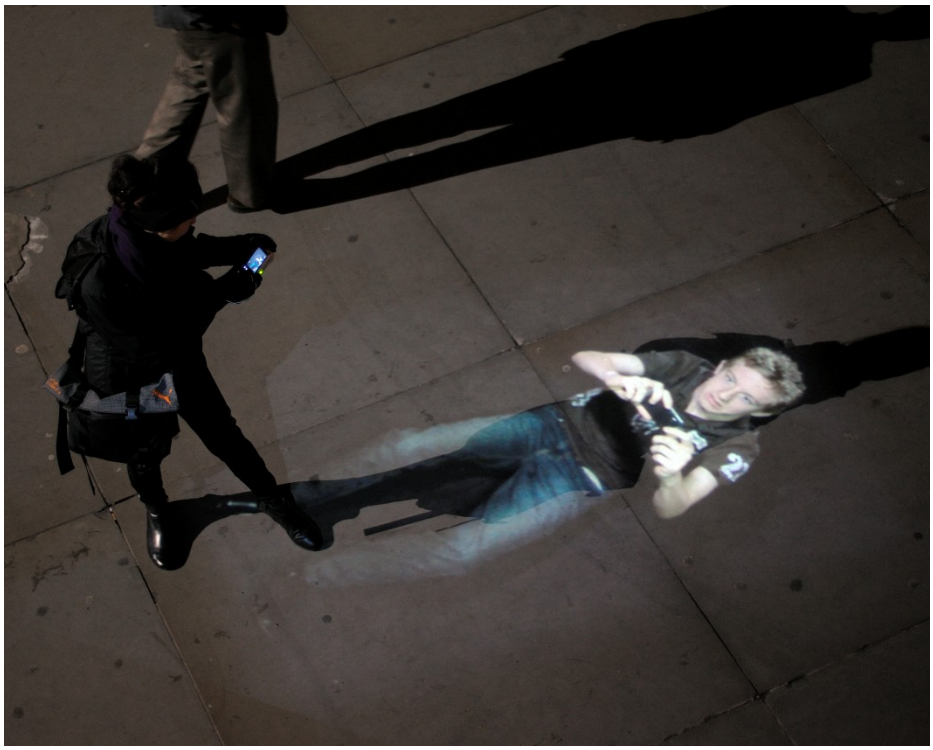

Fig. 1.6. Rafael Lozano-Hemmer, *Under Scan*. 2005-2008. *Relational Architecture 11.* Interactive AR installation. Picture: Trafalgar Square, London, United Kingdom, 2008.

One of the most interesting attributes of this work with respect to the question of AR's (im)possible perceptual spatial continuity is its ability to create an experientially stimulating and

conceptually sophisticated play between illusion and subversion of illusion. In *Under Scan*, the integration of video projections into the real environment via the active body of the viewer is aimed at tempering as much as possible any disparities or dialectical tensions—that is, any discontinuities—between reality and virtuality. Although non-immersive, the work fuses the two levels by provoking an intimate but mute dialogue between the real, present body of the viewer and the virtual, absent body of the figurant via the ambiguous entity of the shadow. "Being "under scan," the viewer inhabits both the "here" of the immediate space and the "there" of virtual image: "the body" is equally a presence in flesh and bones and an occurrence in bits and bytes. But, however convincing this reality-virtuality pseudo-continuum would be, the spatial and temporal fragmentations inevitably persist: there is always a certain break at the phenomenological level between the experience of real space, the bodily absence/presence in the shadow, and the displacements and delays of the video image projection.

An essential role in this game between continuity and discontinuity—between illusion and its subversion—is played by the shadow. The latter is employed here not only as a means of visualization, but also as a conceptual instrument or, more precisely, as a tool that generates a *mise en abyme* effect.[75] A shadow is in a certain sense an illusion; *umbra* (Latin for shadow) refers to a double or a ghost. Shadow is sometimes seen not as a dark side or an outline of a body, but as another corporeal being, which keeps traces of the human's soul or being.[76] Thus,

[75] In his groundbreaking book *The Mirror in the Text,* Lucien Dällenbach defines *mise en abyme* as "any internal mirror that reflects the whole of the narrative in simple, repeated or 'specious' (or paradoxical) duplication." Lucien Dällenbach, *The Mirror in the Text,* trans. Jeremy Whitely and Emma Hughes (Chicago: University of Chicago Press 1989): 43. It is quite significant that Lozano-Hemmer names as his main influences when realizing this project some of the well known examples of *mise en abyme*-based artworks: the play within a play in *Hamlet*, Borges' *The Library of Babel* (a universe consisting of an endless interlocking hexagonal rooms, with shelves and books), Jan van Eyck's *The Arnolfini Marriage* from 1434 in which the main scene is reflected from a reverse angle by a convex mirror situated in the same scene, Velázquez's *Las Meninas* (1656) where the artist is seen painting that very painting (the scene shown on the canvas).

[76] Victor I. Stoichita, *A Short History of the Shadow* (London: Reaktion Books, 1997); see especially Chapter one, "The Shadow Stage."

the shadow is the mark, the trace of a body, the negative side of a presence. It is negative not only in a qualitative sense, but also in the literal sense of the word, since the shadow is the black spot, the absence, the opposite, or the "antonym" of a body. But a shadow is also a way of bringing reality into representation; it was the basis for portraits and according to Pliny in his *Natural History*, painting was born when the human shadow was outlined on a surface. Shadow is also an element of knowledge, as described in Plato's myth of the cave (in *The Republic* 517-19). But in all of the meanings, shadow remains a projection, an illusion. What is more, in *Under Scan* the illusionistic reality of the shadow is transcended (i.e. augmented) by another illusion—that of the video images. An illusion placed *en abyme* by another one, a projection contained into another projection. The video portraits projected in one's shadow induce a fantasy of one's alter ego who is apparently alive, yet mute, on the ground. But at the same time the projected images unveil their own lack of plausibility: how can a shadow be alive, how can I see myself reflected in another person, and to what extent we actually communicate? What counts nonetheless in *Under Scan* is the complex visual and experiential articulation that breaks the boundaries between signifier and signified, between reality and virtuality, while undermining its own verisimilitude and calling attention to its own artifice.

Indeed, the self-reflexive strategy of the *mise en abyme* has yet another facet, described by André Gide as the representation within a work of art of that work's structure.[77] In other words, when a work turns towards itself, when it becomes aware of its existence, when it shows its own organization. In our example, this situation is represented by the short intermezzo of the grid (appearing cyclically at each 7 minutes) when the work reveals its structure, foregrounding the means and processes of its own production. Something reminds us at regular intervals that we

[77] André Gide writes in his *Journal* from 1893: "J'aime assez qu'en une œuvre d'art on retrouve ainsi transposé, à l'échelle des personnages, le sujet même de cette œuvre par comparaison avec ce procédé du blason qui consiste, dans le premier, à mettre le second en *abyme*." André Gide, *Journal 1889-1938* (Paris: Gallimard, 1948): 41.

are actually part of an illusion or game. This alternation between reality and fiction, an intrusion of non-diegetic into diegetic, is the perfect mark of self-reflexivity. This effect is the manifestation of the dialectical play between transparency of the medium (the realistic scaled images projected live) and opacity of the medium (the medium revealed as an illusion, the medium that speaks about itself).

The play between illusion and its subversion is at the core of another AR work, although its formal aspect, its conceptual strategy, and the ways it instrumentalizes the convergence process are quite different from the previous works examined above. *Conspiracy Theory / Théorie du complot* (2003), by Janet Cardiff and George Bures Miller is part of the artists' "Walks" series. The project was commissioned and produced by the Musée d'art contemporain de Montréal (MACM).[78] The work entails the experience of an individual user walking through the spaces in and adjacent to the MACM. The user is provided with a video camera, which plays a previously shot video recording of 16 minutes and 40 seconds, and a set of headphones with binaural recording. Equipped with camera and headphones, the user begins the walk at a precise location within the MACM and then follows Cardiff's voice guidance while viewing the video on the camera screen. As the walk develops, the user interacts with the surrounding public space "appropriated" as an effective part of the work: museums corridors (including spaces that are usually reserved for employees), an underground shopping concourse, a parking garage, and the museum's entrance hall. Indications about location and directions to follow are intermingled in the headphones with a bizarre narrative about conspiracy, murder, disappearances, and chasing—a story described by the authors as "more of a stream-of-consciousness type of piece where you

[78] Janet Cardiff and George Bures Miller, Artworks: Walks, *Conspiracy Theory /Théorie du complot*, 2003, www.cardiffmiller.com/artworks/walks/conspiracy.html (accessed December 2015). A related work is *Alter Bahnhof Video Walk* (2012) that offers the viewer a walking experience between reality and virtual image, past and present time in a train station in Germany, through the use of an iPod.

wander through a maze while different scenes unfold."[79] Writing about Cardiff and Miller's "Walks" in his essay "The Poetics of Augmented Space," Lev Manovich states that "their power lies in the interactions between the two spaces – between vision and hearing (what users are seeing and hearing), and between present and past (the time of the user's walk versus the audio narration, which, like any media recording, belongs to some undefined time in the past)."[80] Indeed, the most fascinating aspect of the work is the way in which it creates osmosis between the temporally and aesthetically different, but phenomenologically almost indistinguishable, layers of expression and meaning. One is the real space, the setting of the work and its real-life activity perceived live by the wandering user; the other is the same setting recorded in advance, rendered as a mediated video image in the camera screen, and therefore functioning as an incongruous occurrence, since inevitably people, sounds, and actions perceived now and those present at the moment of the recording are not the same. Then, there is the fictional story that works as a catalyst for and a deviation from experiencing the real setting of the work. The material reality of the setting, the recorded and consequently delayed reality, and the fictional story are therefore fused and confused in a convergent space of real-virtual perceptual (dis)continuity.

[79] Ibid.
[80] Lev Manovich, "The Poetics of Augmented Space," 226.

Fig. 1.7. Janet Cardiff and George Bures Miller, *Conspiracy Theory/Théorie du complot*. 2003. Performative mobile AR.

Speaking in a dialogue with independent film-maker Atom Egoyan about the complex operations of connecting and disconnecting the separate worlds we encounter, Janet Cardiff recounts: "I do think that unconsciously the walking pieces are a strange attempt to join our separate worlds through a mediated one, to create a symbiotic relationship between the participant and my voice and body but also to heighten the senses so that you can experience or be part of the environment in which you're walking."[81] Surely, Cardiff & Miller's "Walks" create convincing, although quite disturbing, conjunctions between real and virtual worlds, between the physical presence of the user's body in the real environment and the vicarious presence of the artist's body implied by the aural recital heard in the headphones—that is, between direct and mediated experiences. To build such continuities, no sophisticated tools are involved: the ostensible perceptual convergence between the spaces on and off screen is obtained by the spatial experiential alignment of the user's trajectory in the real space with the route performed beforehand by the artist and the walking directions indicated in the audio component.

[81] Atom Egoyan, "Janet Cardiff," *Bomb* magazine 79, (Spring 2002), http://bombsite.com/ (accessed December 2015).

But the "Walks" effectively complicate such relations and undermine such convergences. Relying on partial immersion (only at the aural level) and maintaining a clear difference in scale between the image of the real environment perceived directly by the user and that mediated by the screen, the work always reminds us that we are actually part of a fictional game. The discrepancies are most evident in this piece in the temporal discontinuity between the present tense of the experience in-situ and the anterior moment of the video recording and between these two and the third, fictional, temporality of the narration. Indeed, while relying on an aesthetic strategy that presupposes present-ness and immediacy, this work, like the other AR projects, actually emphasizes at the perceptual level the glitches and the incommensurability of various temporalities. Such a complex articulation between material world, virtual image, and fictional story belongs to an AR aesthetic strategy which, as Christine Ross argues,

> […] temporalizes perception by holding up immediacy in real time, removes the goal of perfect virtual/real alignment to devise a space-time in which an unexpected change might happen. As such, it must be seen as contributing to a regime of historicity that privileges the immediate present – but only if we understand the latter as constitutive of a form of lagging and as an undirected search for the possibility of a different future.[82]

Conspiracy Theory is an expansion of immediacy, a space-time in which unexpected change in the real world, in the mediated reality, and in the eventful story might happen anytime. That is to say, this work is a simple but ingenious artistic exercise that reflects and elaborates aesthetically and perceptually on the unstable role of technology in enhancing and destabilizing reality.

Jeffrey Shaw's *The Golden Calf* (1994) is another AR artwork that engages with the problem of real-virtual spatial convergence as a play between perceptual continuity and

[82] Christine Ross, "Real Time, Lived Time: AR Art, Perception, and the Possibility of the Event," in: *Precarious Visualities: New Perspectives on Identification in Contemporary Art and Visual Culture*, Olivier Asselin, Johanne Lamoureux, and Christine Ross, eds. (Montreal and Kingston: McGill-Queen's University Press, 2008): 334.

discontinuity. This project, perhaps more evidently than in other examples, presents AR technologies and the very idea of representation in a critical manner, as a fascinating yet questionable phenomenon. The work is a relatively small-scale installation featuring an empty white pedestal to which an LCD color monitor is attached with a cable. To experience the work, the user should pick up and hold the monitor in his/her hands and move it around the pedestal. Once pointed at the pedestal, the screen reveals the image of a computer-generated model of a golden calf standing on top of the pedestal, which can be seen from different angles according to user's position. The main effect of the work is based on the paradoxical appearance of the virtual calf that seems to be present in the real space. The illusionistic impression is strengthened by the fact that the body of the golden calf is conceived as a shiny mirror-like surface, whose "skin" reflects the image of the actual venue of the installation, therefore confirming work's site-specific nature. To obtain this effect, the image of the room is shot in advance with a fish-eye lens and then "reflection-mapped" onto the calf's body.[83] While the body of the viewer is not effectively present in this reflective image—although one would reasonably expect that—the viewer's image is somewhat integrated in the visual ensemble due to its partial reflection on the mirrored surface of the monitor, depending on lighting and angle.

Fig. 1.8. Jeffrey Shaw, *The Golden Calf*. 1994. Interactive AR installation.

[83] See Jeffrey Shaw, *Works*, http://www.jeffrey-shaw.net (accessed December 2015).

Commenting on the perceptual consequences of integrating the image of the real space of the gallery and the virtual object of the "golden calf," media philosopher Mark B. N. Hansen writes: "this virtual object […] becomes the projective center for a virtual panoramic representation of the space surrounding the viewer, and moreover, one that brings together past images (again photography's ontological function) with the present experience of the viewer."[84] Thus, the work becomes the converging place of presences and absences and of real spaces and virtual images. But to the same extent, it is also the locus of some uneven temporalities: the immediacy of the body's experience, the past moment of the artist's intervention to capture the image of the room, and the a-temporal dimension of the "golden calf."

If the work's complex technological artifice and mesmerizing realistic effects provide a great degree of visual accuracy, the alleged realization of an ideal real-virtual spatial convergence is inescapably short-circuited by the small inconsistency related to the mirror-like reflection on the object's skin. More precisely, the reflected space of the gallery cannot include the user's bodily presence (whose image is actualized only by the less effective analog mirroring on the screen's surface). Despite the persistence of a discrete gap between real and virtual realms, the work is able to sustain a compelling illusion of the convergent space in both formal and temporal terms. Playing at the limit between corporeality and incorporeality, object and subject, actual and symbolic, immediacy and anteriority, the work incites our perceptual capacity to distinguish between appearance and reality. Significantly, the title of the work makes reference to the biblical episode from *Exodus* 32 of the golden calf which was taken as an emblem of material worship rather than spiritual values. Consequently, *The Golden Calf* is an ironic commentary addressed to "old media" practices that supposedly produces unique artefacts,

[84] Mark B. N. Hansen, *New Philosophy for New Media* (Cambridge Massachusetts and London England: The MIT Press, 2004), 118.

to a fetishist audience, and to the market system that assigns disproportionate value to some art products.

Unique in its spectacular design and concept, *The Golden Calf* is an artistically more sophisticated and technically more advanced outcome of Shaw's longstanding preoccupations with the intermingling of real and virtual. An earlier manifestation of this concern is his *Viewpoint* (1975), a project which is worth noting for its visionary value.[85] As described by the author, the installation was constituted by two structural elements: a large "retro-reflective" projection screen and an optical viewing console that housed a pair of slide projectors. The console was provided with a semitransparent mirror that allowed both viewing the screen (as through a window) and redirecting the projected image from the screen via its mirroring surface back onto the screen. The projected images could be seen only from the console since the screen's reflective surface redirected all the light back to the projection zone.[86] Seen from any other position in the room the screen was a plain grey surface. Because of the reflective quality of the screen and the alignment realized between the brightness of the projection system and the ambient lighting in the museum, a coherent convergence of the projected images with the surroundings was achieved. More importantly the slide images showed exactly that part of the museum room hidden by the screen, thus creating what Shaw considers "a seamless continuity between the virtual and actual spaces."[87] What is remarkable is that the work achieved a spectacular fusion of reality and virtuality into a hybrid, convergent space with no digital artifice. Shaw obtained such a *trompe l'oeil* effect by exploiting the photographic image not as an

[85] The work was realized in collaboration with Theo Botschuijver, and it was shown at the 9th Biennale de Paris, at Musee d'Art Moderne, Paris, France, 1975. Jeffrey Shaw, *Works*, http://www.jeffrey-shaw.net (accessed December 2015).
[86] The twelve slide images shot in advance, show unusual scenes for a museum environment (at least) during visiting hours: a person sleeping on one of the museum benches, people building the projection screen, or a man smashing the windows with a pickaxe. Ibid.
[87] Ibid.

autonomous material element, but as a performative, spatially-integrated entity. However as Mark B. N. Hansen remarks, "while the architectural elements of *Viewpoint* are designed to encourage 'a strong illusory conjunction between the real and projected spaces,' the static form of the projected images functions to undermine just such a conjunction."[88] Despite the sophisticated spatial and optical arrangements designed to obtain a seamless image combining real and virtual, the work inevitably fails to attain a continuum because of the limits inherent to photography as a medium. The artifice is, nevertheless, assumed: the work offers just one viewpoint from which the illusion of spatial convergence works. Seen from any other angle, the work reveals its eye-deceiving condition. It is after all *trompe l'oeil*'s inescapable fate to be divulged and exposed in such a manner.

1.5. Non-AR technologies of interaction: confluences and divergences

The artworks described above and the AR works and applications that will be discussed further down in the present study were selected mainly for their capacity to illustrate what I consider to be the essence of the AR paradigm, namely the ability to provide a perceptual alignment of the real world scene and virtual images in a coherent, yet imperfect, convergent space. It is therefore precisely this feature—the ability to provide a perceptual convergent space—that makes these works representative for and constitutive of the AR model and relevant for defining AR as a specific perceptual paradigm and aesthetic object. I particularly emphasize this aspect since not *every* media artwork that engages interactively with real space and virtual information is necessarily AR. Given the unstable nature of AR as a concept, as technology, and as an artistic practice, many authors (writing equally from popular, technological or socio-

[88] Mark B. N. Hansen, *New Philosophy for New Media*, 62.

cultural perspectives) define AR either too broadly or too narrowly. In the field of art at least, there are numerous examples of media artworks that illustrate the differences between what I judge to be AR projects and other, non-AR artworks.

One of these projects, considered here precisely for its artistic merit, conceptual value and complex technical organization is *Text Rain* (1999) by Camille Utterback and Romy Achituv.[89] The work is an interactive installation which consists of a screen on which is projected in real time the black and white image of the viewer situated in front of the screen. On the projected silhouette of the viewer, color letters fall like snow and appear to land on his/her head and arms. The letters respond to the participant's motions and can be caught, lifted, and then let fall again. If a participant accumulates enough letters on his/her body, s/he will form words or even phrases from a poem about bodies and language. In this way, the work is able to transform—symbolically, but also quite literally—the act of reading from a pure mental exercise into an experience that also involves physical engagement. The most remarkable aspect of this real-virtual visual intersection is the realistic, yet uncanny relation the work establishes between the body of the viewer, mediated by the screen, and the immaterial elements which can be handled and controlled by the participant, regardless of the "ontological gap" between the two interacting realms. However, despite its intricate artistic and technical arrangements, its complex, interactive nature that merges the real presence of the body and the virtual image of the linguistic symbols, *Text Rain* is a work that cannot be included *stricto sensu* in the AR category. Taking into account my definition of AR as essentially a *spatial* and locational experiential entity, the work does not provide the conditions for a comprehensive spatial convergence. More precisely, like in other works of this kind, the local space is not included in the experience. Although

[89] Camille Utterback, *Projects: Text Rain*. http://www.camilleutterback.com/textrain.html (accessed December 2015).

interactive, the work is actually not site-specific, but *only* viewer specific. The expansion of reality into the virtual realm is determined—visually at least—solely by the discrete bodily presence of the viewer. As much as we accept the fact that "bodies produce spaces and spaces produces bodies,"[90] the convergence effect specific to AR is absent here. In so far as it activates only the circumstantial spatiality created by and through the participant's body, the work fails to address either conceptually or visually the contextual space and the specific location where the experience takes place—with all its cultural, historical or social components. It is precisely this lack that proves that this project—although an accomplished and artistically well articulated work—is a related manifestation but not an effective illustration of the AR paradigm.

Another example of an artwork that proposes an experience that both activates and reflects upon the protean border between reality and virtuality is Rafael Lozano-Hemmer's *Articulated Intersect* (2011). Part of the series "Relational Architecture" (like the above discussed example *Under Scan*) this work is a large-scale outdoor installation conceived for the Place des Arts in Montreal, Canada.[91] The installation consists of eighteen powerful light projectors which visitors are able to indirectly position to create sculptures of light in the downtown sky in real time. Six electromechanical levers, each connected to three projectors, can be manipulated by six participants. As a participant moves one of these levers, the respective light beams will automatically intersect in the sky to create an apex above that precise location. The participant may direct the apex anywhere over the city, creating an animated light tetrahedron (a form that, as the artist mentions, is inspired and pays homage to the work of scientist and architect Richard Buckminster Fuller). When two or more apexes intersect through

[90] Jason Farman, *Mobile Interface Theory. Embodied Space and Locative Media* (New York and London: Routledge, 2012), 19.
[91] Rafael Lozano-Hemmer, *Projects*: *Articulated Intersect, Relational Architecture 18*. http://www.lozano-hemmer.com/articulated_intersect.php (accessed December 2015).

the use of optical encoders, the lights stop reacting and engage in a pulsating autonomous animation for a few seconds. In these moments the levers are actually stopped by a mechanical clutch, therefore providing to the participant haptic feedback in the sensation that they are creating a remote light intersection. Visible over a radius of fifteen kilometers, *Articulated Intersect* becomes an open sculpture atelier where participants create personalized (although technically limited) light sculptures over the urban sky.

If this work is indeed able to create complicities between intimacy and public participation, and between the physical presence of the user and the virtual light sculpture, it nevertheless fails to produce spaces of perceptual convergence in the sense of establishing an AR-type perceptual intertwining of real and virtual worlds into a single scene. In this case, the experience is not based on "recognizing" the particular spaces where the interaction takes place. The intervention of the viewer is made through the rigid interface of the pre-installed levers and not through a "natural," user-adapted interface. Moreover, in what concerns the technology employed, unlike AR systems, here no tracking systems are used to address either the body or the environment of the user (whether fiduciary markers, GPS-based or natural feature tracking systems). As a consequence, the user is not the beneficiary of a unique real-virtual graphic overlay, but only of a physically and optically delegated experience taking place in whatever space. Following media historian William Uricchio, "the resulting information in AR systems is quite specific, with meaning assigned to particular locations and information provided that can serve as incentives to act."[92] However, no particular meaning is assigned to the location of *Articulated Intersect*: it lacks spatial specificity and it provides no specific and intuitive body-work encounter, except that of the anonymous and limited interface. Thus, no convergence effect

[92] William Uricchio, "The algorithmic turn: photosynth, augmented reality and the changing implications of the image," *Visual Studies*, 26:1 (2011), 32.

is discernible here: the interaction between physicality and virtuality results in no "dynamic and rich multimedia information spaces," as Manovich describes the augmented spaces. Therefore, these aspects prevent the project from being included within the category of AR, however extended our understanding of AR might be. This in no way means that the meaning and the technical and artistic values of this work are absent or poor; my comments only reflect and provide argument for defining AR as a different artistic approach.

Blast Theory's project *Can You See Me Now?* (2001-ongoing) likewise aims to expand the boundaries of human-machine interaction into a complex tissue that proposes to activate equally material reality and virtual spaces, mobility and stationary interaction—but it also cannot be included into the AR paradigm. The work has frequently been discussed in the literature on AR and interactive gaming where it is praised for its complex technical, aesthetic, and experiential dimensions. The project is a location-based game that happens simultaneously online and on the streets in cities such as Rotterdam, Cologne, Barcelona, Tokyo, Cardiff, etc. Online players are chased through a virtual model of a city by four street performers (the members of the Blast Theory group) who search the streets of the city equipped with handheld computers, wireless connection and GPS receivers, in order to capture the online players. The position of the runners and of the online participants on the map is seen by both categories of participants. Online players can communicate with one another through text messages (visible also to the street performers) while the runners are able to exchange information through walkie-talkies (accessible also to the online players).[93] One of the principal merits of this work from the perspective of the issues in question here is that *Can You See Me Now?* creates a fluid relation between the virtual world of the online users and the real city. It attempts to erase spatial

[93] For more details, see Steve Benford and Gabriella Giannachi, *Performing Mixed Reality* (Cambridge, Massachusetts and London, England: The MIT Press, 2011): 29-34.

differences by bringing together geographically remote players from both sides of the digital divide. If this means the identification of the players as a community based on collaboration and trust, it also reveals a level of control and manipulation. All these aspects prove the close similarity between this project and AR aesthetics, although important differences are also evident. One of the most obvious is that the online users have only a "prosthetic," distant relation to the physical site. On the other hand, street players have an indirect, uncertain relationship with the virtual online component and a limited control over it, despite the frequent contacts and exchanges between the two sides. Therefore, we cannot speak here about perceptual interconnectedness between the body and the virtual image in either case—for either online or street players. Unlike AR, spatial and phenomenological gaps between reality and virtuality persist, despite the consistent interaction between the two. As media theorists Steve Benford and Gabriella Giannachi observe, in *Can You See Me Now?* "both the online players and the runners inhabited separate 'worlds' or environments that were connected together virtually to create 'an *adjacent reality* rather than an augmented reality, which in its ideal tries to seamlessly connect one world to another."[94] Indeed, what this project proposes are rather discrete spaces of interaction that connect but do not integrate real and virtual elements, grounding the work in an aesthetics of concurrence and not of convergence. Therefore, I place this project outside the AR aesthetic framework. Like the two other works discussed above (*Text Rain* and *Articulated Intersect*) this is a close relative of AR experience, but not part of the AR paradigm per se. By calling attention to the differences and distances between apparently comparable projects, I hope to nuance and deepen the understanding of AR as a unique perceptual and aesthetic paradigm. It is important to keep in mind that, as MacIntyre and colleagues show, what distinguishes AR

[94] Ibid., 32-33. Emphasis in the original.

from other media is the unique combination of three features: blending virtual and physical worlds, continuous and implicit user control of the point of view, and interactivity.[95]

To obtain this unique experience, interfaces and display solutions are fundamental. Therefore, the next chapter will be dedicated to discussing the crucial role played by the interface in AR systems. To this end, a few defining technical aspects of the AR display solutions will be assessed, as well as the aesthetic function of the screen and the frame in visualization systems, from painting to VR to AR. Building on these considerations, I will identify three distinctive attributes of the convergent AR space and of the augmented experience: integrativity, projectivity and mobility. Each specific type of AR display can be positioned (head-attached, spatial displays, hand-held) in relation to these three attributes. Therefore, more than a simple technical device, the AR interface is an idea, a concept, that is directly responsible for creating the convergence effect.

[95] Blair MacIntyre, Jay David Bolter, Emmanuel Moreno, and Brendan Hannigan, "Augmented Reality as a New Media Experience," *Proceedings of the IEEE and ACM International Symposium on Augmented Reality (ISAR'01)* (New York, NY, Oct 29-30, 2001): 198.

Chapter 2

The Aesthetics of the Interface: Display solutions as real-virtual convergence tools

2.1. The ambivalence of the screen

"Screens […] are decidedly ambivalent objects—illusionist windows and physical material entities at the same time," writes art historian Kate Mondloch in her book *Screens: Viewing Media Installation Art*.[96], Although Mondloch refers to the screen specifically as media apparatus (i.e. as a technical equipment or instrument), this observation about the double nature of the screen as image and object can be extended to address the idea of the screen in a larger sense—as a conventional term for a wider range of visualization means, old and new, static and mobile, analog and digital.[97] In this larger perspective the concept of the screen would include equally painting, photography, cinema, computer or cell-phone display, all of them ambivalent places of negotiation between objecthood and representation, between materiality and immateriality, between mobility and immobility (on and in front of the screen).[98] However, the

[96] Kate Mondloch, *Screens: Viewing Media Installation Art* (Minneapolis and London: University of Minnesota Press, 2010), xii.
[97] Although Mondloch acknowledges that "screen-mediated art viewing existed well before the invention of still of moving photographic media," she uses the term screen in a more restrictive sense, related specifically to media technologies.
[98] In the present study, the term screen is used alternatively with other terms such as display, display solutions and interface to refer to the artifacts or places of interaction that link systems, people, media, and different portions of matter or space. Social scientist Herbert A. Simon's influential definition of the human artifact is extremely useful in this regard as it can illuminate the very notion of the screen: "An artifact can be thought of as a meeting point—an 'interface' in today's terms—between an 'inner' environment, the substance and organization of the artifact itself, and an 'outer' environment, the surroundings in which it operates. If the inner environment is appropriate to the outer environment, or vice versa, the artifact will serve its intended purpose." Herbert A. Simon, *The Sciences of the Artificial*, Third Edition (Cambridge, Massachusetts: The MIT Press, 1996), 6.

screen is first and foremost associated with various *technological* visualization processes, since it is technology that has contributed to expanding this ambivalence and to complicating the very definition of the screen. As film historian and theoretician Anne Friedberg writes in her book *The Virtual Window*,

> the screens of cinema, television, and computers open 'virtual windows' that ventilate the static materialities and temporalities of their viewers. A 'windowed' multiplicity of perspectives implies new laws of 'presence' – not only here and there, but also *then* and *now* – a multiple view – sometimes enhanced, sometimes diminished – out the window.[99]

Indeed, the moving-image screen of television and cinema, and especially that of computers altered the status of the screen as a static, atemporal interface. Instead of a passive surface, it became an active, user-engaging device; instead of a neutral façade distanced from the user, it became a responsive field for perception and dynamic, interactive spectatorship.

This chapter is concerned with identifying the possible ways in which AR technology complicates even further the screen's ambivalent status. Furthermore, it is concerned with discussing potential shifts in a viewer's experience of space presupposed by a screen (or rather screens, a plural imposed by the multiple display solutions used in AR projects) that is context-aware, user-centric, and therefore better able to offer a perceptual convergence of reality and virtuality. Not so much a "window open to the world," the AR screen is the window *and* the world: as the *plaque tournante* between real and virtual realms the screen is the essential instrument in the spatial convergence process. Of course, the AR screen is not an entirely new species, both technically and phenomenologically. AR evolved from and shares the main types of technological developments in display solutions. Moreover, like in other media visualization systems such as VR or video-based interactive installations, in AR too the interface is situated in

[99] Anne Friedberg, *The Virtual Window. From Alberti to Microsoft*, (Cambridge, Mass: The MIT Press, 2006), 4-5.

a close relationship with the body if not quite internalized by the user. However, while it is not different in terms of technology and functionality from other visualization solutions, I claim that the AR screen differs from these in some important aspects: the AR screen tends to be frameless and phenomenologically "transparent" and therefore is better integrated into the environment. AR's main purpose is not so much to diminish the distance between viewer and image and therefore to make the screen "disappear" (this was rather VR's most ambitious goal), but rather to collapse the perceptual distance between virtuality and reality, between the images on- and off-screen. In other words, the purpose is *to converge the spaces to obtain a greater degree of perceptual continuity between the two realms*. To demonstrate how the process of convergence renders the screen optically and metaphorically transparent, I propose a typology of AR based on the identification of three distinctive attributes of augmented space and augmented experience: integrativity, projectivity and mobility, in which each specific type of AR display could be positioned—head-attached, spatial displays, and hand-held. Technological details are important for understanding the transformations of both the screen and the viewing experience in the field of AR. However, any interpretation of these shifts should go beyond the screen's objecthood or technicality. Thus, the screen is seen here not only as a "thing," as an object, or as a technology (although such roles will not be ignored), but also as an idea. In this sense, it is necessary to start by defining and circumscribing the key terms: the screen, the window metaphor, the frame, and the idea of transparency. Doing so will help us comprehend the aesthetic and perceptual mutations brought in by AR's use of the screen.

Whatever its degree of formal or technical complexity, the screen has always been considered a boundary between two worlds. It is a boundary that conventionally separates rather than unifies the reality surrounding the screen and the virtual images represented within its

borders. In fact, the term screen—as an object, and as a metaphor—has historically been related to the idea of separation. This is what media theorist Erkki Huhtamo suggests in his "archeological" investigation of the screen: in its original use in the 16th century and probably earlier "the screen was above all seen as a surface that protects a person by creating a barrier against something uncomfortable or threatening."[100] It was not until the early 19th century, he writes, that "the word 'screen' began to attain meanings that anticipated its current uses within media culture as a means of displaying and transmitting images."[101] While the screen is indeed the material point where the observing subject encounters mediated images, there is generally little direct interaction between the image provided within the screen's boundaries and its immediate reality: while the screen displays something, it most likely obscures something else. In the field of film theory, André Bazin describes the screen as both a mask and a window: "The screen is a mask whose function is no less to hide reality than it is to reveal it. The significance of what the camera discloses is relative to what it leaves hidden. But this invisible witness is inevitably made to wear blinders; its ideal ubiquity is restrained by framing."[102] At least in conventional cinema, the very optical conditions of the camera and consequently of the screen, act as "blinders" to maintain an inevitable separation between viewer and image or between reality and virtuality: the possible direct exchanges between off-screen and on-screen images remain mostly at the imaginary level rather than at a real, perceptual, or corporeal level.[103]

[100] Erkki Huhtamo, "Elements of Screenology," Introductory Essay, *WRO 01*, 9th International Media Art Biennale, Wroclaw, Poland, 2001. http://wro01.wrocenter.pl/erkki/html/erkki_en.html (accessed December 2015).
[101] Ibid.
[102] André Bazin, *Jean Renoir*, edited with an introduction by François Truffaut, translated by W.W. Halsley II and William H. Simon (New York: Simon and Schuster, 1973), 87.
[103] "The offscreen may be defined as the collection of elements (characters, settings, etc.) that, while not being included in the image itself, are nonetheless connected to that visible space in imaginary fashion for the spectator". Jacques Aumont, Alain Bergala, Michel Marie, Marc Vernet, *Aesthetics of Film*, Translated and revised by Richard Neupert (Austin: University of Texas Press, 1992), 13.

Speaking in the same terms about the cinema and television screen as "our window on the world," psychologist Robert D. Romanyshyn describes it as

> a *boundary* between the perceiver and the perceived. It establishes as a condition for perception a formal *separation* between a subject who sees the world and the world that is seen, and in so doing it sets the stage, as it were, for that retreat or withdrawal of the self from the world which characterizes the dawn of the modern age. Ensconced behind the window the self becomes an observing *subject*, a *spectator*, as against a world which becomes a *spectacle*, an *object* of vision.[104]

So, as much as the screen opens a world, it equally keeps us separated from that world. The same idea of the screen as a separator between two worlds—one real, the other virtual—is formulated by philosopher Stanley Cavell, who refers to the screen as "a barrier:" "it screens me from the world it holds—that is, makes me invisible. And it screens that world from me—that is, screens its existence from me."[105] By screening me "from the world"—or rather *for* the world, I would say—the screen becomes a sort of proscenium to borrow Margaret Morse's expression, one that divides the field to be contemplated from the immediate world of the contemplator: "the screen of film divides the here and now of the spectator from the elsewhere and elsewhen beyond with varying degrees of absoluteness."[106] Writing about the same aspects in the more specific context in *The Language of New Media*, Lev Manovich defines the screen as a visualization tool conditioned by the divisive presence of the frame. As Manovich writes, "the frame separates two absolutely different spaces that somehow coexist. This phenomenon is what defines the screen in

[104] Robert D. Romanyshyn, *Technology as Symptom and Dream* (New York: Routledge, 1989), 43.
[105] Stanley Cavell, *The World Viewed: Reflections on the Ontology of the Cinema* (New York: Viking Press, 1971), 24.
[106] Margaret Morse, "Video Installation Art: The Body, the Image, and the Space-in-Between" in *Illuminating Video. An Essential Guide to Video Art*, ed. Doug Hall and Sally Jo Fifer (New York: Aperture in association with the Bay Area Video Coalition, 1990), 156.

the most general sense…."[107] Therefore, we can safely assume that the idea of separation is taken to be a key feature in defining the screen.

As all of these authors acknowledge, despite different degrees of complexity of the screen there is always a certain tension—if not quite a clear separation—between the real space of the viewer's body and the virtual representation bound to a screen. If the real and virtual spaces coexist on either side of the screen, they are not necessarily contingent. To establish a certain experiential contingency between the two—in other words, a convergent space—is actually the main ambition of AR research and art projects.

2.2. Framed illusions: the screen as window

If we agree, following these authors, that the screen is fundamentally a border that equally opens up spaces of vision and separates them from the surrounding environment, the question that arises is to what extent is this condition of the screen maintained or modified in specific circumstances like those offered by the more complex VR and AR technologies?[108] That is, how is the conventional, modern screen affected by technologies that are more body-centered and spatially-aware than the cinematic or televisual screen invoked in the examples above? How is it affected by technologies that base their visual effects on the efforts to erase as much as possible any separation between viewer and image and between image and reality, respectively? A way to approach these questions is to consider how much the window metaphor (usually associated with the screen) persists in the visual and technological context of VR and AR. More

[107] Lev Manovich, *The Language of New Media* (Cambridge: The MIT Press, 2001), 95.
[108] It is important to remind that VR is an important player in the genealogy of AR visualization techniques. Therefore, the reference to VR is necessary in this context as it can illuminate the aesthetic, phenomenological and technological mechanisms at play in AR projects discussed here.

precisely, is it possible, on the one hand, to dissolve the traditional distance between image and viewer imposed by the framed, window-like representational regime and, on the other hand, to rethink the window not as a metaphor for the framed view, but as a metaphor for transparency and for perceptual synchronization between the spaces on- and off-screen?

In commenting on the idea of the screen as a boundary, all the authors quoted above—although writing from different perspectives—assume, in one way or another, that the screen is basically a window-like, framed surface that contains the object of vision in a space separated from the here and now of the spectator. Certainly, the window is the most powerful metaphor to describe the rules of visual representation in the Western tradition, from Renaissance perspectival painting to cinema, television, or computer screen imaging. The metaphor of the window became an element through which we not only compare, but also define these new mediums against those of the recognizable past. As Martin Lister *et al*. observe: "metaphors help us to see things in terms of what we are already familiar with; that is, they enable us to map the familiar onto the unfamiliar."[109] Like other metaphors, the window functions as a useful rhetorical device for understanding the complex circuits of transfer between tradition and new technologies. From the architectural aperture of the Albertian window that should assist the artist to understand the space of vision to Microsoft's *Windows* program that builds upon the same leitmotif to configure its Graphic User Interface, the window is conventionally considered the representational paradigm that structures the construction and the perception of the image. If the metaphor of the window appears to function equally well with regard to what Leon Battista Alberti described as *costruzione legittima*[110] and modern screen imaging solutions, it is because

[109] Martin Lister, Jon Dovey, Seth Giddings, Iain Grant, Kieran Kelly, *New Media: A Critical Introduction* (London and New York: Routledge, 2003), 115-116.
[110] *Costruzione legittima* is a system of perspectival representation described by the Italian architect and humanist Leon Battista Alberti in his treatise *On Painting* (1435-1436).

it works to convey the idea of an "aperture" towards a virtual realm, defined by the presence of the frame. And—it should be added for the purpose of my argument—the metaphor of the window always relies on a visual organization that leaves the viewer outside the image and the image separated from the surrounding space. Therefore, the window can be seen, in all of these cases, more of a framed view than, in its literal sense, a provision for transparency.

Anne Friedberg addresses the problem of the window metaphor by arguing that actually for Alberti "the frame was what mattered, not the view from a window,"[111] an observation that sheds interesting light on my own argument about the innovative role of AR in rearticulating the window metaphor through the process of spatial convergence. For Alberti, writes Friedberg, the window as a visual metaphor functions as a structural model for possibly reinscribing the image onto another image, the painting, and not as a guarantee for realism: "Alberti used the window predominately as a metaphor for the frame—the relation of a fixed viewer to a framed view—and *not as a 'transparent' window on the world*, as has been suggested widely by art historians and media theorists."[112] The framed window to which Alberti refers is the area where representation takes place and not a "live" image of the real space behind its surface. It should be added, then, that Friedberg's "condition of the window"[113] is not media specific: it characterizes not only—as Alberti proposed—painting or drawing, but also the modern screen of film, TV, computer and mobile devices. It characterizes what I call here the "conventional" screen as the limited surface or space containing static or dynamic images separated from their immediate surroundings, situated at a certain distance from the viewer's body, and defined essentially by the

[111] Anne Friedberg, *The Virtual Window*, 30.
[112] Ibid., 12. (my emphasis)
[113] Ibid., 16.

convention of the frame.[114] The "conventional" framed screen is what painting or even theatre is visually based upon, despite the fact that the general use of the term "screen" in relation to cinematic and/or electronic visual systems suggests a more restrictive definition. Diderot, in the eighteenth century, was one of the first thinkers to centralize the concept, although the term he employed was "tableau." For him, the tableau is the representational pattern par excellence used in art (painting, dramaturgy and literature) but also in thinking and language processes.[115] Other authors have delved into the same theme, notably Roland Barthes, who discussed the fundamental role of the tableau via Diderot, in the work of Brecht and Eisenstein. As Barthes explains, "the tableau (pictorial, theatrical, literary) is a pure cut-out segment with clearly defined edges, irreversible and incorruptible; everything that surrounds it is banished into nothingness, remains unnamed, while everything that it admits within its field is promoted into essence, into light, into view."[116] Thus, tableau and "conventional" screen can be considered different expressions of the same visual paradigm—a window-like representational field with clearly defined edges—that traverses genres, epochs and technologies. Elaborating on this idea, Barthes writes: "The scene, the picture, the shot, the cut-out rectangle, here we have the very

[114] My definition of the "conventional" screen corresponds to a certain extent to what Lev Manovich describes as the "classical screen": a flat, rectangular surface, that is intended for frontal viewing and that acts like a window into another space (*The Language of New Media*, Ibid., 95). However, Manovich sees this type of screen in a more restrictive sense, as part of a three-part typology that includes: the "classical screen" which displays a static image (like in painting or photograph), the "dynamic screen" which presents a moving image of the past (this is the screen of cinema, television and video), and the "real-time screen" which shows an image of the present, (as it is the case with radar, live video, or computer screen) (*Ibid*. 95-100). Manovich's proposed genealogy (based on the idea of temporality) proves to be problematic if not quite misleading since it explains not so much the evolution or a typology of the screen, as it presents the aesthetic developments of the *image* inside the screen. It should be emphasized that a "conventional screen" can host equally a static, dynamic, or real-time image, without changing its characteristics. Therefore, in my study, the term "conventional" is applied to a certain category of screens defined according not to the type of image they convey, but to their physical and phenomenological organization.

[115] Diderot's definition of the tableau occurs in the dialogues from *Entretiens*, where he defines the "scene muette" as "a painting": "Une disposition de ces personnages sur la scène, si naturelle et si vraie, que, rendue fidèlement par un peintre, elle me plairait sur la toile, est un tableau." Denis Diderot, "Entretiens sur le Fils naturel", in *Œuvres esthétiques*, edited by Paul Vernière (Paris : Éditions Garnier frères, 1959), 88.

[116] Roland Barthes, "Diderot, Brecht, Eisenstein," translated by Stephen Heath, in *Narrative, Apparatus, Ideology: A Film Theory Reader*, edited by Philip Rosen (New York: Columbia University Press, 1986), 173.

condition that allows us to conceive theater, painting, cinema, literature, all those arts, that is, other than music and which could be called *dioptric arts.*"[117] The screen, in a larger sense, should therefore be defined not necessarily by what it contains (what kind of artistic or mediatic expression it re-presents), but rather by how it defines that content: by framing and highlighting the fiction, the virtual, the art vis-à-vis the viewer and his/her context.[118]

Of course the ways in which the viewer approaches and engages the "conventional" screen varies largely from one art form to another and from one particular medium to another. For example, the interaction between viewing subjects and representational objects is implicit in the case of painting (meaning a tacit involvement), but explicit in the case of the computer display (meaning a direct and open contact). However, regardless of the degrees of interactivity and technological or artistic complexity proposed, the "conventional" screen functions through an internal logic that is based on exclusion. In other words, a "conventional" screen will always maintain a fundamental distance between the viewer and the image and, consequently, a gap between the real and virtual spaces. And this gap is, to be sure, supported by the presence of the frame.

Anne Friedberg gives a comprehensive account of the visual and structural role of the screen's frame as a separator:

> Like the frame of the architectural window and the frame of the painting, the frame of the moving-image screen marks a separation—an 'ontological' cut—between the material surface of the wall and the view contained within its aperture… The frame becomes the threshold—the liminal site—of tensions between the immobility of a spectator/viewer/user and the mobility of images seen through the mediated 'windows' of

[117] Ibid.
[118] I use "virtual," "fictional," and "art" not as undifferentiated and interchangeable terms. They are used together to stress the idea that, regardless of the artistic or mediatic content, the screen is actually a general visualization paradigm or, as Barthes puts it, the element that constitutes "the very condition" of representation.

> film, television, and computer screens. But the frame also separates the *materiality* of spectatorial space from the *virtual immateriality* of spaces seen within its boundaries.[119]

As it separates materiality and immateriality, the frame—as a concrete element, as an optical or graphical element, or as a symbolic limit—more often than not marks a rupture in spatio-temporal terms between the surrounding world and the represented image. What lies within the frame contains a fractured space, since the virtual representation most likely has a different scale than that of the surrounding environment. Likewise, what takes place within the screen's borders usually has a different temporality than the off-screen world. Certainly exceptions are possible, such as an immersive VR screen that provides an image at the bodily scale, or personal computer or surveillance camera screens that transmit real-time images. Even in these cases, the frame (or at least its convention) is not completely abolished; a certain rift between the real and the virtual realms still persists.

As the liminal element that operates an "ontological cut"[120] between materiality and immateriality, mobility and immobility, real and virtual spaces, temporal realism and indirect time, the frame, like the screen, appears therefore to be a slippery terrain of signification since the literal and metaphorical senses of the term always collide and converge. A very insightful analysis of this double (and slippery) nature of the frame is provided by Jacques Derrida in his emblematic work *The Truth in Painting*. In this book, Derrida interrogates the nature of the frame (taking Kant, Hegel and Heidegger as necessary prolegomena) in terms of *parergon*: "neither work (*ergon*) nor outside the work [*hors d'oeuvre*], neither inside nor outside, neither

[119] Anne Friedberg, *The Virtual Window*, 5-6.
[120] The term "ontological cut" belongs to Victor I. Stoichita and it was used in his book *The Self-Aware Image: An Insight into Early Modern Meta-Painting* (Cambridge: Cambridge University Press 1997), with reference to the seventeenth-century obsession with the "aesthetic boundary" or the "ontological cut" established by the frame of the painting.

above nor below, it disconcerts any opposition but does not remain indeterminate and it *gives rise* to the work."[121] Derrida explains the ways in which the frame "gives rise to the work" as a complex mechanism that involves both perceptual and philosophical interactions:

> What is incomprehensible about the edge, about the *à-bord* appears not only at the internal limit, the one that passes between the frame and the painting, the clothing and the body, the column and the building, but also the external limit. *Parerga* have a thickness, a surface which separates them not only (as Kant would have it) from the integral inside, from the body proper of the *ergon*, but also from the outside, from the wall on which the painting is hung, from the space in which statue or column is erected, then, step by step, from the whole field of historical, economic, political inscription in which the drive to signature is produced…. No 'theory', no 'practice', no 'theoretical practice' can intervene effectively in this field if it does not weigh up and bear on the frame, which is the decisive structure of what is at stake, at the invisible limit to (between) the interiority of meaning (put under shelter by the whole hermeneuticist, semioticist, phenomenologicalist, and formalist tradition) *and* (to) all the empiricisms of the extrinsic which, incapable of either seeing or reading, miss the question completely.[122]

As Derrida remarks, the frame is not only a representational prop—the element that separates and links the inside form the outside the work—but also a discursive tool (a "decisive structure of what is at stake") that emphasizes the historical, economic, and political differences (or ruptures) in time and space between the "interiority of meaning" and the "empiricisms of the extrinsic." Derrida's observation that the frame demarcates the outside in order to define the inside as equally an "internal limit" and an "external limit" (in both physical and metaphorical senses) echoes André Bazin's remarks about the dynamics involving the interior and the exterior of the frame in cinema. While the screen, writes Bazin, is "centrifugal," opening up the spaces of

[121] Jacques Derrida, *The Truth in Painting*. Translated by Geoff Bennington and Ian McLeod (Chicago and London: The University of Chicago Press, 1987), 9.
[122] Ibid. 60-61.

representation to the exterior, to the off-screen environment, the frame is "centripetal" in the sense that it tries to deny any exterior interference by circumscribing the image as a pure occurrence.[123] This established relation between the "interior" virtual image and the "exterior" real space is radically challenged by VR and AR technologies, as is the role of the frame as separator between the two realms. VR attempts to completely abolish the exterior, and AR significantly relativizes the frame by rendering the screen transparent. Since these observations need further explanations, I will explore them in more detail in the following sections through several examples, as to better illuminate the process of converging spaces in AR art and applications.

2.3. Open windows: immersive image and the "disappearance" of the screen

Since the sixties, "the unconventional uses of media screens and the curious mutations of the virtual-window paradigm in gallery-based installations"[124] and the recent reconfiguration of screens by VR and AR technologies have led to a progressive relativization of the defining features of the "conventional" screen. For example, in their desire to solve the ambiguity of the screen as both illusionistic window and material object, VR artists and developers have concentrated on doing away with the phenomenological presence of the interface by offering the viewer the experience of a "total" and apparently "screen-less" image-space.

One of the most accomplished VR projects in both technical and aesthetic terms is Canadian artist Char Davies' *Osmose* from 1995. The work is an immersive interactive environment with 3D computer graphics and sound. The user experiences the work using a HMD

[123] André Bazin, *What is Cinema*, vol. I, (Berkley: University of California Press, 1967), 166.
[124] Kate Mondloch, *Screens. Viewing Media Installation Art*, xvi.

(head-mounted display) and a real-time motion tracking system that captures breathing and body balance. Unlike other immersive VR systems, that offer a partial immersion, *Osmose* proposes a full-body immersion in a 360-degree enveloping space. Moreover, in contrast to manual interface tools such as joysticks and trackballs, *Osmose* incorporates the intuitive processes of breathing and body balance as the primary means of navigating the virtual world. The complete floating experience is usually achieved within ten minutes of immersion; after this period, the images slowly but irreversibly recede, bringing the session to an end.[125] The virtual environment through which the immersed user navigates is formed by a dozen "world-spaces" mostly based on metaphorical aspects of nature, including: Clearing, Forest, Tree, Leaf, Cloud, Pond, Subterranean Earth, and Abyss.[126] Although inspired by nature the images are not quite realistic; the objects are abstracted, their corporeality is fragile and translucent; textures are imprecise, but suggestive. The relationship between figures and background is spatially ambiguous, and transitions between worlds are subtle and slow. Treated more like a painting, the forms "evoke" rather than illustrate. It is significant to note that Char Davies started her artistic career as a painter. The sound also contributes to the user's sensation of multidimensionality since it is designed to respond to changes in the user's location, direction, and speed. As Char Davies writes about her work, "*Osmose* is a space for exploring the perceptual interplay between self and world, i.e. a place for facilitating awareness of one's own self as consciousness embodied in enveloping space."[127] But, to be sure, this "enveloping space" is entirely artificial, a computer generated image-space that, in the opinion of some theoreticians, is not even a space.[128]

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[125] For more details about the immersive experience of Davies' *Osmose* and her related work *Ephémère* (1998), see Laurie McRobert, *Char Davies' Immersive Virtual Art and the Essence of Spatiality* (Toronto: University of Toronto Press, 2007), 20-29.
[126] Char Davies, "Osmose", *Immersence*, 1995-2008, http://www.immersence.com (accessed December 2015).
[127] Ibid.
[128] See among other comments on this aspect: Anthony Vidler, *Warped Space. Art, Architecture, and Anxiety in Modern Culture* (Cambridge: The MIT Press, 2000), 235-238; Lev Manovich, *The Language of New Media*. Ibid.,

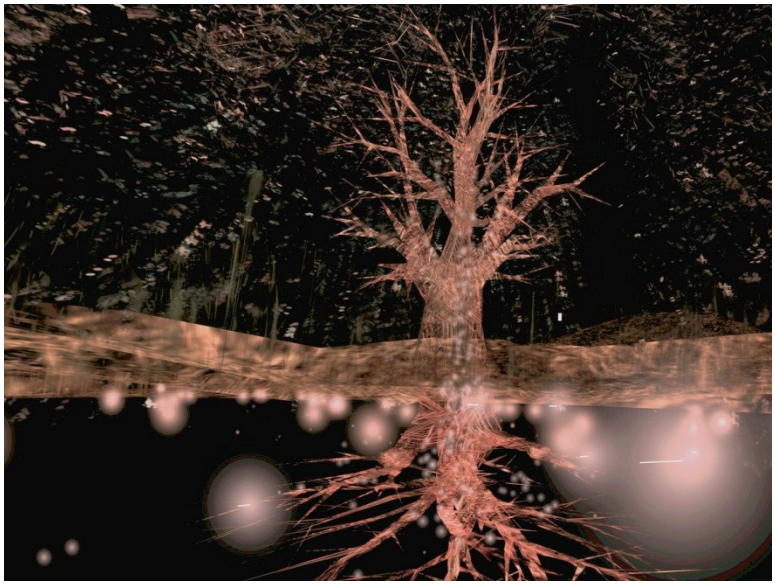

Fig. 2.1. Char Davies. "Tree Pond," *Osmose*. 1995. Digital still image captured during immersive performance of the virtual environment *Osmose*.

Indeed, in *Osmose* the user is absorbed into the fictional environment at the expense of any contact he/she may entertain with the surrounding, real world. The technical nature of the HMD, worn by one user at a time and designed to leave no openings to the outside world, makes the viewer's experience a highly intimate one. The viewer experiences a total immersion into the exclusive virtual realm via a personalized "trip" that presupposes no collaboration and no collective involvement. Literally embodied by the user as extension of one's own visual and tactile senses, the screen seemingly disappears and the user effectively "enters into" the image. As Martin Lister et al. write: "this experience is captured in the widespread use of the phrase that is, arguably, the main metaphor for immersive VR: when a user dons the head-mounted display of a VR apparatus they are thought to 'step through Alberti's window'."[129] If this is a way to

253; and Margaret Morse, *Virtualities: Television, Media Art, and Cyberculture* (Bloomington: Indiana University Press, 1998), 17 and 102-103.

[129] Martin Lister, et al. *New Media: A Critical Introduction*, 125.

"step through" it is also a way to figuratively "step on" the long tradition of the Albertian window: VR and AR both realize a different visual regime that rejects equally the presence of the screen and the convention of the frame.

The HMD is not the only device able to offer a "total" frame-less immersive experience into a VR environment. Another display solution—which further challenges the Albertian model—is the CAVE (Cave/Computer Automatic Virtual Environment). The technology was developed by computer art pioneers Tom DiFanti and Dan Sandin of the Electronic Visualization Center at University of Illinois, Chicago. The system provides 3D sound and stereoscopic three-dimensional images projected on all the surfaces of the room in which the user is situated. The user only needs to wear lightweight polarized sunglasses in order to experience the immersive effect. A tracking device senses the position of the body and a haptic interface allows the user to control direction and movement through the virtual world.[130] The name alludes to Plato's myth of the cave (in *The Republic* 517-19) that describes how chained prisoners who cannot perceive something other than the shadows of objects and people projected on the wall in front of them would mistake that image for reality—it is a myth about the intricate relationship between representation, illusion, reality and human perception.

Issues of illusion and reality, of memory and trauma are at the core of the CAVE-based VR immersive environment called *World Skin. A Photo Safari in the Land of War*, realized by Maurice Benayoun in 1997 and presented at Ars Electronica festival in Linz, Austria in 1998, where it won the Golden Nica Award in the Interactive Art category. The polarized projections that fill the walls, ceiling, and floor present a collage of photographs from news reports transmitted from different war zones. The arrangement of images constructs a continuous world

[130] See Stephen Wilson, *Information Arts. Intersections of Art, Science, and Technology* (Cambridge: The MIT Press, 2002), 707.

of mute conflict and violence. Photo cameras suspended from the ceiling are operated by the users "like weapons," but instead of capturing pictures the cameras wipe out the projected images (i.e. the "world skin"), leaving empty silhouettes in the projection. As the visitors take more pictures, they gradually change the war landscape turning it into a white surface. Therefore, the visitors in the *World Skin* play the roles of tourists, journalists, and participants equally, in a weird theatre of war. In the words of Benayoun, "Here, being engulfed by war is an immersion in a picture, but it is a theatrical performance as well. (…) This has to do with the status of the image in our process of getting a grasp on this world. The rawest and most brutal realities are reduced to an emotional superficiality in our perception."[131]

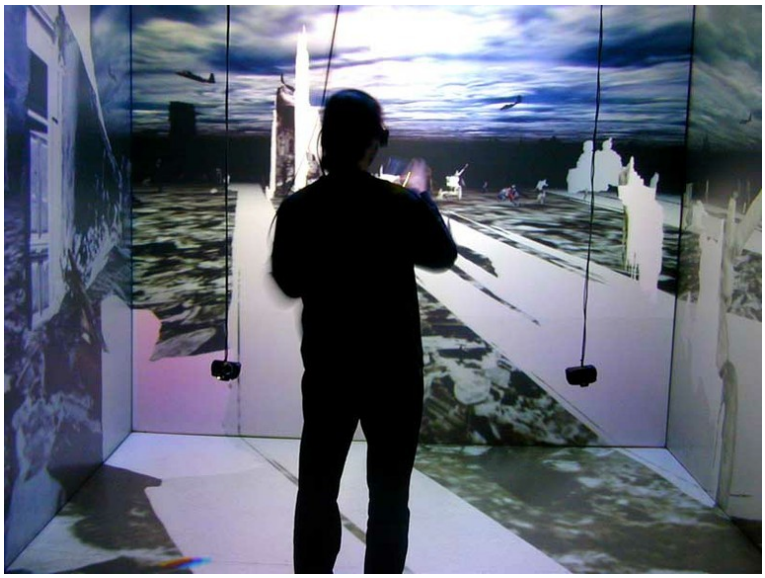

Fig. 2.2. Maurice Benayoun, *World Skin. A Photo Safari in the Land of War*. 1997. Virtual Reality environment.

It is interesting to note that in this "theatrical performance" of real war within a real game the most prominent role is played not by the screen and the projection—now figured as an engulfing illusionistic image—but rather by the photo camera used by the visitors. The

[131] Maurice Benayoun, *World Skin. A Photo Safari in the Land of War*, in Works, 1997. http://www.benayoun.com (accessed December 2015).

subjective use of the camera plus the effective disappearance of the screen are compelling ways to prove the "emotional superficiality in our perception" and the place of technology in that perceptual act. Moreover, if in the previous example (Davies' *Osmose*) the immersion is essentially an individual experience, here the "immersion in the picture" is a collective, symbolic participation in the drama of war. *World Skin* is in this sense an insightful comment on the status of the image: about its fragility, but also its power of manipulation. But the work speaks also about the intricate relationships between war and media, individual and public access to information, and the reality of the war and its virtual reflection in imagery and games.

Another way to address immersion in a surrounding spatialized image is the display solution proposed by the artist and designer Luc Courchesne, called "The Panoscope 360°." The system consists of a hemispheric screen (an "inverted dome") that allows the spectator to stand at the center of the screen. The image is projected with hemispheric lens from above, while surround-sound audio components provide a sonic counterpart to the immersive visuals. The panoramic (anamorphic) single channel image is adjusted in real time to fit the shape of the hemispheric screen and therefore to create a credible illusion. The system presents advantages compared to the costly CAVE-type systems and head-mounted displays as it considerably simplifies the production and presentation of panoramic and immersive content, normally for more than one user.[132] Luc Courchesne explored the possibilities of the Panoscope 360° in his work *Where are You/T'es où?* (2005), an immersive experience in an imaginary world that questions—as the title suggests—our position as viewers vis-à-vis reality and the proposed illusion. The work is conceived as a multi-layered navigation, activated through the manipulation of a joystick, through different spaces: at level 0 the image appears like a simple XYZ grid

[132] See "Les Panoscopes" in *TOT* [Territoires Ouverts - Open Territories], a project initiated by the Society for Arts and Technology [SAT], Montreal, 2007 http://tot.sat.qc.ca/dispositifs.html (accessed December 2015).

defining the experience of the navigable space; at level +1 the imaginary world turns out to be a subjective (author's) archive of pictures, sounds, texts and objects; at level +2 the previous level's components become elements in an impressionistic and almost abstract world-image; and level +3 reveals a landscape that suggests the Romantic sublime.[133] One of the work's most remarkable aspects is that during the multi-level immersive journey the user can encounter other people—either via prerecorded video images or live online contact—but also his or her own image recorded by cameras at the moment of participation. Thus, the work questions the privileged distance the viewer "normally" entertains with the Albertian window-image. More precisely, it challenges the established model by suspending as much as possible the clear distinction between the position of the subject in front of or behind the screen, as well as the evident differences between the real participant (now active both physically and as an avatar within the immersive image) and the other virtual human presences (transmitted in real time or recorded).

Fig. 2.3. Luc Courchesne, *Where are You/T'es où?*. 2004. Virtual Reality environment. Credit - Joey Kennedy.

[133] See the description at Society for Arts and Technology [SAT], Exhibitions: "Fantastic Voyages," October 2007. http://www.sat.qc.ca/ (accessed December 2015).

What all three VR projects described above have in common is their capacity to create a spatial experience for the spectator radically different from the frontal, relatively immobile viewing posture imposed by the "conventional" screen. Specifically, they offer the participant the sensation of a total immersion in the image that leads to a state of disembodiment[134] and a sense of floating into an environment with no apparent objective limits. Providing such experience is made possible by breaking from the established models of the screen as a framed window and from the viewing experience as a distanced relationship with the image. In these VR environments, regardless of the display solution being used, the frame loses its role as a "defining edge" and looks as if it is dissolved into the screen. Furthermore, the screen apparently gives up its function as a "cut-out segment" and seems to vanish into the image. That image in turn refuses to function as a phenomenological zone of tension between surface and transparence, becoming instead a perceptual field defined by immersivity and artificial spatial continuum. Such transformations of the visual regime from the window-like to the immersive model of visuality indicate, as Lister et al. has shown, that "no stepping through [Alberti's window] has occurred but two other things have—the spectator has lost sight of the frame and the surface of the image, and they cannot gauge their relationship to it, perceptually, imaginatively, or physically."[135] Therefore, once the conventional elements of the screen and the image are denied, the traditional distance we entertain as viewers from the image will be radically diminished. And this happens not only at the perceptual level, but *also* at the conceptual (aesthetic, philosophical, social) one.

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[134] The notion of disembodiment is understood here in the sense given by Ken Hillis in *Digital Sensations*: "Disembodiment (…) may be felt to occur when one's body is marginalized during virtual subjective experience. However, it is prudent to acknowledge that any such claim may be potentially nostalgic to the degree that it is not really a noting of actual body loss but perhaps only of a subjective ideation of the human body that always did lie at a certain conceptual remove from the modern subject's location." Ken Hillis, *Digital Sensations: Space, Identity, and Embodiment in Virtual Reality* (Minneapolis and London: University of Minnesota Press, 1999), 235 n5.
[135] Martin Lister, et al., *New Media: A Critical Introduction*, 134.

In his book *Virtual Art. From Illusion to Immersion*, Oliver Grau comments on the consequences of such diminishment and, more precisely, on the (im)possibility of maintaining aesthetic distance from the image in VR immersive environments (taking Davies' *Osmose* as example):

> As the interfaces seem to dissolve and achieve more natural and intuitive designs so that the illusionary symbiosis of observer and work progresses, the more psychological detachment, the distance from the work vanishes. Without it, a work cannot be perceived as an autonomous aesthetic object. Inside the 'omnipresence' of virtuality, any mechanism of knowledge acquisition will be affected and influenced. In virtual environments, a fragile, core element of art comes under threat: the observer's act of distancing that is a prerequisite for any critical reflection.[136]

It is true that by abolishing the perceptual distance and the psychological detachment of the viewer vis-à-vis the illusionistic image, VR manages to give up at least partially the idea of screen—and implicitly of the image—as window-like visualization solutions. But paradoxically, this effort ends up reinforcing another equally powerful (although maybe not so old) myth: the uncritical faith in machines and, consequently, in the "magic" effect of the images *ex machina*.

Surely, VR systems such as those discussed above prove to be very convincing in offering illusionistic and immersive experiences, by comparison with previous, less technically accomplished attempts. But such an effort comes at a price: while trying to reproduce (or invent) reality effects, VR actually neglects almost entirely the surrounding reality it aims to replicate. The immersed body "cannot *see* the world it occupies," observes Martin Lister et al.[137] Indeed, VR ignores or rather rejects any effective link or perceptual relationship of the body with the

[136] Oliver Grau, *Virtual Art: From Illusion to Immersion*. Translated by Gloria Custance (Cambridge, Massachusetts and London, England: The MIT Press, 2003), 202.
[137] Martin Lister, et al., *New Media: A Critical Introduction*, 133.

immediate real world. For example, with its small LCD screens situated at close proximity to the viewer's eyes, the HMD in *Osmose* facilitates a compelling immersion into the digital vistas, but it also obscures, like a pair of blinders, any contact with the external (real) world. In *World Skin* and *Where are You* the participant is incapable of distinguishing anything else except for the immersive image that occupies practically the whole physical space within which the viewer is situated; such a situation inevitably leads to the obliteration of social relationships a participant can engage in during the perceiving act—even when a certain sociality is encouraged as in *World Skin* and *Where are You*. In these cases, spectatorship is in fact limited to the act of participating in a closed system (much like in an online game) that leaves little or no place at all for further or alternative engagements with the external world.

It should be pointed out that the efforts made in the field of VR research and art to dissolve the screen—either by expanding it to the size of the room or situating it at close proximity to spectator's eyes—are not meant to abolish the perceptual limit between reality and virtuality, but are rather aimed at suspending reality altogether in order to render the virtual image more credible. And here "credible" means an apparently screen-less image that absorbs the whole space of the body and which determines the perceptive act and the body's movements. Commenting on these aspects, Lev Manovich rightly remarks that, in VR "the physical space is totally disregarded, and all 'real' actions take place in virtual space. The screen disappeared because what was behind it simply took over."[138] However, this presupposed "disappearance" announced by Manovich and many other theoreticians writing about VR spectatorship and visuality is highly problematic.[139] Of course, despite the important efforts made by VR

[138] Lev Manovich, *The Language of New Media*, 114.
[139] About the problem of the disappearance of the screen, see among others: Christine Ross, "The Disappearing Screen: An Incomplete Matter", *Parachute* 113 (2004): 15-29; Oliver Grau, *Virtual Art*, 202-204; Lev Manovich, *The Language of New Media*, 97; Kaja Silverman, *The Threshold of the Visible World* (New York: Routledge,

developers and artists to erase the presence of the interface, "the screen remains" as Christine Ross very aptly remarks.[140] In Ross' opinion, "it is not so much the frame that is disappearing in virtual reality as our experience of a detectable frame, surface and image. This evanescence brings about a loss of relation and distance between the physical and imagined world."[141] It is precisely this shortcoming—this "loss of relation and distance" between reality and virtual image and actually the total subordination of the real to the virtual—that AR comes to contest by opening the perceptual field equally to virtual realm and real (although mediated) world.

2.4. Real and virtual rendezvous: screen as a transparent threshold

As a way to create the experience of a hybrid, convergent space, AR operates through radical transformations vis-à-vis the conventional visual regime characterized by clear separations between reality and virtuality and between the work and the viewer. Of course, at the epicenter of these changes and exchanges is the screen. Or, at least, what we generally consider today as screen—the very component that this chapter seeks to define and disclose as a pivotal player in the convergence effects of AR. In AR, little remains of the conventional screen: it appears to be no longer the dividing surface between reality and virtuality as in painting, photography, video, or even VR, but rather the unifying platform between the two. In what follows I will demonstrate that in AR the phenomenological and aesthetic role of the conventional screen, or in other words its "window condition,"[142] is challenged in two ways.

1996), 197, 233; Margaret Morse, *Virtualities: Television, Media Art, and Cyberculture*, 181; Martin Lister et al. *New Media: A Critical Introduction*, 125.

[140] Christine Ross, "The Disappearing Screen: An Incomplete Matter", 19.

[141] Ibid.

[142] Robert D. Romanyshyn, *Technology as Symptom and Dream*, 43.

On one hand, this is achieved by relativizing the role of the frame either by rendering it "invisible" (as in HMD-based projects such as Jan Torpus' *Living-Room II*), by abolishing its manifest role as a separator between on-screen and off-screen images (in projects that formally still maintain the presence of the frame, such as Janet Cardiff and George Bures Miller's *Conspiracy Theory* and Jeffrey Shaw's *The Golden Calf*), or by eliminating it completely (in locational, projection-based works such as Rafael Lozano-Hemmer's *Under Scan*). Therefore, if AR does not entirely erase the screen (which is actually impossible), then it does try to abandon our experience of a perceptible frame and all the conventions associated to it. In other words, AR tries to merge the "inside" and "outside" of the screen temporally and spatially, while investing the screen with increased maneuverability and mobility (especially in the case of mobile technology). That's why in many AR projects the screen is no longer a fixed cut-out rectangle that divides reality and representation, like the conventional screen, but rather an intermediary device, a context-aware interface that actively connects the viewer, virtual images, and location. The AR screen is, as I will explain in more detail later on, a zone which is no longer the exclusive realm of virtuality. Internalized by the user and/or physically integrated in the environment, the screen is a flexible presence in both real and virtual spheres; it is the mediator, but also the protagonist in the game of transfers between real and virtual.

On the other hand, AR questions the conventional screen model (and implicitly Alberti's precepts about the windowed view) by rendering the screen "transparent." Transparency is understood here principally as the screen's capacity to offer an optical or video-mediated image of the space behind the material surface of the display in real time, as if it were transparent. I will explain below how various technical solutions are used in this sense. But transparency has yet another, metaphorical sense. Torpus' *Living Room II* offers an evocative example where the

literal and metaphorical senses converge. In this case transparency is manifested as both the phenomenon of apparently "seeing-through" the objectual presence of the screen (and this is the aspect that I emphasize now with reference to AR screen) and the effect of the medium's disappearance, which Marie-Laure Ryan calls the "virtual reality effect", meaning "the denial of the role of hardware and software (bits, pixels, and binary codes) in the production of what the user experiences as unmediated presence."[143] In the words of Jay David Bolter and Richard Gruisin, this is the "interfaceless interface." They write: "what designers often say they want is an 'interfaceless' interface, in which there will be no recognizable electronic tools—not buttons, windows, scroll bars, or even icons as such. Instead, the user will move through the space interacting with the space 'naturally,' as she does in the physical world."[144]

To be sure, this second sense of transparency is something that—although perfected in the realm of artificial visualization systems by VR—has older roots, namely, in the Renaissance's ambition to deny the opacity of the medium's representational surface through the use of illusionistic perspective. According to Dürer (as mentioned by Panofsky's text) "*perspectiva* is a Latin word which means 'seeing through'"[145] Nevertheless, as I will further clarify, there are important differences and possible convergences between "seeing-through" as a perceptual phenomenon associated with a specific use of the screen and "seeing-through" as a representational means associated with illusionistic image making. At this point in our discussion it is also important to recall Anne Friedberg's claim that Alberti used the window in his metaphor not for its transparent quality but for its structural role *as a frame* that helps to

[143] Marie-Laure Ryan, *Narrative as Virtual Reality. Immersion and Interactivity in Literature and Electronic Media* (Baltimore and London: The Johns Hopkins University Press, 2001), 57. The complex relationships between virtuality, transparence and illusionistic representation will be discussed in more detail in chapter three of this study.
[144] Jay David Bolter and Richard Gruisin, *Remediation: Understanding New Media* (Cambridge, Mass: The MIT Press, 1999), 23.
[145] Erwin Panofsky, *Perspective as Symbolic Form*, trans. Christopher S. Wood (New York: Zone Books, 1997), 27.

construct the perspectival, virtual space of vision. Friedberg points out that "Alberti supplies us with a Renaissance root for the concept of a windowed 'elsewhere'—not a realism of subject matter but a separate spatial and temporal view."[146] Thus, it is precisely this separation in temporal and spatial terms—specific for most displays that provide a "windowed elsewhere"—that the AR screen challenges by proposing, against Alberti, the window as a transparent surface. More precisely, AR "screens" suggest not an illusionistic opening (even if illusionism is still an important device), but the idea of perceptual permeability and convergence. Of course, this is also a way to rethink the apparent exclusions between the phenomenal—optical or mediatic—transparency of the "see-through" screen and the virtual or metaphorical transparency of the representation. This challenge addresses not only Alberti's window metaphor to explain painting's perspectival imaging, but points to an entire spectrum of visualization solutions, from painting, to photography, cinema, video, and computers, which all rely on the idea of the screen as a framed and opaque medium[147]. Certainly, considering these very diverse mediums and display systems collectively is in no way meant to elide their specificities and their differences in terms of the technologies, aesthetic qualities, or visual experience they use and provide. What should be emphasized here is AR's capacity to rethink the window metaphor and consequently the screen's established nature, regardless of its technical or phenomenological specificities. By reconsidering the role of the frame as a separator and by challenging the idea of the screen as an opaque interface, AR is able to offer the viewer a different experience of a convergent space. The examples discussed below will help us better understand the nature of transparency in AR context.

[146] Ann Friedberg, *The Virtual Window*, 32.
[147] Anne Friedberg's observation about the "convergence" of various visualization systems whatever their visual regime or technology, is relevant for my argument: "[The] new space of mediated vision is post-Cartesian, postperspectival, postcinematic, and posttelevisual, and yet remains within the delimited bounds of a frame and seen on a screen." Ibid., 7.

As noted above, AR distinguishes itself from other forms of media not because of the different display technologies it employs, but because of the specific ways in which it uses and reconceptualizes them. If AR and its practical realization bring something different to visual experience and the technological repertoire, some of AR's most basic ideas, technical features, and representational solutions were already subjects of reflection and research for scientists and artists several decades ago. In the field of art, Jeffrey Shaw's 1975 installation *Viewpoint* is a good example of AR *avant la lettre*.[148] In the fields of graphics, interface design, and industry, the research conducted by computer scientist Ivan Sutherland mark important milestones in the progress of AR. If he is seen by some authors as one of the most important forerunners for AR technology, this is not without reason. His visionary ideas about the possible new experiences for the viewer offered by digital technology, as well as his substantial contribution to the development of display solutions (including the invention of the first Head Mounted Display-HMD) are a few crucial landmarks in the history of AR. Although Sutherland does not use the term AR nor explicitly defines AR technology, he does write about concepts such as 3D computer modeling, visual simulation, computer-aided design (CAD), and virtual reality—all of these having particular relevance in the research and development of AR systems. In his seminal essay "The Ultimate Display," published in 1965 while conducting research on immersive technologies, Sutherland makes his famous predictions about the possibility of a "kinesthetic display" that would allow users to involve all their senses when interacting with the virtual worlds of the computer. Yet to be invented as a physical, functional device, the "kinesthetic display" remains a significant concept and technical principle as it anticipated some of AR's actual possibilities, including the possibility to expand the physical objects and the perceptual functions of the user into the virtual realm. Sutherland writes: "There is no reason why the

[148] See the first chapter, section 1.4., where I discuss the technical and aesthetic dimensions of this work.

objects displayed by a computer have to follow the ordinary rules of physical reality with which we are familiar. The kinesthetic display might be used to simulate the motions of a negative mass. The user of one of today's visual displays can easily make solid objects transparent - he can 'see through matter!'"[149] Two particular aspects in this statement should be emphasized: one is the idea of transparency, an essential feature of the most AR display solutions. "Seeing through the matter"—that is, through the screen or through the real objects augmented with virtual information—is namely the premise of Jeffrey Shaw's *Golden Calf* with its "permeable" screen and Jan Torpus' *Living Room II* in which the real walls of the room are effectively replaced by virtual images in one of its scenarios.

Fig. 2.4. Ivan Sutherland, "The Ultimate Display." 1965. I.E. Sutherland, Proceedings of IFIPS Congress, New York, May 1965, Vol. 2, 506-508.

Another important aspect mentioned by Sutherland which is significant to the crystallization of the idea of AR is the strong confidence given to the power of virtual information to intervene effectively in the real world. While AR and other comparable systems

[149] Ivan E. Sutherland, "The Ultimate Display", *Proceedings of the International Federation of Information Processing Societies (IFIPS) Congress*, New York, USA , May 1965; vol. 2, 506-508.

are not yet able to "simulate the motions of a negative mass," AR is surely able to simulate motions, objects, or figures that do not "follow the ordinary rules of physical reality with which we are familiar." Sutherland elaborates on this ideal of technological control over reality and on the crucial role the display plays in attaining such results, in one of his most quoted fragments:

> The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked.[150]

In spite of its somewhat bombastic and overenthusiastic tone, Sutherland's proclamation is quite significant to the history of AR, at least for its visionary value. Think for example of the room-sized VR or AR projects that rely in great part on the ideas of realism, immersion, and multi-sensorial interaction. But his idea of the "ultimate display" also took a concrete form in his HMD project realized in 1968.[151] The device was rudimentary by today's standards in terms of both usability and visual quality. Being too bulky to head mount, the display needed to be attached to a mechanical arm suspended by a rod from the ceiling of the lab. In order to experience the image, the user's head was strapped into the device. The formidable aspect of the hanging mechanism inspired its nickname: "The Sword of Damocles." As for its visual capabilities, this HMD was essentially a set of glass prisms that reflected images from two small video monitors. A computer supplied the images to the monitors: a single wireframe cube delivered images in

[150] Ibid.

[151] About this subject, see among others: Ken Pimentel and Kevin Teixeira, *Virtual Reality. Through the New Looking Glass*, Second edition (Blue Ridge Summit, PA: Windcrest/McGraw-Hill, 1995), 44; Brenda Laurel, ed., *The Art of Human-Computer Interface Design*, (Reading, Massachusetts: Addison-Wesley Pub. Co., 1990), 445; Steve Jones, ed., *Encyclopedia of New Media: An Essential Reference to Communication and Technology* (Thousand Oaks, CA: Sage Publications, 2003), 428; Woodrow Barfield and Thomas A. Furness, eds. *Virtual Environments and Advanced Interface Design* (New York: Oxford University Press, 1995), 21-22.

stereoscopy to the viewer's eyes. But unlike other "classical" stereoscopic images, these were interactive: the pictures in the monitors changed according to the user's head orientation and position, which were tracked by sensors situated in the helmet and in the rod. What was particularly significant, especially with regard to our subject, is that Sutherland's HMD permitted the user to see the room *through* the transparent elements of the hardware. Thus, it is not surprising that most specialists in the field considered "The Sword of Damocles" as the first AR display. Whether his ideas were applied or remained at the level of intention, Sutherland's role in the development of AR is incontestable. More precisely, by suggesting as a possible direction of research the idea of empowering physical reality with technological information via a body-responsive display, Sutherland points to one of the foundational principles of any AR system: to bring together reality and virtuality into the same perceptual matrix—what I call here the convergent space.

The research dedicated to the field of AR per se incorporated the achievements of Sutherland and other forerunners resulting in the development of more reliable and sophisticated display devices. The scientific literature dedicated to the problem of the screen took on similar proportions, establishing the indices of such development in the theoretical realm. A constant in these efforts is the reiteration of a "frameless" view and the transparency of the visualization systems as essential prerequisites for obtaining a better augmented image. In this sense, as computer scientists Oliver Bimber and Ramesh Raskar write: "Augmented reality displays are image-forming systems that use a set of optical, electronic, and mechanical components to generate images somewhere on the *optical path* in between the observer's eyes and the physical object to be augmented."[152] Technically speaking, the same authors explain, AR displays fall into

[152] Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality. Merging Real and Virtual Worlds* (Wellesley, Massachusetts: AK Peters, 2005), 71.

three main categories: *head-attached*, *spatial displays*, and *handheld*, all of them presupposing their own specific subcategories.[153] While AR spatial displays sometimes use a projection-based system to mix the real scene with the virtual images, most displays (in all three categories) use a visual solution with a more prosaic term, "see-through." As Milgram *et al*. explain, this is a system

> characterised by the ability to see through the display medium directly to the world surrounding the observer [or a real-time video stream of the same space], thereby achieving both the maximal possible extent of presence and the ultimate degree of 'realspace imaging.' Most commonly display augmentation is achieved by using mirrors to superimpose computer generated graphics optically onto directly viewed real-world scenes.[154]

Milgram *et al*.'s description—although made at an early stage of the development of AR technology—has a symptomatic value, since it argues about AR's capacity to destabilize the visual regime of the conventional screen: once the display is rendered transparent, the perceptual separation between virtuality and reality is drastically reduced. While such an operation may hardly produce the "ultimate degree of 'realspace imaging'," AR can nevertheless offer a convincing experience of convergent space, no matter how unstable the balance between continuity and discontinuity in the real-virtual intermingling.

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[153] As Bimber and Raskar point out, these different types of display solutions are not competitive, but rather complementary (Ibid., 8). This specification can also be seen as an argument for the idea that AR is not *a* technology, but rather a set of technologies that share the same preoccupation for offering a different perceptual paradigm. For an overview of the AR display types see Bimber and Raskar, *Spatial Augmented Reality*, Chapter 3, 71-92. One technical aspect explained by these authors has a particular relevance for understanding how AR articulates the interactions between reality and virtuality and between "live" and mediated image. As described by the two researchers: "When *stereoscopic rendering* is used to present mixed (real and virtual) worlds, two basic fusion technologies are currently being used: *video-mixing* and *optical combination*. While video mixing merges live record video streams with computer-generated graphics and displays the result on the screen, optical combination generates an optical image of the real screen (displaying computer graphics) which appears within the real environment or within the viewer's visual field while observing the real environment." 71-72.

[154] Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum" *SPIE* [The International Society for Optical Engineering] Proceedings, Vol. 2351: *Telemanipulator and Telepresence Technologies*, (1994), 284.

While some display solutions like HMDs or certain projection-based displays offer an immersive experience of the augmented scenario, others like the monitor-based or hand-held displays such as cell-phones, laptops, or tablets do not. Certainly, there are advantages and disadvantages to each of these technologies. While handheld devices permit the viewer greater mobility, more static or location-bound HMDs and spatial displays currently provide a higher visual quality and sometimes a better illusion of the augmented image. Nevertheless, the choice of a particular display solution is in great part dictated by the intended visual effect, by the technical provisions of the respective AR project, and, last but not least, by the means and the pecuniary resources available for production (an aspect that has a particular significance for artists).

Looking more closely at the recent evolution of AR systems and applications, one can notice a certain shift in the frequency of use of certain display solutions at the expense of others—a shift that mirrors in fact a change in AR's general philosophy and objectives, translated in the move from immersivity to mobility.[155] It is noteworthy that a great number of scientific writings dedicated to AR research—especially those published in the 1990s and early 2000s—considered the HMD as best suited to deliver an augmented image and therefore as the most typical interface for experiencing AR. To some extent, this option indicates the persistence of the previous paradigm from which AR research has emerged: VR and its emblematic interface, the HMD (used extensively especially in early VR projects[156]), together with the visualization strategies based on immersive 3D graphic design. The fact that AR is still partially reliant on the HMD apparatus and its visualization logic, proves its effectiveness in providing a

[155] About these changes in the options for specific display solutions, see the section "Spatial Augmented Reality" in Bimber and Raskar, *Spatial Augmented Reality*, 7-8.
[156] As observed by, among others, Bimber and Raskar, "the virtual reality community has oriented themselves away from head-mounted display (…) towards spatial displays" (*Spatial Augmented Reality*, 7).

better (although still imperfect) illusion of the real-virtual hybrid image. However, as the AR research has developed, the immersive and illusionistic potential of the AR system has been surpassed in importance by the attention given to its mobile capabilities and to the quantity, quality, and accessibility of virtual information used to overlay physical reality. Implicitly, such a shift marked the move from the HMD supremacy towards the predominance of handheld displays and, as a consequence, from mainly indoor to primarily outdoor, mobile AR applications.

2.5. Towards a typology of AR visualization solutions

Regardless of the degree of immersivity or mobility provided by an AR application or artwork, the screen remains the key player in the convergence process. The screen in AR is the factor that largely determines not only the experience and the configuration of spectatorship (i.e. *how* one sees), but also the content of the augmentation and therefore the visual regimes of AR (i.e. *what* one sees). As an example, see the differences in terms of experience and content between, say, Torpus' HMD-based immersive worlds and Cardiff's handheld camera video walk.[157] Therefore, it is important to examine closely the connections between the screen's specific technological features (the visualization capabilities and the means used to engage with the participant and the site), and the ways in which convergence processes become "effective" ("effective" referring to one or more aspects related to the accuracy of the real-virtual intertwining, to mobility, locational adequacy, informational capacity, interactive functionality, immersivity and illusionistic potential).

[157] See Chapter 1, Section 1.4. of the present study for more details.

To proceed with this examination, I propose an instrument for evaluating the process of convergence: an AR "typology" based on the technical and phenomenological specificities of different types of display solutions used in AR projects. This typology is an analytical tool that will help us to investigate the ways in which the material and technological basis of the AR screen determines the visual effects of the artwork, the degree of immersivity or mobility provided for the viewer, and the way in which virtual information is inscribed into the actual environment "in real time." It is important to mention that identifying different "types" of augmentation does not suggest any aesthetic or technical hierarchy. Nor does my interpretation attempt to establish boundaries or exclusive criteria of analysis. This typology is rather intended to work as a framework for assessing—from an art historical and visual studies perspective—various manifestations of the AR convergence process where the screen persistently acts to secure the convergence effect.[158] I distinguish three different types of augmentation related to the three basic models of AR display solutions, all of which reject the conventional screen model. These types are *integrativity*, *projectivity* and *mobility*. They correspond to the three main categories of the AR screen technology, *head-attached*, *spatial displays* and *handheld*.[159]

The integrative type is about seamlessness, about an ideally flawless (although inevitably discontinuous) intertwining of real space and virtual data. Researchers and artists working with this type of augmentation are concerned with immersivity, depth of field, and the "perfect"

[158] A possible taxonomy of "spectator interfaces" is presented by Steve Benford and Gabriella Giannachi in their book *Performing Mixed Reality* (Cambridge: The MIT Press, 2011). This taxonomy defines and compares two dimensions in order to chart out an overall design space for spectator interfaces: one is *manipulations* (the actions carried out by the primary user of the interface) and *effects* (the display of graphics and sounds or the movement or other actuation of physical devices) (p. 156-57). The merit of this taxonomy is that it tries to synthesize the specificities of AR in using the interface, but, conceived as it is on only two axes (manipulations and effects), this taxonomy is actually less instrumental in understanding the complexities of the convergence process in AR, one that presupposes, in various degrees, immersivity, projectivity and mobility.

[159] See also: Yolande Kolstee, "A Short Overview of AR," and Joike Verlinden, "Pixels Want to be Freed! Introducing Augmented Reality, Enabling Hardware Technologies," in *AR[t] Augmented Reality, Art and Technology*, no. 1, (April 2012): 8-11, and 42-50, respectively.

illusion: the virtual objects are rendered three-dimensionally, the image's flatness is replaced by profoundness, immersion substitutes arm's length visual experience. The viewer seems to be literally inside the convergent space amongst its objects and images (both real and virtual) and not in a detached, "cinematic" mode of perception. Jan Torpus' *Living Room II* provides a very good illustration of the integrative type: the see-through interface and the 3D graphics superimposed congruently with the real space and the viewer's position provide an immersive sense of realism and depth, a feeling that one is effectively *integrated* into the real-virtual convergent space. The convention of the frame is practically absent in the all-embracing visual sphere (although, technically speaking, the frame is inescapably present), and the screen, once rendered transparent via the see-through facility, gives a compelling impression of continuity between the real space of the room and the virtual computer-generated, graphical objects.

The use of a more sophisticated display solution like a HMD is essential to accommodate such a complex visual scenario. The HMD offers in most cases a stereoscopic view, is able to present the output closer to the wearer's eyes, can include a tracking device so that the image in the monitor and the user's point of view are aligned, permits certain mobility and therefore it provides better immersivity.[160] According to Bimber and Raskar, the HMD's invention marks "the birth of augmented reality,"[161] and, at least in the first stages of development, AR experience has been synonymous with HMD usage.[162] However, this display solution does have

[160] For more technical details of the HMD, see Ozan Cakmakci and Jannick Rolland, "Head-Worn Displays: A Review," *Journal of Display Technology*, 2, no. 3, (September 2006).
[161] The authors refer to Sutherland's development of the first functioning HMD. Bimber and Raskar, *Spatial Augmented Reality*, 4.
[162] As a short historical digression, it is worth mentioning here the experiments involving proto-HMDs conducted by the avant-garde group of architects Haus-Rucker-Co. (Laurids Ortner, Gunter Zamp Kelp, Klaus Pinter), working in Vienna, Austria and later Düsseldorf, Germany, between 1967-1992. Among their numerous projects and research themes involving artistic and architectural interventions, the idea of a "second nature"—the fusion of the naturally grown and the artificially created objects—should particularly be emphasized in this context. Under the sign of "second nature" the group created, between 1967 and 1968, a series of devices dedicated to experiment with the possibility of obtaining new sensorial experiences. Among the practical efforts in this direction is the creation of a

some drawbacks as well: heaviness, an unstable screen resolution, and a limited field of view—not to mention the high cost. Partly because of these inconveniencies and partly because of the development of other, more flexible and reliable interfaces that go beyond the head-mounted display paradigm,[163] the HMD seems to be utilized less and less now compared to one or two decades ago. But this does not mean that the HMD has become a museum relic. Despite the drawbacks and the recent research trends towards mobile display solutions, the HMD is still utilized, especially in lab-based projects, precisely for its capacity to offer an illusionistic, immersive experience which creates a more effective "osmosis" (to allude to Char Davies' work) between the user, the real environment, and the virtual worlds displayed.

The following example is illustrative in this sense: *Exercise in Immersion 4.1* is a project created by Dutch artist Marnix de Nijs in collaboration with V2_Rotterdam.[164] Conceived site-specifically for the V2_Lab, the work is a sort of first-person game that aims to question the degree to which virtual images can be integrated within a real space. The user wears a sophisticated crash suit, a backpack with a computer, and goggles that provide a stereoscopic video feed of the hall recorded by a camera attached to the head.[165] As the user walks into the room, s/he perceives small virtual spheres, or, as the author names them, "bionts" flying around.

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series of helmets/masks called *Environment - Transformer* (1968): *Flyhead*, *Viewatomiser* and *Drizzler*. As Laurids Ortner, one of the group members, describes them: "*Environment - Transformer* are appliances that change sensory impressions for a limited time in a visual and acoustic way. The processes of seeing and hearing are drawn out of their habitual apathy, separated into their individual functions and put together again as special experiences." (Ortner & Ortner Baukunst, Haus-Rucker-Co. Splendid Blend, http://www.ortner.at/ (accessed December 2015). It should certainly be added that the practical function of these proto-HMDs is hardly evident. However, their value relies mainly in the visionary concept they propose—to create a perceptual link of the natural and the artificial worlds.

[163] "The emergence of several trends, such as the increased availability of wireless networks, miniaturization of electronics and sensing technologies, and novel input and output devices is giving rise to user interfaces suitable for use in our daily living. A range of displays, both on-body and in the environment, are being developed to provide visual output for the users." Ozan Cakmakci and Jannick Rolland, "Head-Worn Displays: A Review", 199.

[164] See V2_Lab, *Exercise in Immersion 4.1*, http://www.v2.nl (accessed December 2015). A demo version of the work was on display in the exhibition at DEAF07—the Dutch Electronic Art Festival, 2007.

[165] For more technical details and the technological context of the work, see Jan M.V. Misker and Jelle van der Ster, "Authoring Immersive Mixed Reality Experiences" (especially section 14.4.4 "Directing the User Experience") in *The Engineering of Mixed Reality Systems* eds. Emmanuel Dubois, Philip Gray, Laurence Nigay. (London: Springer, 2010), 286-290.

The user collects the bionts by walking up to them, after which they "stick" to the user's body. The bionts are used to advance in the higher levels of the game, but they also help the user navigate in the physical space. Since the bionts tend to gather around the concrete pillars in the room (which are not always visible because of the goggles), the small flying spheres help the user avoid crashing into the pillars; in this sense, they become an extension of user's physical body and senses. As the game advances, the world presented to the user changes from a video feed of the real space into a virtual, adapted 3D copy of it. At first, the simulated space matches the real room, but gradually, as the player collects more bionts, the virtual space becomes more and more manipulated. Thus, the viewer is slowly transported perceptually from the real world to a virtual world quite different from the one he/she physically inhabits. Speaking about the effects of such transformation the artist states:

> The gameplay focuses on the boundary between virtuality and reality, between real and unreal. I place myself at that boundary and play games with it, like taking away pillars in the game world that are there in reality, so you run into them. It's a physical way of showing that boundary. It doesn't get any more physical than that. You smash right into the pillar, and out of the artificial world. That's why you're wearing a crash suit. The dividing line between reality and unreality, immersion and non-immersion, [always] plays a part in my work.[166]

As de Nijs explains, *Exercise in Immersion 4.1* is approached as a game, in the sense that it involves interaction with the user interface, it generates visual feedback, it has different successive levels, the user has a certain "mission" to achieve, etc. However, the work's main focus is not only on the accomplishment of certain tasks but mostly on the visual experience it

[166] Arie Altena, "Interview with Marnix de Nijs about EI4", V2_Archive, http://www.v2.nl (accessed December 2015).

offers to the participant, on the effects provided by the illusionistic and immersive shifting environment.

Fig. 2.5. Marnix de Nijs, *Exercise in Immersion 4.1*. 2007. Immersive AR installation. In collaboration with V2_Rotterdam.

In this sense, the work explores the core nature of the idea of the game in general: to invent, develop, and play with different "other" worlds while remaining anchored in our immediate reality. As architect and theoretician Alberto Iacovoni very pertinently observes when speaking about what he believes to be the most characteristic and pervasive power of the game, "to play is first of all *in-ludere*, literally 'to enter into the game' but it is also 'illusion', to construct each time a new *in-lusio*, the illusion of a possible reality, of a separate world with different rules from those which, sometimes unfortunately, we observe during most of our waking hours."[167] This is what *Exercise in Immersion 4.1* aims to offer the participant: a gaming world created *in-ludere*, an illusionistic realm in which at a certain point the player loses connection with the real world, only to abruptly reconnect with it once he/she crashes into the physical reality of the game setting. Of course, the role of the screen is crucial in creating this illusionistic discourse: against the Albertian metaphor of the window, the screen conceals the

[167] Alberto Iacovoni, *Game zone: Playgrounds Between Virtual Scenarios and Reality*, trans. Gail McDowell, (Basel: Birkhäuser, 2004), 10.

clear presence of the frame as a "cut-out" rectangle, while it allows through its "transparent" surface a progressive merging of real and virtual images. The way in which the viewer engages with the interface and experiences the immersive image is not completely different from that of VR environments, where, as Christine Ross writes,

> The screen exists but it ceases to generate an experience of the frame, the surface and even the image. This means that the traditional tension that characterizes our habitual media experience, the tension between 'seeing the surface' and 'looking through it,' is diminished in favour of an experience in which the rhetoric of the image's transparence (where the image is explored in such a way as to hide the means of its production and to depreciate its reflexivity) becomes primordial.[168]

But if indeed the experience of the frame ceases to exist and if the surface of the screen is turned into a "thin membrane"[169] the presence of the display is not completely denied in this particular circumstance: there is an inevitable perceptual constrain due to the limited field of view provided by the HMD, not to mention the cumbersome physical configuration of the equipment worn by the participant. Moreover, the "transparent" illusion is undermined by the very technical nature of the apparatus: the inevitable perceptual inconsistencies between the two overlaid registers, real and virtual, will always call the user's attention to the artificial nature of this immersive game. But this is what the process of AR spatial convergence will always be: a fragile balance between illusionistic continuity (a different perceptual syntax created to expand the world within virtual information) and discontinuity (the unavoidable failure to realize a "perfect" real-virtual merging).

[168] Christine Ross, "The Disappearing Screen: An Incomplete Matter," 18.
[169] The expression belongs to Margaret Morse. She is quoted by Martin Lister et al. who note that Morse "thinks of the TV screen as a thin membrane between an immaterial world of symbols—a 'pocket' of virtuality—and the material world from which we view it." Martin Lister, et al. *New Media: A Critical Introduction*, 125.

The second type of augmentation in my proposed typology is *the projective type*. This is about the screen as a spatial display.[170] Artworks and applications within this category use, in most cases, the actual site as a projection surface. But, unlike a simple video projection on a façade for example, where surface and image are not aligned, here the projected image is adjusted to fit the setting and at the same time is adapted to the position of the moving participant in space. A better alignment helps to bring a more dissembling effect, one that could apparently dissolve the virtual image and the possible phenomenological presence of the screen into the physical environment.[171] Rafael Lozano-Hemmer's work *Under Scan* (described in the first chapter) provides a good example of how the projective type of augmentation operates. Mapping the real environment of the work (the public square) and the position of the participants' bodies (more precisely their shadows) in the same space, the system is able to deliver an almost congruent projection of the virtual images (the video shots of various volunteers) within the shadows of the participants, as a *mise en abyme*. The extent to which the illusion is realized—

[170] The spatial display is described by computer scientists Bimber and Raskar as follows: "In general, spatial displays detach the display technology from the user and integrate it into the environment. Compared to head- or body-attached displays, spatial displays offer many advantages and solve several problems that are related to visual quality (e.g., resolution, field-of-view, focus, etc.), technical issues (e.g., tracking, lighting, etc.), and human factors (e.g., cumbersomeness, etc.), but they are limited to non-mobile applications." (*Spatial Augmented Reality*, 7).

[171] Here, too, a short historical excursus is needed. A work that suggests *avant la lettre* the projective AR's visual regime is Peter Campus' video installation called *Interface*, from 1972. The installation is organized around a large transparent glass screen that has on its opposite sides a video camera and, respectively, a video projector plus a light source. Once entered in the interaction zone in front of the glass, the viewer perceives on the screen two simultaneous, near-life-size images of himself/herself: one is the directly mirrored image, the other is the video image captured by the camera behind the glass and projected onto the viewer's side of the screen. Depending on the participant's position within the installation, these two images appear either superimposed, or side by side, but always in a reverse position. The result is an illusionistic environment that combines real-time the reflected and the video mediated image of the body on an apparently frameless and transparent screen. AR projective type's efforts to erase the frame (and even the screen) and to visually integrate the body of the viewer directly into the image is actually very close to Campus' attempt to turn the screen into a performative zone, while manipulating and fusing two different spaces together. In her very insightful analysis of Campus' work, art historian Kate Mondloch insists on *Interface*'s ability to "enable visual *continuity* in terms of the spectator's spatial perception, thereby destabilizing the screen's conventional role of depicting representations that are visually and/or conceptually *discontinuous* with the spectator's own space. This reversal is profound inasmuch as it challenges our traditional experiences with both screen space and real, material space in an art context." (Kate Mondloch, *Screens. Viewing Media Installation Art*, 72). For the description and discussion of two other similar works by Campus, *mem* and *dor* (both 1974), see Rosalind Krauss, "Video: The Aesthetics of Narcissism," *October* Vol. 1 (Spring 1976): 50-64.

that is, the degree of dissemblance—is something supposedly negotiable: if there is never a perfect overlay of the video image in the shadow, the viewer will nevertheless enter the deceiving game through establishing eye-contact and mute dialogues with the virtual characters. Therefore, like in the integrative type of augmentation, but with different effects, in this case too the boundaries between separation and convergence of spaces remain fragile.

Two other examples belonging to the projective type are relevant for understanding the particularities of AR convergence process. One is Adam Frank and Zack Booth Simpson's work entitled *Shadow* (2004).[172] Like the above example, this project relies as well on live human participation and on the deceiving presence of shadows. However, in this case the shadow is not "*met en abyme*" by video projections, but is revealed instead in its most evident manifestation: as a black spot. The work requires the presence of a participant in a dark area illuminated by spotlights where, alongside his/her shadow, a disembodied, virtually generated human shadow appears projected on the ground (real-time 3D graphics and video sensors are used to inscribe the virtual projection in the real space in an illusionistic and interactive manner).

Fig. 2.6. Adam Frank and Zack Booth Simpson, *Shadow*. 2004. Interactive AR installation.

[172] Adam Frank, *Installations*: *Shadow* (2004), http://www.adamfrank.com (accessed December 2015).

The focus of the work is on the confrontation between the participant and the disembodied shadow: the seemingly living silhouette chases the viewer's real shadow attempting to merge with it. When this occurs, it appears that the invisible figure insinuated by the virtual shadow inhabits the viewer's own personal space. Thus, by seriously blurring the distinctions between the chimerical image of the virtual shadow and the reality of the body (the latter which implies an illusion, too—that of its own shadow) the work articulates a critical terrain in which the clear distinctions of real and virtual tend to be seriously relativized, as do the established physical and communicational distances we normally maintain in relation to other bodies in public space (what anthropologist Edward T. Hall has called proxemics[173]).

Another example of the projective type is *Spac[E]scape*, a series of site-specific installations created between 2006 and 2007 in different locations[174] by the Workspace Unlimited group, an organization founded by media artist Thomas Soetens and architect Kora Van den Bulcke, whose work mainly operates at the convergence of media arts, architecture, and design. *Spac[E]scape* proposes a complex visual experience by bringing together real architectural spaces and virtual, digitally generated ones in networked hybrid environments of interaction. The work consists of a 3D modeled simulation of the exhibition space where the work is installed which is seamlessly integrated, through a full scale projection, within the real exhibition setting as a digital *trompe-l'oeil*. In the virtual architectural space the viewer sees two avatars with their backs towards the viewer who watch the images (captured by two webcams) of

[173] Edward T. Hall developed the concept of proxemics in his 1966 book *The Hidden Dimension*, (first edition, Garden City, NY: Anchor/Doubleday, 1966). Hall defines proxemics as "the interrelated observations and theories of man's use of space as a specialized elaboration of culture" (*The Hidden Dimension.*, 1). Hall distinguishes four categories of spatial distance in personal and cultural interactions: intimate distance, personal distance, social distance, and public distance (Ibid., 116-29).

[174] The work was commissioned and exhibited at: Stuk Art Center, Leuven for the *Artefact* festival (2007); LABoral Art Centre, Spain, for the exhibition *Gameworld* (2007); V2_ Institute for the Unstable Media for the *DEAF* festival (2006); Art Center Nabi, Seoul for the exhibition *Connected*. See: Workspace Unlimited website http://www.workspace-unlimited.org/ (accessed December 2015).

real participants wandering within the space of the installation, now rendered as a virtual space. The video capture of the real participants, once displayed within the virtual architecture, becomes another virtual space. From a computer terminal situated in front of the screen the participant can control the avatar to navigate the virtual space. When the avatars approach the virtual video screens (containing the webcam images), the latter become portals to other virtual worlds connected to (and simulating) other real locations in Ghent, Rotterdam, Gijón-Spain and Montreal. The connection—realized through the Common Grounds network—permits the users situated physically in disparate locations to be reflected and interact with each other within the same hybrid spaces of the *Spac[E]scape*.[175]

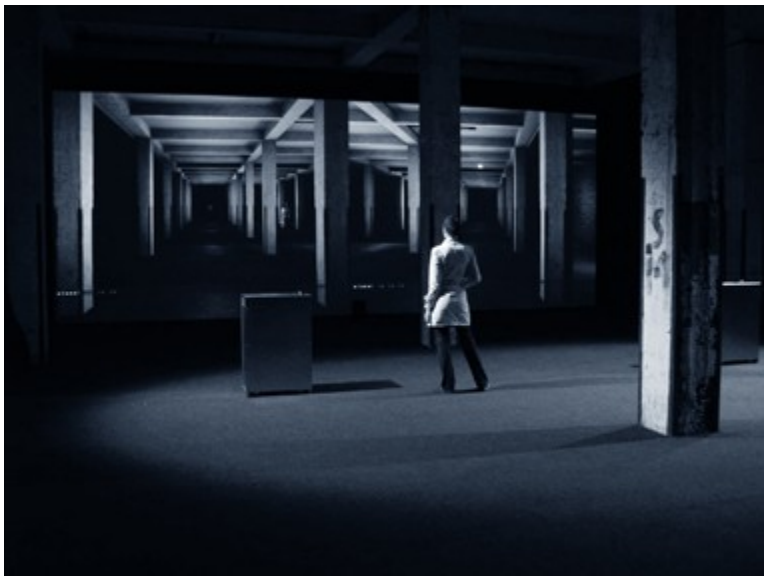

Fig. 2.7. Workspace Unlimited, *Spac[E]scape*. 2006-2007. Interactive AR installation.

[175] As explained by the Workspace Unlimited group, "Common Grounds installations are unlike traditional game spaces since they are inextricably linked to their physical surroundings in existing public spaces and architectural environments in Europe, Asia and North America, while fundamentally remaining available in the Common Grounds network. Examples include *Extension* (2002), created for the Society for Arts and Technology in Montreal, *Devmap* (2004), commissioned by the V2_ Institute for the Unstable Media in Rotterdam, and *Implant* (2006), linked to the Vooruit Arts Center in Ghent." Workspace Unlimited website, Ibid.

In all these examples of the projective type, the screen is used in ways that contest the conventional screen, both as a media object and as a viewing regime. But this is accomplished not by enabling the viewer to embody the interface (like the integrative type's HMD), but rather by challenging the neutral position that the screen typically maintains vis-à-vis the real environment where it is situated and experienced (think cinema, TV or computer monitor). Here, the screen—or rather the surface that acts as a screen—is no longer a detached object, nor is it the guarantor of the limit between real and virtual spaces; rather, it is part of the environment. The display actually is the built environment *and* the technical apparatus, it is the real *and* the virtual space at the same time. Transparency is an important factor too in challenging the principles of the conventional screen. While in the case of the HMD—and, as we will see below, of the mobile devices—transparency relies mainly on the optical permeability of the apparatus, in the case of the displays used in the projective type, transparency consists of the phenomenal illusionism of the virtual images projected onto or integrated into the environment, an effect that belies the material opacity of the surface. In this particular context, the difference between optical and metaphoric senses of surface transparency is more nuanced.

To better understand this nuance, I consider the observations about the various effects of transparency in the context of modern painting and architecture made by the architect Colin Rowe and the painter Robert Slutzky in their influential text "Transparency: Literal and Phenomenal." Proposing a clear differentiation between the two terms, Rowe and Slutzky define "literal" transparency as a condition of non-opaqueness, as in their example of the Bauhaus Dessau, which provides a literal transparency of the glass facades. Meanwhile, "phenomenal" transparency is described as a circumstance that allows for a simultaneous perception of different spaces within the same spatial framework. Here they give as example the interplay of

architectural spaces in Le Corbusier's villa at Garches, in which, as the authors put it: "these stratifications, devices by means of which space becomes constructed, substantial, and articulate, are the essence of that phenomenal transparency…."[176] All three works discussed above propose "stratifications" within the same framework of different visual layers—shadows and video projections (Hemmer and Frank and Simpson), or real and virtual spaces within spaces (Workspace Unlimited). Thus, in these specific cases, transparency appears to be a more complex issue, one that implies, as Rowe and Slutzky remark, "more than an optical characteristic. It implies a broader spatial order. Transparency means a simultaneous perception of different spatial locations. Space not only recedes but fluctuates in a continuous activity."[177] Far from being an analysis of augmentation (the text was originally written in 1955-1956), their text nevertheless provides important insights on the possibility of articulating (and the means to analyzing) complex, multi-layered spatial situations that ask for "simultaneous perception." These observations shed light on my own analysis of the convergence process, one that, indeed, is manifested as a "fluctuating continuous activity" between different spatialities.

One of the "side effects" of the phenomenal transparency in *Under Scan*, *Shadow*, and *Spac[E]scape* is the reduction of the screen at its contained image. If the screen is still present, its presence is not manifested in the form of a discrete object, as a third party player in the economy of the visual experience of the work. The screen *is* the environment, or more accurately, the real environment is the screen and implicitly the virtual image contained within it. Writing about how the video artist Michal Rovnar approaches the screen in her 2002 installation *Time Left* (in a way which is close to this type of AR, and therefore relevant for my argument),

[176] Colin Rowe and Robert Slutzky, "Transparency: Literal and Phenomenal," *Perspecta*, Vol. 8 (1963), 53.
[177] Ibid., 45. In the more particular context of media visualisation, the idea of transparency in relation to the screen is discussed by Anne Friedberg, *The Virtual Window*. in the section "Transparency, 'dematerialization,' and the end of perspective," 117-123.

Christine Ross demonstrates how by allowing the screen to take the place of the walls her work creates perceptual situations that "affirm the persistence of the screen as a projection space, but which affirm it by designating its precariousness and the ensuing increase in the fictionalization of the real."[178] In a similar manner, the works discussed here integrate the screen physically and phenomenologically into the real space, thus identifying it with the real space and thereby creating a hybrid space formulated as a "fiction of reality"—an essential aspect of the AR convergence process (to which I will return in the next chapter). However, two important differences set the AR works apart from Rovnar's video installation: the interactive dimension and the life-size scale of the virtual images in the AR works, two aspects that significantly contribute to the dissembling effect of the projective type.

Another important element at play in blurring the border between the real space and the virtual image projection, that is, in articulating the "fictionalization of the real," is the absence of the frame. While in the case of the integrative type the presence of the frame is somehow suggested by the limited visual field of the HMD, or if in the case of the nomadic type—as we will shortly see—the frame is still present despite its diminished role, here the frame seems to disappear altogether. At least that conventional (objectual) frame that clearly marks the territory of representation and which assigns to the virtual zone a different ontological status vis-à-vis the real world. Of course, in our examples, the absence of the frame does not completely eradicate the tension between the viewing subject and the spaces of representation. Approached as a projection surface, the screen still maintains a certain discrepancy (if not quite an "ontological cut") between the actual environment and virtual image. However, in contrast with the conventional screen, here the "cut-out rectangle" of the frame becomes vague or indistinct. The perceptual separation between different materialities and between surface and surrounding space

[178] Christine Ross, "The Disappearing Screen: An Incomplete Matter," 20.

are reduced to a minimum: unframed, virtual images seem to be part of the real setting. Projected (read assimilated) on the ground or on the wall, these virtual images claim something of the real environment; they belong somehow to the environment. Furthermore, there is something else that invalidates the screen-as-window metaphor in the projective type of AR (as seen in *Under Scan* and *Shadow*): the orientation of the display surface. In these cases, the screen is not positioned for a vertical, conventional view, but presupposes a high-angle viewpoint, as the virtual images are projected on the ground in relation with participants' real shadows. This not only manipulates the conventional perception of the screen, but also reveals the possibility of a tactile involvement: in both these works, the participant is prompted to be involved physically with the piece. It is fair enough, then, to say that exploring the limits of the conventional viewing experience by aligning two orders of reality (the physical and the virtual) within these parameters, the projective type of AR attests to a different aesthetic and phenomenological dimension of the screen. But, however convincing the effect of this alignment may be, the illusion offered by the screen is not complete. There is always something to remind the viewer that he/she is part of a deceiving discourse, that the illusion is neither perfect nor permanent, and that there lies in the work an unavoidable perceptive split between virtual and real.

The third type of AR experience called *the nomadic type* is about the mobile screen—the screen prêt-à-porter; the screen as a tiny device that inhabits our pockets and purses; the screen that is at the same time, tool and jewelry, information platform and toy. This is the personalized screen in the user's hands, ready to interact and, ideally, always aware of the viewer's position on the map. It is the networked screen of democratic access to information. It is the interface destined to experience location-aware information, i.e. "locative media": the smart phone, the tablet, the personal digital assistant, or the laptop, hooked up to a wireless network (WiFi) and

surveilled by Global Positioning Systems (GPS).[179] What's more, it is the screen that is able to enhance our experience of the environment on the spot, through mobile augmentation—an augmentation on the go.

The idea of expanding the computation experience in the mobile mode was on researchers' agenda since the 1960s. Various attempts were made, with varying degrees of success, especially in the last years, to make the screen more wearable and therefore to integrate the virtual data more feasibly within the material world space.[180] It was in the first decade of the 2000s, however, that more reliable systems for mobile AR were launched. From this point, several platforms and applications, developed equally by corporations and by independent researchers, supported this type of AR experience. The most popular "reality browsers" designed specifically for AR include: Wikitude, (the first Augmented Reality Browser for smartphone-users) an AR travel-guide and personal navigation system developed initially for Google's Android handset that displays on the mobile camera view data about user's surroundings, drawn from Wikipedia;[181] Layar, an AR browser that layers information delivered through open-source content management system over the actual image of a real space, streamed live on the mobile

[179] The term "locative media" was coined in 2003 by Karlis Kalnins, the Technical and Creative Director of Locative Media Lab, an international network of people from various areas preoccupied by the technological and social potential of the portable apparatuses. The term locative media was proposed as a concept meant to make the latter creative explorations of media and space distinctive from the internally-organized technological services clearly attached to a fixed location and usually and restrictively provided by a corporate organism. (See Anne Galloway and Matt Ward, "Locative Media As Socialising And Spatializing Practice: Learning From Archaeology" *Leonardo Electronic Almanac*, Vol. 14, Issue 3/4, June 2006). Ben Russell, the author of a manifesto for the locative media (the "Headmap Manifesto") gives a comprehensive definition of the term in the proceedings of the Transcultural Mapping workshops: "Locative media is many things: A new site for old discussions about the relationship of consciousness to place and other people. A framework within which to actively engage with, critique, and shape a rapid set of technological developments. A context within which to explore new and old models of communication, community and exchange. A name for the ambiguous shape of a rapidly deploying surveillance and control infrastructure." (Ben Russell, "TCM Online Reader: Introduction", *Transcultural Mapping (TCM) reader*, 2004. Available at http://web.archive.org/web/20060720212044/http://locative.net/tcmreader/index.php?intro;russell (accessed December 2015). See also Ben Russell: "Headmap Manifesto - Know your Place. Headmap. Location Aware Devices," originally published in 1999 at http://www.headmap.org Available at Technoccult, http://technoccult.net/wp-content/uploads/library/headmap-manifesto.pdf (accessed December 2015).

[180] For a historical framework of the development of mobile technologies that aim to integrate virtual information into material world, including AR, see Annex 1 "Historical moments in the development of mobile technology."

[181] Wikitude was released in 2008. See Wikitude http://www.wikitude.org/ (accessed December 2015).

phone display;[182] and Junaio, an AR platform for smartphones and tablets that augments the view of the environment seen through the video camera with relevant information, based either on location or on image recognition.[183] Although different in terms of technical standards and design, most of these mobile AR apps and platforms are based on the same principle and are approached practically in the same way: the user points the phone's camera at various locations and, instantly, different strata of information are superimposed on the image of the respective location.

Normally, the data disclosed correspond to general information about a place or building; historical facts; information about popular bars, hotels, and shops, public transportation, real estate, jobs on offer in the area; a lists of local doctors, ATMs, etc. Precisely which and how the items in the real world are overlaid by information will vary from one AR application to another. Each of these platforms has a specific database, and offers development tools and interfaces third parties can use to create their own content. Users can also contribute to expanding the knowledge pool, and in this sense, social networks play an important role. The fact that people's texts, images, or videos are geotagged—that is, provided with geographical coordinates—helps users in the field engage with both the immediate environment and the virtual community. But regardless of the source or the type of data provided, for all these AR platforms the basic idea is to offer as much information as possible with as much spatial accuracy as possible. Therefore, the mobile phone must be equipped with a camera, fast internet connectivity, satellite-positioning (GPS) functions, tilt sensors, and a digital compass.[184] These devices help determine where a handset is situated, what its orientation is relative to the ground, and the direction it is pointing.

[182] It was launched in 2009. See Layar: Augmented Reality Browser http://www.layar.com/ (accessed December 2015).
[183] The system was released in 2009. See: http://www.junaio.com/ (accessed December 2015).
[184] For example, Junaio's use of marker-based augmentation in addition to GPS localization is able to provide the user more spatially-accurate information.

In addition to GPS some systems[185] use a camera-tracking system, which maps the environment without the need for pre-stored maps, markers, or known templates. The system recognizes objects and scenes through the visual appearance of their features that form a "digital signature" of the location (a detailed "map" with thousands of landmarks); 3D graphics projected into the video stream of this "mapped" location augment the scene in real time, at a standard frame-rate. Nevertheless, if the internal organization of these systems differs, the overall outcome of their augmenting process is basically the same. Important, after all, are not the technical details and principles of these applications (they evolve and change at an extremely rapid pace), but rather their visual dimension, their capability to offer the viewer a different experience: a perceptual convergent space.

In the artists' hands, mobile AR apps and platforms become vehicles of expression that often defy established commercial formats. One example of a creative way to explore the nomadic type of augmentation is Julian Oliver's project *Artvertiser* (2008-in development).[186] The project investigates the possibility of virtually replacing street advertising content with artworks by different local artists in advertising-saturated places such as Times Square in New York, the Puerta del Sol in Madrid, and Shibuya in Tokyo. *Artvertiser* is based on software that recognizes individual advertisements, the surfaces of which are treated as "virtual canvas" onto which static images or videos are superimposed when viewed through the hand-held device. As

[185] See for example: Google Goggles—a service developed in 2009 by Google that allows both GPS-based search in situ and search based on the object recognition (Google Mobile Labs , http://www.google.com/mobile/goggles), The Parallel Tracking and Mapping [PTAM] software developed by the Oxford Active Vision Group at Oxford University (Active Vision Group, Department of Engineering Science, University of Oxford, http://www.robots.ox.ac.uk/~lav/), and the AR prototype for mobile phones based on both GPS and image recognition systems, developed as a collaborative work between The Computer Vision Laboratory, ETH Zurich and the Swiss company Kooaba (The Computer Vision Laboratory, ETH Zurich http://www.vision.ee.ethz.ch/ and Kooaba http://www.kooaba.com/ and https://www.qualcomm.com/products/vuforia). (all links accessed December 2015).

[186] The project was developed in collaboration with Clara Boj and Diego Diaz. See: http://julianoliver.com/ (accessed December 2015).

Oliver writes in the description of the work, "while offering itself as a new platform for public art, The *Artvertiser* seeks to highlight the contradiction of Public Space in the context of what can and cannot be written on the surface of our cities. Neither graffiti nor Fine Art, The *Artvertiser* exploits the inevitable redistribution of these surfaces in media such as digital film and photography, providing an alternative memory of the city."[187]

Fig. 2.8. Julian Oliver, *Artvertiser*. 2008-in development. Mobile AR application.

Another comparable work that engages the urban milieu in a parasitical, guerilla-art manner is *We AR in MoMA*, a "DIY Augmented Reality exhibition/art invasion," held as an "uninvited" event at the Museum of Modern Art in New York in October 2010 during the Conflux Festival, an annual New York festival dedicated to psychogeography.[188] The project consists of a selection of virtual works created by different artists, "curated" by Mark Skwarek and Sander Veenhof, made available to the visitors through the Layar app, in specific places in MoMA. As the user points the smartphone to certain locations, virtual 2D and 3D images of the

[187] Julian Oliver, http://julianoliver.com (accessed December 2015).
[188] Sander Veenhof and Mark Skwarek, http://www.sndrv.nl/moma/ (accessed December 2015).

virtual works appear seamlessly inserted in the real exhibition space; a virtual seventh floor was also "added" to the building.

Fig. 2.9. Mark Skwarek and Sander Veenhof, *We AR in MoMA*. 2010. Mobile AR application. ARt Critic Face Matrix with Frank Stella exhibit, MoMA NY, April 2011.

Here, like in Oliver's project and in the examples of apps mentioned above, we have a reconfiguration of the public space through AR technology. What all these applications have in common—regardless of whether they have a practical or artistic purpose—is an ability to offer the *flâneur*-turned-user a different urban experience, marked by the shift from lived geography to subjective cartography and from physical framework to communicational network. Indeed, adding an artistic "flavor" or informational content to the urban tissue means not only to expand the city in the media sphere, but also to provoke complex interactions between architecture (as a public statement) and information (as a personal discourse), between the physical space as a corporate or institutional establishment (e.g. the street ads in Oliver's project or the MoMA in Veenhof and Skwarek's) and the subjective, socialized, networked user. The city therefore becomes a vast information platform with diminished distances between private and public, a place of surveilled intimacies, of direct and sometimes radical artistic interactions on and off-line, a space of subjective, yet rigorously organized memory.

The meeting place of these creative encounters is evidently the screen. A nomadic screen that is also the convergence place of different technologies and applications, the mobile screened device (of the last generations) is at the same time telephone, camera, player, GPS device, map, web browser and more. These multiple possibilities affect much of the relationship the user entertains with the apparatus, with its content and the environment where he/she is situated, and, after all, they complicate the role of the user as a simple consumer. We regard the mobile screen as much as we *perform* it. Speaking about the differences between traditional static screens and the mobile, application-based screens, media theoretician Nanna Verhoeff affirms that:

> Because of these characteristics (application-based hybridity + "intimate" closeness) mobile screens put forward practices of a mobile and haptic engagement with the screen that fundamentally revise the spatial coordinates of large, fixed and (paradoxically) distancing televisual, cinematic, and architectural screen-dispositifs. When the screen is becoming an interactive map, camera, and a networked communication device all-in-one, these mobile (touch)screens and *practices of mobile screening* problematize set boundaries of agency, between making, transmitting, and receiving images (who "makes", "programs" and watches them). Moreover, these devices turn the "classical" screen as flat and distanced window on the world, into an interactive, hybrid navigation device that repositions the viewer central within that world.[189]

One of the most important consequences of this "mobile and haptic engagement with the screen" is that once the screen is integrated into the private sphere of the body, it brings both the virtual content and the real material space closer together and into the user's perceptual field. The buffering distance that characterizes our relationship with the conventional screen (fixed, passive and physically detached) is now abolished in favor of an intimate interaction. The mobile screen

[189] Nanna Verhoeff, "Creative Cartographies: Mobile Screens and the Interactive Navigation of Urban Space", conference presentation at *Urban Screens 2009: The City as Interface*, organized by Institute of Network Cultures, Amsterdam. http://networkcultures.org (accessed December 2015).

is now in our hands. We can control its content through touching. We can experience, in fact, the haptic dimension of communication. Indeed, the gesture of touching the screen is what prompts, in our examples, the image—the hybrid image consisting of the actual material space (viewed through the built-in camera) plus the virtual information superimposed on it. This simple gesture gives the subject the impression of controlling simultaneously the inside and the outside of the image and thus of being able to create fictional convergent spaces within reality, through the screen. That is, creating an embodied and highly contingent space, continually renewable, a fictional, yet real world built with both material and virtual means.[190]

Like in the other two regimes of augmentation, in the nomadic type too experiencing the convergence of the real and the virtual is facilitated by the apparent absence of the frame. Of course, materially speaking the frame is still present. Moreover, the small dimensions of the handset, the difference in scale between the real vista and the mediated image on the display and the implicit lack of immersivity are factors that will always remind the user about the gap between the two perceptual levels, real and virtual. However, the conventional status of the frame—as a cut-out rectangle that clearly separates the fiction and the virtual from the real and the "nothingness" of the ordinary (as Barthes put it[191])—as well as the perceptual differences in spatio-temporal terms between the two realms tend to be more and more relativized in this context. The frame is less likely to be a *parergon*, a "no man's land" between art and non-art or between media and physical reality. The frame seems to abandon its conventional function as a separator in favour of assuming more clearly the role of a linking element. Linking the "inside" and the "outside" it connects in real time the direct view of the place and its mediated image now augmented with additional virtual information. In the process, the Albertian idea of the

[190] I will develop this point in Chapter 3.
[191] Roland Barthes, "Diderot, Brecht, Eisenstein," 173.

windowed "elsewhere" is undermined by the phenomenal transparency of the screen. The "see-through" effect provides not only a unified vision, but it is meant also to destabilize the very objectual nature of the screen. Of course, an important factor in providing this effect is mobility. Being human-centric, and therefore closely related to our moving body, the screen constantly changes its orientation; and since it renders an image according to a specific location and the user's precise position, it involves less predictability in terms of content compared with, a TV, cinema, or even a desktop computer screen. Other variable factors, such as data selection or the automatic shifting of content according to geo-positioning, play as well significant roles in the changeable outcome of the real-virtual view (as in the ever-changing content provided by Wikitude, Layar or Junaio apps or the visual diversity offered by *Artvertiser* or *We AR in MoMA* databases).[192] In this sense, one can speak about the "nomadic" display as a screen of the relentlessly shifting presences—of the real, mediated, or augmented image (continually renewed) and of the moving user (constantly mobile).

Crucial for understanding the ways in which AR—more precisely the use of interface in AR—critically reevaluates the established models of media- and screen-based interactions is to see AR in a larger artistic and communicational perspective (this was one of the main goals of this chapter and of the whole study). One important point in this sense is that the types of AR screens and applications analyzed here share with other non-augmentative media art forms—beyond the differences, sometimes quite important, between them—the goal to establish a closer interaction between the virtual image and the physical body of the viewer. As Kate Mondloch observes with reference to non-AR installations by Ken Goldberg and Lynn Hershman, (an

[192] A particular case within the "nomadic" type of AR is Jeffrey Shaw's *The Golden Calf*. Although the phenomenal role of the screen and the effect it provides is very similar to that produced by the smartphones' apps, the screen of the *Golden Calf* has inevitably a limited mobility and it provides no haptic interface (although the haptic dimension of perceiving the work is present in the very fact that the user manipulates the screen).

observation that is nevertheless relevant for my argument), "activities represented in screen-based sites can easily fuse with material reality in terms of surveillance, control, and the teleactive and telepresent passage of subjects, objects, images, and information."[193] Indeed, media art forms and the use of computers in general has led, according to Anne Friedberg, to a new mode of perception that is multiple and fractured.[194] But it is AR that pushes even further the engagement between material reality and virtual images or information, by blending off-screen and on-screen content into a more perfected, body-centric augmented space-image. In this sense, AR radically redefines the established paradigms of visualization in cinema, television, desktop computing, or even other non-AR media installations. In the process, AR also complicates the defining properties of the conventional screen, already challenged to some extent by other media arts practices. Tending to collapse as much as possible the perceptual distance between reality and virtuality, AR seriously undermines the window metaphor and the condition of a cut-out rectangle traditionally associated with the screen (which still persists in most visual media forms). As a *plaque tournante* between reality and virtuality, the screen plays a crucial role in converging spaces—that is, in obtaining a greater degree of perceptual continuity between the two realms. But what exactly is linked (or blended or hybridized) in the process of convergence? In other words, what does "reality" stand for in AR and what does "virtual" mean from the AR perspective? The next two chapters answer these questions by extending the investigation of the convergence process through the analysis of real and reality (Chapter 3) and virtual and virtuality (Chapter 4) as general spatial expressions for constructing AR experience.

[193] Kate Mondloch, *Screens: Viewing Media Installation Art*, 92.
[194] Anne Friedberg, *The Virtual Window*, 194.

Chapter 3

Species of Spaces in the real world

Contents:

3.1. What does "Reality" stand for in AR?

If AR's main potential is to erase as much as possible the perceptual differences between the real world and virtual information, one question that should be legitimately asked is: what does the viewer perceptually identify as "reality" in AR experience? Or, to put it another way, what exactly does AR augment, if we assume that both real and virtual elements comprising AR experiences are, in their own ways, different expressions of a perceptual reality? And, why do we speak about "reality" at all in this context? The answer to the last question, we can reasonably assume, is contained in the AR term itself. AR is about reality, about enhancing the perception of reality, so to analyze the idea of AR and the phenomenon of convergent spaces—including their formation, perceptual dimensions, and aesthetic relevance—means to understand what exactly converges in AR. That is, we must first understand what material, phenomenological, aesthetic, and social premises within the real world are engaged by the viewing practice of an AR artwork

or application, then we must evaluate the ideas of virtual and virtuality that contribute to the production of media illusionist spaces (the latter will be addressed in Chapter 4). As stated at the beginning of this study, I see AR as a perceptual and aesthetic paradigm. This idea remains at the core of how I also define "reality" in AR: as a perceptual and artistic manifestation and not as an empirical or metaphysical entity. More exactly, I define it as a specific condition of perceptual reality—a precise space and time within what we accept as common or everyday reality that acquires sense through and within the AR work or application and the experience it entails.

I propose a term to describe this specific condition of the reality in AR circumstances: *the design(at)ed space*. This is the real-world environment that is—depending on the work or application—either *designed* from the ground as a setting for the work or a *designated* area within the existing architectural and urban configuration that serves as a matrix for the augmentation experience. To clarify this point, let us consider some of the AR artworks examined until now. Projects like Jan Torpus' *Living-Room 2* or Jeffrey Shaw's *The Golden Calf* propose augmented experiences that take place in designed, custom-built settings that can take the form of installations, while other works, such as Adam Frank and Zack Booth Simpson's *Shadow*, Workspace Unlimited's *Spac[E]scape*, Janet Cardiff and George Bures Miller's *Conspiracy Theory* / *Théorie du complot*, or Julian Oliver's *Artvertiser*, are works that designate specific areas in existing indoor or outdoor urban environments as places for augmenting experience. If the design(at)ed space is not a uniform spatial and temporal typology, this is in part because it is highly contingent and geographically, culturally, historically, and socially specific. Moreover, it is defined by a specific temporal occurrence, evident in the equally non-uniform "liveness" of AR experience. Therefore, design(at)ed space is manifested as much in the material presence of the physical environment as in a string of events, or a discursive projection

on the spot. In this sense, this space is as much a product as a practice; it is as much a mise-en-scène (borrowing Mieke Bal's definition, "a meeting between (aesthetic) art(ifice) and (social) reality"[195]) as it is a socially produced and organized entity (in the sense of Henri Lefebvre's interpretation of the production of space as a social process.[196]) These aspects provide arguments for considering design(at)ed space an "installationist" entity: by this I am referring to the fact that AR and installation art share the same spatial strategy and configuration—they both construct "fictional" areas within material reality, that is, mise-en-scènes that are aesthetically and socially produced. It is from this perspective that installation art should be seen as an important ingredient in the AR genealogy. Thus, the purpose of this chapter is to clarify the idea of reality in AR through the notion of design(at)ed space; to discuss the conditions in which the latter is produced and experienced; to identify the affinities and differences between design(at)ed space and related concepts of milieu, *Umwelt*, place, site and location; and to explore the particularities of the ideas of fiction and mise-en-scène in the context of AR. I will develop my argument through four interrelated concerns: "documentary," philosophical, aesthetic and social.

First of all, we should note that the literature dedicated to AR research (technical or otherwise) generally does not provide a specific definition or a theoretical statement about what reality is or how reality is experienced in AR. Thus, can we take "reality" in these circumstances simply as a common-sense assumption? That is, can we merely consider reality as something that is empirically knowable, as the things around us, the material world as opposed to the immaterial realm of representations and ideas? Following this logic, can we consider, for example, the built scenography and furniture of the room installation in Jan Torpus' *Living-*

[195] Mieke Bal, *Travelling Concepts in the Humanities: A Rough Guide* (Toronto, Buffalo, London: University of Toronto Press, 2002), 97.
[196] Henri Lefebvre, *The Production of Space*, Trans. Donald Nicholson-Smith (Malden MA, Oxford UK, Carlton Victoria-Australia: Blackwell Publishing, 1991).

Room 2 as the elements that are "reality"? In Janet Cardiff and George Bures Miller's *Conspiracy Theory* / *Théorie du complot* or Workspace Unlimited group's *Spac[E]scape*, is the material presence of the built indoor environments what counts as reality? Or is reality perhaps the busy, urban spaces in Rafael Lozano-Hemmer's *Under Scan* and Julian Oliver's *Artvertiser*? Of course, these descriptions can provide a certain idea about *where* augmentation takes place, but they cannot provide an explanation about *what* reality means and *how* it participates in AR experience. It will not suffice to assume that reality in AR is a given décor, an a-priori container, or something simply granted. Further reflection is needed because, as these examples show, what counts as reality in the context of AR can mean different things (different settings, locations, situations, objects, people) and because, in fact, reality or what we name "reality" is highly dependent on the specific experience provided by each work. Actually, this is how we operate with the complex and problematic concept of reality in most circumstances. Art historians Damian Sutton et al. are right to observe that,

> however much our everyday linguistic habits might suggest otherwise, there is in fact no one property that is being ascribed to things when we designate them as real. This is true regardless of whether we are dealing with simple objects or a more general notion of the 'real world', understood in either its colloquial or philosophical sense. The meaning of the word is dispersed across a vast and complex pattern of linguistic possibilities, performative contexts and private intentions.[197]

Indeed, the multiple conceptual facets and the contingency of the terms real and reality make difficult any strict definition and quantification in a commonsensical, aesthetic, phenomenological, or philosophical sense. As media theorists Martin Lister et al. rightly observe,

[197] Damian Sutton, Susan Brind, Ray McKenzie, eds., *The State of the Real. Aesthetics in the Digital Age* (London; New York: I.B. Tauris, 2007), 5.

reality is "a term with many meanings which always begs further definition and context."[198] This opinion is shared by philosopher Georges Canguilhem, who goes further by affirming that "the qualification of 'real' can only be applied rigorously to an absolute universe."[199] But, as Sutton et al. maintain, such difficulties do not in themselves rule out the possibility of theoretically identifying and defining the real and the cognate reality—if not in general, then at least in a technological context (in our case, one defined by AR)—although, it should be added, such a precarious philosophical maneuver needs a cautious approach.

In this sense, it is important to mention that when I refer to the perceptual material reality within the AR context throughout this chapter and dissertation by alternatively employing terms such as real world, reality, real space, etc., this is not meant to ignore the important differences between them (as artistic, phenomenological, or analytic signifiers). "Real" and "reality"—to name the most recurring notions—are evidently not interchangeable, even in this particular analytical context. My choice of terminology (the use of one term instead of the other) depends on the referential framework in which it is relevant and operative, so as to give a detailed and nuanced account of the multifaceted manifestations of the perceptual reality in AR. That is why I propose the phrase "design(at)ed space" as a means to bundle these various terms into a more consistent and manageable concept.

3.2. A play on worlds: augmented realit*ies*

As a way to approach the questions formulated at the beginning of this chapter about what the viewer perceptually identifies as "reality" in AR experience, I will first explore how

[198] Martin Lister, Jon Dovey, Seth Giddings, Iain Grant, Kieran Kelly, *New Media: A Critical Introduction* (London and New York: Routledge, 2003), 121.
[199] Georges Canguilhem, "The Living and Its Milieu," translated by John Savage, *Grey Room* 3 (Spring 2001), 27.

reality is defined and interpreted in AR literature (both scientific and non-scientific) while commenting on some of the AR artworks given as examples. The goal is to provide arguments for my claim that reality in AR is a perceptual entity defined within a precise spatio-temporal framework both by discursive practices and techniques of visualization and by the active participants.

In the field of computer science, Paul Milgram and his collaborators explain the idea of reality in the context of AR through the schema of the "mixed reality continuum." At one end of this continuum we find the real environment, something that "clearly must be constrained by the laws of physics;" and at the other end we find the virtual environment, a "completely synthetic world."[200] Although opposed, assures Milgram, the terms should not be seen antithetically, but as reference points within the same continuum—an idea that suggests actually a considerable relativization of the two concepts. According to Milgram, both reality and virtuality can constitute what he calls a *substratum* onto which the augmentation process is built; the resulting differences in experience are determined by which substratum, real or virtual, plays a principal role. Milgram defines the real-world substratum as "the environment being observed principally real, with added computer generated enhancements" and the virtual substratum as "the surrounding environment principally virtual, but augmented through the use of real (i.e. unmodelled) imaging data."[201] The assumed coexistence and the purported continuum between the two types of spaces suggested in Milgram's article are fundamental for understanding the essence of AR's convergence process and in fact of the very idea of reality in this context. In AR, the real environment should be seen neither as a simple participatory milieu nor as a mere

[200] Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum" *SPIE* [The International Society for Optical Engineering] Proceedings, Vol. 2351: *Telemanipulator and Telepresence Technologies* (1994): 283.
[201] Ibid., 285.

informal media-permeated setting (such as a wireless access zone, a Bluetooth-enabled environment, a GPS-controlled location, or any conventional, interactive video installationist scenery). While AR might presuppose one or all of these possibilities, the real-world environment is taken as more than a simple setting, more than a spatio-temporal background for media interaction at large. The real-world environment—what I call AR's design(at)ed space—is the specific material and social platform where the two levels, reality and virtuality, not only meet, but spatially coexist in the viewer's perception—however problematic that coexistence might be.

Therefore, I have certain reservations regarding the too general manner in which real-world space is sometimes described in AR circumstances. One case in point is media theorist Lev Manovich's position regarding "reality" in AR described as physical space overlaid with dynamically changing information:

> *particular urban spaces* such as shopping and entertainment areas of Tokyo, Hong Kong, and Seoul where the walls of the buildings are completely covered with electronic screens and signs; convention and trade show halls; department stores, etc.; and at the same time, *any human constructed space* where subjects can access various information wirelessly on their cell phones, personal digital assistants [PDAs], or laptops).[202]

This is too broad a view about AR. With no intention of restricting the idea of AR, I maintain that spaces covered with screens and wireless access areas cannot be considered design(at)ed spaces of AR. Design(at)ed spaces are environments conditioned by specific artistic, mediatic, and social convergence processes and in which virtual information is precisely localized in time and space. By localization, I mean the adaptation of specific information to a specific place and moment, according to user's body orientation. Regarding this aspect, Manovich is right to

[202] Lev Manovich, "The Poetics of Augmented Space," *Visual Communication* 5, no. 2 (2006): 219. (emphasis in the original).

observe that AR means a localized experience: "the physical space overlaid with dynamically changing information, multimedia in form and localized for each user."[203] So, despite Manovich's few disputable arguments, this point and other important observations he makes in the article—such as referring to reality as a spatial form in AR—resonate with my interpretation of what reality means in AR. If we take a look at our examples, we can note that the idea of localization is extremely important in works such as *We AR in MoMA* by Mark Skwarek and Sander Veenhof.[204]). Conceived to add to the perceptual field of the viewer, via the smartphone interface, virtual "artworks" embedded in the museum's exhibition halls, the effect of the work is based on localized and synchronized overlaying of information. In such a situation, the real and virtual spaces converge; they don't simply function contiguously like in a public square covered by screens. It is precisely this different fashion in which AR rethinks reality and virtuality and their encounter that provides argument for understanding it as a different perceptual and aesthetic paradigm.

Computer science researchers Oliver Bimber and Ramesh Raskar refer to the idea of reality in AR experience as "the real environment" where the system embeds synthetic supplements.[205] Not without significance, Bimber and Raskar consider that the real environment should play a dominant role in AR experience (in comparison with VR, for example, where the real environment is absent), even if it is much more difficult to control technically and optically than a completely synthetic one. However, they maintain that what counts in AR experience is for the augmented information to have a strong link to the real environment. In their words, "this

[203] Ibid.
[204] They are members of the "Manifest.AR", an international collective of artists working in the AR field. See Mark Skwarek et al., "The AR Art Manifesto", http://www.manifestar.info/ (accessed December 2015). See also *(Un)seen Sculptures*, a mobile 3D augmented reality art show, http://www.unseensculptures.com/ (accessed December 2015).
[205] Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality: Merging Real and Virtual Worlds* (Wellesley, Massachusetts: AK Peters, 2005), 2.

link is mostly a spatial relation between the augmentations and the real environment. We call this link *registration*."[206] Two important aspects should be highlighted here (to be discussed later in this chapter): first, the convergence process is essentially a live, *spatial* relation between reality and virtuality; second, this spatial relation takes place not in any environment, but in specific designated areas, regardless of width and variability (especially in the case of mobile AR).

To demonstrate how the process of augmenting reality is essentially a spatial operation (as shown by Bimber and Raskar) and how spatiality entails establishing connections not only at the perceptual level but also, I argue, at the conceptual and artistic ones, consider once again Jan Torpus' *Living Room 2*. In this project, the augmented experience relies on integrating virtual information (or "scenarios," as the artists call them) within a custom-built living room (a designed environment): a wood and cardboard construction in the first version of the work and a walled area arranged with furniture and domestic objects in the second version. As Torpus states, the room initially designed as a research setting later became an interactive box with its own identity for the artists, designers, or students working there. Such a space, recounts the author, reminds us "of our own childhood: crawling into cardboard boxes, painting them with crayons and augmenting them by pure imagination into houses, spaceships, boats or fire trucks."[207] Therefore, the real-world environment that the viewer engages with during the augmentation experience is not any space whatever,[208] but a space specifically designed as a subjective realm,

[206] Ibid. (emphasis in the original)

[207] Roderick Galantay, Jan Torpus, and Maia Engeli, "'Living-room'. Interactive, Space-Oriented Augmented Reality," *MULTIMEDIA '04*, Proceedings of the 12th annual ACM international conference on Multimedia, New York, 2004, 64-71.

[208] The term "any space whatever" is used with no specific reference to the sense given to the same expression (although in a hyphenated form) by the philosopher Gilles Deleuze in *Cinema 1: The Movement-Image*, Trans. Hugh Tomlinson and Barbara Habberjam (Minneapolis: University of Minnesota Press, 1986). He writes: "Any-space-whatever is not an abstract universal, in all times, in all places. It is a perfectly singular space, which has merely lost its homogeneity, that is, the principle of its metric relations or the connection of its own parts, so that the linkages can be made in an infinite number of ways. It is a space of virtual conjunction, grasped as pure locus of the possible" (109). Deleuze asserts that he borrowed the term "any space whatever" (*espace quelconque*) from a certain Pascal

as a discursive space, not unlike Bal's mise-en-scène.[209] It is as much a material space as it is an imaginary (or fictional, as we will later demonstrate) space that recalls childhood games, now perceptually enhanced for and by the participant-viewer through the interactive use of digital graphics and animations.

Bimber and Raskar's position on the dominant role of reality vis-à-vis virtuality in AR is shared by authors such as Jung Yeon Ma and Jong Soo Choi, who not only contend that "AR still holds the real elements and analog conditions as indispensable part of its nature,"[210] but also submit that "the Reality of AR should be a primary quality and the Virtuality of AR should be a secondary one."[211] Therefore, AR is seen by the two researchers as a conjugation between real elements that constitute the immediate reality and virtuality that is associated with a "second-order reality."[212] Such hierarchization might seem problematic, since I consider that reality and virtuality should be understood in this context not as autonomous and hierarchically positioned terms, but as convergent and consequently mutually dependent provisions. Milgram's schema describing the continuum real-virtual is relevant in this sense, despite its limited application in fields other than those strictly technical.

Take for example *Spac[E]scape* by Workspace Unlimited group: the designated spaces in which the viewer is situated and where he/she experiences the work—e.g. indoor public areas in buildings located in Rotterdam, Gijón-Spain, or Montreal—are as important for the augmentation experience as the virtual projection of that precise space and of the other

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Augé, but like many times in his writings no specific text is given as reference. As Réda Bensmaia suggests (in "L'espace quelconque," *Iris* 23 (Spring 1997)), Deleuze makes a mistake: he perhaps refers to the sociologist Marc Augé, although the latter never uses the term "any space whatever." As an explanation for Deleuze's confusion and omission, Bensmaia associates Deleuze's "any space whatever" with Marc Augé's "non-places."

[209] See 3 fn.1.

[210] Jung Yeon Ma and Jong Soo Choi, "The Virtuality and Reality of Augmented Reality," *Journal of Multimedia* 2, no. 1 (February 2007): 36.

[211] Ibid., 32.

[212] Ibid.

interaction settings are—spaces situated at hundreds of kilometers distance and provided only as 3D virtual models projected on the walls. More exactly, a participant situated in the Rotterdam location would experience equally the real-world space in which he/she is situated (the V2_, Institute for the Unstable Media exhibition space), the 3D modeled image of that precise space projected as a digital *trompe-l'oeil* in front of him/her, like a mirror, as well as the 3D virtual images of the other participant environments situated in, Gijón (the spaces at the LABoral Art and Industrial Creation Centre) accessed through the manipulation of the avatars via the online connection. Similarly, participants from Spain will be able to interact via their avatars with other remote but networked spaces in Rotterdam or other locations.[213] Of course, there are important differences between how we experience a real-world space in-situ and how we perceive and engage a real space rendered as a 3D virtual model, and the idea of mediation applied to both situations can provide a key to understand this difference. But before turning our attention to the issue of mediation (to be discussed in Chapter 4), the question that should be asked at this point is: how do common, real-world environments such as the architectural spaces situated in different cities in *Spac[E]scape* make sense as discursive spaces, that is, as design(at)ed spaces for the AR experience, whether experienced in the actual, real-world location or via online connection? Or, to revert to the question formulated at the beginning of this chapter, what exactly does AR augment, if we accept that both real and virtual spaces experienced by the viewer are, in their own ways, different expressions of a perceptual reality? My point is this: a certain real-world space becomes a particular interactive ground for artistic/information discourse and perceptual augmentation—in other words, it becomes a design(at)ed space—as long as it is activated and transformed by the artist (or application) and by the participant users

[213] See Workspace Unlimited, Portfolio: *Spac[E]scape*. http://www.workspace-unlimited.org/ (accessed December 2015).

into a sort of mise-en-scène, a spatio-temporal framework that is effectively defined by "what the people practicing it make of it."[214] This presupposes equally an effort to design or designate it—that is, to (artistically) arrange, equip, regulate, and map it as a space of interaction in-situ—as well as a way to *produce* it via bodily, social, and technological uses. In fact, it is in this sense that we must consider Jung Yeon Ma and Jong Soo Choi's important remark that "AR is not just what we are looking at, but also what is really happening here and now."[215] This is, I argue, a way to affirm that the AR viewing experience (more precisely, the localized and personalized overlaying of virtual data in the perceptual field of the viewer) is both a consequence of and a condition for defining a real-world spatial and temporal framework. In this case, "spatial" entails both a prerequisite setting in the real-world (the design(at)ed space) and a social and technological process of defining that setting (the "here"). And "temporal" is equally a provision for an ideal real-time interaction and a mode of subjective development and control over the perceptual process through menu selection, body actions, and movements (the "now").

Other computer-engineering scholars, such as Ronald Azuma, describe reality in AR contexts as the perceived 3D real environment. To augment reality, considers Azuma, means actually to "enhance a user's perception of and interaction with the real world."[216] Therefore, the perception of the real world (or, what he describes elsewhere as the "real objects from the perceived environment"[217]) within the circumstances of AR technologies is actually a set of operations that presuppose, as Azuma stipulates, a combination of real and virtual objects in a real environment, an interaction in real time and a registration (alignment) of the real and virtual

[214] Mieke Bal, *Travelling Concepts in the Humanities*, 99.
[215] Ibid., 33.
[216] Ronald T. Azuma, "A Survey on Augmented Reality," *Presence: Teleoperators and Virtual Environments*, 6, 4 (August 1997): 355-385. Available from: Human Interface Technology Lab (HITLab), University of Washington. http://www.hitl.washington.edu/projects/knowledge_base/ARfinal.pdf (Accessed December 2015).
[217] Ronald Azuma, Yohan Baillot, Reinhold Behringer, Steven Feiner, Simon Julier, Blair MacIntyre, "Recent Advances in Augmented Reality", *IEEE Computer Graphics and Applications* vol. 21 no. 6, (November/December 2001): 34.

objects. As Azuma writes, "an AR system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world." [218] Thus, for him, augmenting a user's perception is a way to enhance the perception of the real world up to the point where one will not be able to tell the difference between what is real and what is given as virtual. What exactly and how much of the two ingredients—reality or virtuality—is enhanced remains surely a subject for reflection and research, and it will always vary depending on the type of experience the application or the artwork will offer. Worth noting—at least *en passant*—is that this spatial coexistence in AR should be seen not so much as an "enchantment" of the world through technology as many enthusiast thinkers of the last decades have announced, but, indeed, as an *enhancement* "of a user's perception of and interaction with the real world." More importantly, to obtain such a compelling effect, as Azuma maintains, an AR system "requires knowledge of the user's location and the position of all other objects of interest in the environment."[219] The way I read this statement with regard to the present discussion is that the perceptual reality considered for the AR experience is and should be conceived—that is, designed or designated—as a specific spatio-temporal framework whose relevance in the AR experiential order pertains equally to the particular physical characteristics rigorously mapped by the technical system, the cultural meanings inscribed in the elements of that environment, and the subjective engagement of these elements by active users.

Significant in this sense is, for example, Julian Oliver's *Artvertiser*, where the spaces designated for augmentation by the faux ads are not *any* spaces in the urban milieu, but precise spots along the city's main boulevards: street ads and billboards mapped beforehand with awareness of their physical position, dimensions, and orientation, as well as with regard to their

[218] Ibid.
[219] Ibid., 36.

significance in a cultural (notably, political and critical) order. That is to say that the participant artists' interventions—the virtual images, photographs, or videos, that augment the existing billboards, via Oliver's project—are aware and make reference not only to the content of the advertisements they "parasite," but also to the precise locations in which those banners are situated. This is a way to prove that, indeed, reality in AR is to be seen not as an abstract (perhaps metaphysical) concept, but as a perceptual and localized phenomenon; AR's real-world space is not an a-priori, neutral container, but a space co-produced equally by technological processes, aesthetic practice, and social interaction.

As this example and the others discussed above prove, in AR virtual information is perceptually overlapped on many different spatial environments and there is a great variety of ways to engage them. However, we should note that it is not the physical configuration of the design(at)ed space that necessarily creates the differences between what I identify as the integrative, projective, and nomad AR types. As we have seen in the previous chapter, this is rather related to the distinct technical properties of the interfaces employed by the respective system as well as the perceptual experience they provide to the user. We can hardly speak about environments that require one specific visualization device instead of another (although, typically, HMD would be more often used for indoor applications, while mobile interfaces would be considered more appropriate for outdoor use). What counts for any AR experience type (integrative, projective, or nomad) is after all, as Azuma shows, a good knowledge of the user's location and his/her position in space through the creation and command of specific spatial and temporal conditions within ordinary reality—i.e. a design(at)ed space—defines and is defined through the AR experience.

3.3. Reality in the philosophical expanded field

3.3.1. On Materiality

It should be emphasized once again that to understand the perceptual spatial convergence in AR we should understand first of all what reality (the "R") signifies in AR, in other words, to explore which material, aesthetic, and social premises within the real world are engaged by the user of an AR artwork or application. We have learned from the examples of artworks discussed and from the researchers' theoretical positions summarized above that what counts as reality in AR experience is actually perceived by the viewer as *a spatial form*, a material real-world environment that presupposes an equally important, although less substantial, temporal dimension: the design(at)ed space. Yet, what is the ontological status of this real-world spatial form (of the design(at)ed space) vis-à-vis virtual information that comes to augment or enhance this space? Or, to put it differently, as I laid out at the beginning of this chapter, what exactly does AR augment if we see this question in a philosophical expanded field? A way to approach such thorny questions is to address first, the problem of the AR real-world spatiality defined as materiality; second AR spatiality as a phenomenological manifestation (including the specific conditions in which it is manifested), which will lead to an explanation in the following sections of its aesthetic and fictional dimensions as an installation-like mise-en-scène; and finally, AR spatiality as social process and locational construction.

What we can safely assume is that the real-world spatiality experienced in the AR process, i.e. the design(at)ed space, is a manifestation of the *material presence* of objects and subjects and their interaction. This assumption is based equally on what the perceptual experience of the discussed works offer and on what the theoretical accounts regarding this

subject suggest. At this point, a short clarification is in order regarding the terms "material" and "materiality." The sense in which I use these terms is close to that of cultural theorist Bill Brown, who explains the concept of materiality this way:

> [it] can refer to different dimensions of experience, or dimensions beyond (or below) what we generally consider experience to be. Like many concepts, *materiality* may seem to make the most sense when it is opposed to another term: the material serves as a commonsensical antithesis to, for instance, the spiritual, the abstract, the phenomenal, the virtual, and the formal, not to mention the immaterial.[220]

The material is therefore a certain state of the matter defined equally in its immediate physicality and, as Brown puts it, in its "look and feel."[221] Materiality is seen here not so much as an a-priori condition, but as the immediate perceptual content of this world that is apprehended as a meaningful presence shaped by form and bodily interaction and to which virtuality is both ontologically opposed and perceptually conjoined. This is the material premise (understood in both its figurative and literal senses) arranged for and by the viewer's AR experience. More exactly, it is something in the common material world that is either already present out there for us to experience (e.g. a building, or a street, or a public square) or constructed specifically for the AR interaction (e.g. an installationist space conceived and built expressly for the purpose of a project). Such a material space (the design(at)ed space) is defined and becomes "a meaningful presence" (only) via the user's AR experience, that is, via the user's experience of the virtual information (broadly defined) overlapped on that particular space and handled by the users. In this sense, any definition of the real in this context (i.e. of the real as material in the perceptual order) depends on the occurrence of the virtual. In fact, some researchers affirm that "in some respects current cultural distinctions, both in theory and practice about what is real and what is

[220] Bill Brown, "Materiality" in *Critical Terms for Media Studies*, edited by W.J.T. Mitchell and Mark B.N. Hansen (Chicago and London: The University of Chicago Press, 2010), 49.

[221] We should recall here the role played by the interface's frame in operating links but also making "ontological cuts" between the material and the virtual realms, both literally and metaphorically. See Chapter 2 for more details.

virtual, no longer apply with the same force,"[222] and that "the terms [real and virtual] cannot be used in isolation from one another."[223] There are, indeed, a number of technological manifestations (and AR is one of them) where as viewers we are not always entirely able to distinguish perceptually between reality and virtuality. However, it is important to emphasize that while reality and virtuality become indistinguishable in some specific circumstances, this is due to the fact that what is perceived as real and what is seen as virtual presuppose the same type of experience (they are perceptually almost equivalent), although reality and virtuality remain, ontologically speaking, quite different as I will later explain.

Thus, the use of the terms material and materiality in this context is part of the effort to define and distinguish theoretically what is "real" in AR vis-à-vis the virtual. Certainly, the terms material or materiality are not without problems, as much as are the other terms generally employed to describe reality in AR circumstances: physical and physicality. Part of the problem is that virtual information presupposes its own physicality and materiality. As Martin Lister et al. show the experience of VR, although facilitated by invisible electronic or digital processes, is also in its own sense physical.[224] This position is shared by Bill Brown who writes: "information (and our access to it) relies on the physical support of communication technologies: integrated circuits depend on a silicon substrate; different optical fibers have different properties and serve different functions; any wireless communication depends on truckloads of wire."[225] Moreover, beyond the aspects related to the physicality of the technical infrastructure, scholars address the problem of materiality of media also in terms of what N. Katherine Hayles calls "the

[222] Ron Burnett, *How Images Think*, (Cambridge, Massachusetts and London, England: The MIT Press, 2004), 59.
[223] Jason Farman, *Mobile Interface Theory. Embodied Space and Locative Media*. (New York and London: Routledge, 2012), 22.
[224] Martin Lister *et al*., *New Media: A Critical Introduction,* 121.
[225] Bill Brown, "Materiality," 55-56.

materialities of embodiment,"[226] the different forms of physical interaction that occur between humans and technology. Nevertheless, as fair as these observations might be, we should admit that one cannot speak about virtual media information as a material presence per se. In fact, in most circumstances, the terms material and physical are associated rather with the real world than with the virtual electronic media. It is evident that platforms, wires, and interfaces are nothing but vehicles for information and they cannot give the measure of the latter's ontological status. The same is the case with the so-called "materiality of embodiment": this is a form of bringing and circulating the virtual within the material world, but it explains neither the virtual nor the material's internal nature. Virtual is rather, as Anne Friedberg very justly upholds, something "liminally immaterial"—a material entity of a different kind, more like a second-order materiality (e.g. optical, technological, or artisanally produced representations or appearances).[227] I will explore this point in greater detail in the following chapter. What is important to emphasize for now is that although ontologically different, real and virtual are, perceptually speaking, mutually dependent in AR: after all, the virtual reinforces our sense of the material, as much as the material grounds and determines the perceptual outcome of the virtual.

3.3.2. Reality under specific conditions

Even if we accept as a basic operating assumption that reality in AR is a spatial manifestation in the material world perceived and activated by the viewer through the interactions facilitated by the AR systems, this should be seen not as a general provision. Since not *any* space within the material world counts as "reality" (i.e. as a design(at)ed space) for the

[226] N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics* (Chicago: University of Chicago Press, 1999), 245.
[227] Anne Friedberg, *The Virtual Window. From Alberti to Microsoft*, (Cambridge, Massachusetts: The MIT Press, 2006), 11.

AR experience, no matter how much instrumental, social, technological, etc. control one might have over a particular environment. Milgram and Azuma actually show that to accomplish an AR experience, not only a good but also a specific knowledge of the real environment (Azuma) or real-world *substratum* (Milgram) to be augmented is needed. In other words, precisely because AR functions fundamentally as a localized and temporalized experience, as a specific form of reality-virtuality-viewer encounter, not every sector and moment of the material world is settled for the AR interaction. We can enjoy AR experience in one place but not necessarily in another; some spaces are AR-ready, while others are not.

Thus, these are spaces designed or designated *specifically* by the AR artist or the AR application's configuration within what we generally define as common or everyday material reality. Such spaces acquire sense (in the experiential, media, and aesthetic orders) through users' individual or social interactions. In this sense, the design(at)ed space is about reality *under specific conditions*. Simply put, this means a fragment of the material reality that is preset and therefore set forth for (and by) our experience as users. In other words, it is a section of reality designed or designated and controlled by specific (technological, physical, cultural, etc.) "knowledge" about it and then presented and activated as a potential area for the augmented experience.[228] It is a staging of the material world performed with its own means and enhanced with technology's instruments.

But the question that remains is what creates these specific conditions? Is there an ontological distinction between the design(at)ed space and everyday material reality, or does the difference reside solely in the aesthetic and communicational mechanisms at work in the AR artwork or application activated by the user? Moreover, if we have accepted that the design(at)ed space of the AR experience is a spatial form within the ordinary world, how can we distinguish it

[228] See Paul Milgram et al., "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum".

as a specific perceptual and functional spatial entity vis-à-vis other established and relevant concepts of world space, such as milieu and *Umwelt*?

Let us start with the last question and build an explanation of the specific conditions of material reality in AR. Speaking about the relationships between real world, human senses and art, philosopher Jean-Luc Nancy observes that "art does not deal with the 'world' understood as simple exteriority, milieu, or nature. It deals with being-in-the-world in its very springing forth."[229] Nancy's remarks are significant here since it is in this sense that I understand the way in which AR art and design deal with the material reality of the world: not as simple exteriority or milieu, but as the springing forth of a certain manifestation of the world (a specific manifestation, as Nancy upholds, of "the being *of the* world"[230]). Of course, such a "springing forth" varies greatly in its outcome from one type of art to another (Nancy's title is, significantly, "Why Are There Several Arts and Not Just One"). Unlike most artistic expressions, AR (and to an equal extent installation art and performance art) is able to seize and present as a dedicated space-time of artistic experience a specific area and a specific moment within the everyday real world while maintaining a perceptual continuity with that real world. The fine line existing between the world and the work is what both defines and defies the artistic status of such pieces. For example, the streets and the ad billboards in Julian Oliver's project are equally part of the everyday world and of that specific work, their status being established by the subjective and

[229] Jean-Luc Nancy, *The Muses*, Trans. Peggy Kamuf (Stanford, California: Stanford University Press, 1996), 18. The term being-in-the-world was introduced by Martin Heidegger to explain the fundamental grounding state of Being. It underscores the fact that in Heidegger's philosophy "Being" (the Being of *Dasein*) and "the world" are not separate entities but must be grasped together. (Roderick Munday, "Glossary of Terms in *Being and Time*," 2009, http://www.visual-memory.co.uk/b_resources/b_and_t_glossary.html#b). For Nancy, being-in-the-world (or, as he indicates, "the being *of the* world") means that the world is not an object I can represent. World is only world for he who inhabits it. Or similarly: as soon as the world appears to me, I take part in it and experience its internal resonances (cf. Ignaas Devisch, "The Sense of Being(-)With Jean-Luc Nancy," *Culture Machine* 8 (2006): http://www.culturemachine.net/index.php/cm/article/viewArticle/36/44). Thus, world-being is not given an a-priori sense, but it *is* the sense. That is to say, it is something that "gives or produces being as en effect" (John van Buren, quoted in Jeff Malpas, *Heidegger's Topology* (Cambridge, Mass, and London, England: The MIT Press, 2006), 6). Links accessed December 2015.

[230] Jean-Luc Nancy, *The Muses*, Ibid., 19.

sporadic intervention of the viewer—in both phenomenological and aesthetic senses. Nancy makes some important remarks (although from a more general perspective, not specifically related to AR) about how art establishes a synthetic unity and continuity with a world of life and activity. He writes:

> In the final analysis, that world is less a sensuous world than an intelligible world of markers, functions or uses, and transitivities—in the final analysis less a world, perhaps, than a milieu, an *Umwelt* (that of the '1 percent of information'). Art isolates or forces there the moment of the *world* as such, the being-world of the world, not as does a milieu in which a subject moves, but as exteriority and exposition of a being-in-the-world, exteriority and exposition that are formally grasped, isolated and presented as such.[231]

Like other artistic manifestations, AR isolates and forces a moment or a spatial segment of the world for us to experience. But it does so not only by formally grasping, isolating, and presenting it "as such" to our senses (for instance, in a "non-media" installation, performance, or social intervention), but also by perceptually augmenting it with images and information in the virtual realm. Under the artistic and technological conditions of AR the real world is most evidently *not* taken as a simple background, milieu, or *Umwelt*, but as a design(at)ed space, a specific matrix of possible interactions and expanded experience. In this way, my proposition of material reality as "design(at)ed space" in AR experience acknowledges both connections and differences with regard to concepts such as milieu and *Umwelt*.

In a general sense, *Umwelt* is understood and translated as "environment" or "surrounding world." The concept plays a fundamental role in Martin Heidegger's major work, *Being and Time* (1927). In the words of Heidegger:

[231] Ibid., 18.

> the expression 'environment' [Umwelt] contains in the 'environ' ['um'] a suggestion of spatiality. Yet the 'around' [Umherum] which is constitutive for the environment does not have a primarily 'spatial' meaning. Instead, the spatial character which incontestably belongs to any environment, can be clarified only in terms of the structure of worldhood.[232]

Georges Canguilhem's definition of *Umwelt* is particularly relevant here as he discusses the term in relation with the other related concept mentioned here, milieu. For him,

> *Umwelt* designates the behavioral milieu that is proper to a given organism; *Umgebung* is the simple geographical environment; and *Welt* is the scientific universe (…). *Umwelt* is therefore a voluntary sample drawn from the *Umgebung*, the geographical environment. But the environment is precisely nothing other than man's *Umwelt*, that is, the usual world of his practical perspective and experience. Like this *Umgebung*, this geographical environment that is external to the animal is, in a sense, centered, ordered, and oriented by a human subject (that is to say a creator of techniques and values).[233]

On the other hand, Canguilhem writes,

> The milieu that is proper to man is the world of his perception, that is to say the field of his practical experience in which his actions, oriented and regulated by values that are immanent to his tendencies, carve out certain objects, situate them relative to each other and all of them in relation to himself. This occurs in such a way that the environment he is supposed to be reacting to finds itself originally centered in and by him.[234]

Of course, in most circumstances (AR or not), the real world is experienced by any subject more or less as an *Umwelt* or as a milieu: as a *spatial* reality that can be clarified only as a "worldhood" (per Heidegger) or an environment "centered, ordered, and oriented by a human

[232] Martin Heidegger, *Being and Time*, Trans. John Macquarrie and Edward Robinson (Malden, MA and Oxford, UK: Blackwell Publishing, 1962), 94.
[233] Georges Canguilhem, "The Living and Its Milieu," 19-20.
[234] Ibid., 26.

subject" (per Canguilhem). But, if we dig behind these labels, it becomes evident that although *Umwelt* and milieu are effective terms to describe and conceptualize the real material world of human beings and human actions in general (with or without technology), they are not sufficient for articulating the specificities of the AR's real-world spatiality.

As we have seen, the design(at)ed space—the way in which the viewer experiences the real world in AR—involves all the aspects of an *Umwelt* or a milieu, but it is not reducible to any one of them. The design(at)ed space in AR is more than milieu, *Umwelt*, geographical background, or regulated environment, regardless of the implicit worldhood-ness and the importance played by the human factor. Therefore, not simply against, but rather beyond these definitions of the real world as milieu or *Umwelt* we should see AR's design(at)ed space as a *specific indication*—a formal grasping and presentation (or "exposition," according to Nancy) of a specific fragment and a timing of the common material world for possible and multiple artistic activations and social interactions. With the important provision that, this time, such actions are necessarily expanded also in the virtual media sphere. This is what I mean by reality under specific conditions. It is a manifestation of reality that shows itself for us or, we might say, it *opens up* in its particularity, as a precise material space and a precise time of interaction, as it is activated by an artistic and technological intervention and by all the social encounters this might generate. But, what exactly does this "opening up" of a space-time in the real-world mean in phenomenological terms?

3.3.3. Opening up a world: On Place

Certainly, every work of art creates its own reality, or perhaps its own spatial and social experience of the real world. In fact, as Heidegger suggests in his essay "The Origin of the Work

of Art," any work of art is able to "open up a world."[235] Nevertheless, it is perhaps in AR where this account acquires more evident and surely more complex dimensions, since we can see AR (along with installation art, to be sure) as the emblematic artistic discourse that—to employ Heidegger's terminology—manifestly both "sets up" and "sets forth" a specific world, while remaining ontologically part of the real world. This is to say that, in Heidegger's view, a work of art both "erects" a world "in the sense of dedication and praise" (something more than "a bare placing"), and sets forth a world causing "beings in the first place to come forward and be present in assuming an outward aspect."[236] To illustrate this, Heidegger gives as example a Greek temple (which I draw upon here to clarify my argument regarding how the design(at)ed space of/as the artwork "opens up a world"). As Heidegger points out, the temple is the extension and delimitation of a precinct, one able to "fit together and at the same time to gather around itself the unity of [different] paths and relations."[237] Like the Greek temple which "stands there" and "opens up a world", the AR's design(at)ed space (and for that matter installation art's spatiality, as I will demonstrate below) opens up a world, or multiple worlds, while gathering around them a multitude of paths and relations: human, cultural, technological, etc.

If I semantically conflate the reality of the artwork and that of the world, it is to suggest a fact: in AR the material reality not only participates as a representational model or a backdrop (read milieu or *Umwelt*) in the production of an AR experience; it *is* the artwork. That is to say, *everyday reality and the AR artwork share the same ontological and perceptual status*, but the real world participates in the AR experience as far as a certain space and time frame within

[235] Martin Heidegger, "The Origin of the Work of Art," trans. Albert Hofstadter, *Martin Heidegger: Basic Writings*, ed. David Farrell Krell (San Francisco: Harper Collins Publishers, 1977/1993), 169. It is assumed here that this brief exposition of Heidegger's concepts is not able to provide a fair evaluation of the philosopher's complex claims. It is not my concern here to examine in more depth the relevance of Heidegger's theory in possibly assessing AR art and technology, although, with no doubt, there could be many such possibilities.
[236] Ibid., 169, 184.
[237] Ibid., 167.

reality is designed or designated specifically to this end and as far as it is activated by the user. For example, the city public square in which Lozano-Hemmer's project *Under Scan* is installed becomes part of the work—but only as far as it is temporarily arranged, displayed, and experienced by viewers *as a work*. There is nothing intrinsic about certain public spaces in London, Leicester, Northampton, Nottingham, or Venice where this project was presented that marks these spaces as definitive, self-sufficient, and structurally different entities in the artistic order (though it should be emphasized that the cultural, human, social, or political characteristics of these specific locales were crucial players in the experience of the work). These spaces remain "everyday reality" for most of the time, but they function as provisional areas and momentary events of artistic experience once they are included within a precise artistic project, that is, once they become designated spaces for the AR interaction.

From the standpoint of our discussion of the design(at)ed space via Heidegger, we should note that it is not only about *what* the (AR) artwork is, but also about *where* it is and *how* it acquires sense for the viewer. For Heidegger, the question he asks in the first place in "The Origin of the Work of Art" is not what a work of art is, but "where does a work of art belong?"[238] Thus, it is significant to note with regard to our present argument the importance he gives to the *place* of an artwork: "we shall attempt to discover the essence of art in the place where art undoubtedly prevails in an actual way."[239] As we are told, the "place" of a work not only refers to its geographical location, but also to its situatedness as a defining feature. Thus, the idea of "fixing in place" becomes for him central in explaining the nature of art. That is why Heidegger considered it necessary to return to this theme in the essay's addendum, where he further explains that the "fixing in place" of a work can be better understood as "*setting*-into-work" (a

[238] Ibid.
[239] Ibid., 144. Noteworthy is that in other editions, "essence" is translated with "nature" and "actual" is translated, more accurately I would say, with "real".

formula that—I speculate—might suggest also the idea of a mise-en-scène). As the philosopher argues, "the Greek 'setting' means placing, as for instance, letting a statue be set up. It means laying, laying down an oblation. Placing and laying have the sense of bringing *here* into the unconcealed, bringing *forth* into what is present, that is, letting lie forth."[240] But, as Heidegger further points out, "the 'fix' in 'fix in place' can never have the sense of rigid, motionless, and secure. 'Fixed' means outlined, admitted into the boundary (*peras*), brought into the outline."[241] And this boundary, we are told, "sets free into the unconcealed." Thus, the "'fixing in place' of truth, rightly understood, can never run counter to the 'letting happen.' For one thing, this 'letting' is nothing passive but a doing in the highest degree."[242] This statement echoes and justifies my argument that the design(at)ed space is not a passive thing, but a material entity that acquires sense only through a specific set of human actions that are "let happen": e.g. the user's presence and movements, his/her gesture of accessing the augmenting information through the interface, as well as the complex social encounters that such an interaction presupposes, one that permits, indeed, boundless experiences.

Nonetheless, a disclaimer is needed here. Although Heidegger's vocabulary and methodology are useful for expanding out discussion of the AR experience, my understanding of

[240] Ibid., 207. Unconcealment (*Unverborgenheit*) is understood by Heidegger in "The Origin of the Work of Art" as "disclosure of beings," their unveiling, something that the Greeks called *alētheia*—truth as unconcealment. *Alētheia* is Greek for "truth; truthfulness, frankness, sincerity". An initial a- in Greek is often privative, like the Latin in- or the Germanic un-. (The "privative alpha" occurs in many Greek-derived words: "anonymous", "atheism", etc.) *Alēthēs*, *alētheia* are generally accepted to be *a-lēthes*, *a-lētheia*, that which is "not hidden or forgotten", or he who "does not hide or forget". Cf. Raul Corazzon, *Theory and History of Ontology*, 2011, http://www.ontology.co/heidegger-aletheia.htm (accessed December 2015). To understand the significance of the term *alētheia* in the present context, it is important to discern between the sense Heidegger gives to the expression in "The Origin of the Work of Art" and the different meaning ascribed to it in the later texts (more precisely in his 1964 essay "The End of Philosophy and the Task of Thinking"). If initially *alētheia* was equated with truth, specifically, the truth of a work of art, one that "emerges into the unconcealment of its Being," (Martin Heidegger, "The Origin of the Work of Art," 161), Heidegger eventually revised this interpretation, giving the term the connotation of unconcealment in the sense of opening: "as clearing of presence and presentation in thinking and saying" (Martin Heidegger, "The End of Philosophy and the Task of Thinking," trans. Joan Stambaugh, *Martin Heidegger: Basic Writings*, 447).

[241] Martin Heidegger, "The Origin of the Work of Art," 208.

[242] Ibid.

the idea of place and that of the "fixing in place"—and actually my reading of Heidegger—does not presuppose the issue of "truth" as it is exposed by the philosopher in his text. What is at stake in my argument is not the truth attached to/emerging from the artwork (is that something possible, after all?[243]) but rather the AR artwork's capacity—if it is to keep Heidegger's vocabulary—to open up a world, to "fix in place" a discourse that will enhance the experience of the real world. In other words, to design or designate a specific space (or, indeed, perhaps a place, as we will shortly see) in the material reality—considering its historical, social and political contingent conditions—that will be perceptually enhanced with artistic or informative data through the use of AR technological apparatus.

This operation of designing or designating space pertains fundamentally to the aesthetic and perceptual strategy of AR. It is seen by media theorist Jason Farman as a way "to imbue space with meaning, thus transforming a space by giving it a sense of place."[244] His statement that brings to the forefront the modern theoretical distinction between space and place, which entails questioning the century-old belief that space is an abstract notion, an "unacted" entity, and proposing instead the idea of place as an embodied, "practiced" space. Philosopher Edward S. Casey makes an important contribution to this debate by situating this argument into a larger

[243] Heidegger's approach to the problem of truth in art (as appears in "The Origin of the Work of Art") was criticized among others by Meyer Schapiro and Jacques Derrida. Schapiro addresses Heidegger's example of a painting by Van Gogh representing a pair of old shoes, which Heidegger affirms expresses the truth of the peasant's way of being. Schapiro argued that, in fact, the pair of shoes depicted belonged to Van Gogh himself, a detail that would negate Heidegger's reading of the importance of the visual representation to infer the truth. (Schapiro's criticism appeared under the titles "The Still Life as a Personal Object—A Note on Heidegger and van Gogh," and "Further Notes on Heidegger and van Gogh,", both published in M. Schapiro, *Theory and Philosophy of Art: Style, Artist, and Society*, (New York: George Braziller, 1994). Jacques Derrida provides a critical cross-reading of both Heidegger and Schapiro in "Restitutions of the Truth in Pointing [*pointure*]," in *The Truth in Painting* trans. Geoff Bennington and Ian McLeod (Chicago and London: The University of Chicago Press, 1987). Rather than defend either Heidegger or Shapiro, Derrida exposes the trap of representational thinking in both cases: Shapiro and Heidegger comment by assuming the traditional paradigm of painting – realism and representation. As Derrida demonstrates, "it is not the truth of a *relationship* (of adequation or attribution) between such-and-such a product and such-and-such an owner, user, holder, bearer/wearer-borne. (…) Art as 'putting to work of truth' is neither an 'imitation,' nor a 'description' copying the 'real,' nor a 'reproduction,' whether it represents a singular thing or a general essence." (Ibid., 312).

[244] Jason Farman, *Mobile Interface Theory*, 40.

historical and philosophical perspective.[245] In the vein of the phenomenological tradition that puts emphasis on lived experience, he argues no more no less that "we don't live in 'space,'…instead, *we live in places*."[246] How relevant this distinction is in the present context and how the dialectic relationship space-place would affect the theorization of AR spatial experience is not my point here. Nor is a possible engagement with the intricate history and theory of the debate that opposes space and place. What interests me instead is to see how some specific conceptual themes issued from the debates on the idea of place can contribute to further explaining the spatiality of AR, i.e. the design(at)ed space, and, by extension, the convergence process. In this sense, three important aspects of the concept of place mentioned by Casey in his historical account will be addressed. First, the question of particularity of place, a crucial quality that apparently was lost in the homogenized modern world. As Casey notes, "place brings with it the very elements sheared off in the planiformity of site: identity, character, nuance, history."[247] This is what AR is able to bring to a place: its identity, character, nuance, or history. Since, as I already stated here, not any space is "ready" for AR perceptual enhancement, and that in AR the convergence process not only depends but is crucially related to the specific—individual, social, historical, and political—contingent conditions of the place. Thus, by bringing the particular to a global scale of communication and interaction, AR is—we might argue—one among many modalities that de-homogenize the spaces of the modern world. Second, the problem of embodiment, i.e. of the place as embodiment: as Casey points out, without the body "space would be merely a neutral, absolute block or else a tangled skein of pure relations built up from

[245] See Edward S. Casey, *Getting Back Into Place. Toward a Renewed Understanding of the Place-World* (Bloomington: Indiana University Press, 1993), and especially Edward S. Casey, *The Fate of Place: A Philosophical History*. (Berkeley and Los Angeles, California; London, England: University of California Press, 1998).
[246] Edward S. Casey, *Getting Back Into Place*, xiii.
[247] Edward S. Casey, *The Fate of Place*, xiii. Casey describes the notion of site as a "modification" of space. More precisely, a "leveled-down, monotonous *space for* building and other human enterprises" (Ibid., x).

pure positions."[248] Thus, "the lived body not only activates places but needs them in turn; it finds them as well as founds them."[249] It is in this sense that I understand the design(at)ed space and the convergence process as both preconditions and effects of embodiment—the body that *finds* as well as *founds* a place. Janet Cardiff and George Bures Miller's "guided" video/audio walk, *Conspiracy Theory* best illustrates this idea in that the spatial experience of the work relies on equally finding the space and founding it via the wandering body. But, what is even more interesting in this work is that this is a body in a double hypostasis: one is the user's body present in the real environment and the other is the vicarious presence of the artist's body implied by the voiceover in the headphones. Both bodies fulfill the same spatial operation of finding and founding, although in slightly different manners—one body is physically present, the other is absent; one is live, the other mediated; one is real, the other is virtual. Third, place is not a simple presence, but, as Casey puts it, "an event capable of implacing things in many complex manners and to many complex effects."[250] In this sense, he writes, place is "eventmental," which he defines as "something in process, something unconfinable to a thing."[251] Contrary to Casey's position, I argue that as much as place is "eventmental," in AR it remains also, to employ Casey's term, "entitative," something confined to a location "as a foundation has to be,"[252] since AR experience requires site-specific coordinates to come about. In other words, place in AR is as much a thing as it is an event, as much a specific location as an embodied, socially constructed space, an argument to which I will return later.

To a certain extent, design(at)ing spaces for AR can be seen as place-making, at least as far as this is understood in the parameters sketched above. However, I should again emphasize,

[248] Ibid., 210.
[249] Ibid., 226.
[250] Ibid., 337.
[251] Ibid.
[252] Ibid.

what is important for my argument is not identifying the abstract differences or connections between the concepts of space and place. What is important is rather how the viewer experiences the real world in these artistic and communicational circumstances: what the viewer perceptually identifies as "reality" in AR experience as well as the phenomenological and aesthetic stakes involved in this spatio-temporal experience. The notion of design(at)ed space proposed here precisely cuts across such intricate definitions. And in this sense, this term attests to the hybridity of AR; it is both a functional attribute of the AR process and a theoretical instrument capable of mapping out, tracing, and explaining the complex dimensions of AR spatiality.

3.4. Reality as fiction

Let us summarize the arguments made so far by saying that what counts as reality in AR experience is perceived by the viewer and theorized by both scientists and humanities scholars as *a spatial form*. It is explained here as a material real-world environment which, while sharing the same ontological and perceptual status with everyday reality, it functions as a specific experiential and conceptual category—as long as it is defined within a precise spatio-temporal framework by the AR discursive practices, its techniques of visualization, and the active participants. This is what I have called the design(at)ed space: reality under specific conditions. Up to this point, the specific conditions of the content, creation, and experience of the design(at)ed space have been discussed mainly in technical and descriptive terms through art examples and concrete scientific explanations or with respect to philosophical and phenomenological vocabulary such as milieu, *Umwelt*, and "place." But the question that persists is: how can we define this spatial manifestation of reality in AR from an aesthetic point of view?

To be more precise, to what extent can we consider (if any at all) AR's process of enhancing reality—of perceptually augmenting the design(at)ed spaces in the real world—as a specific, though unstable and discontinuous, way to participate in the fictionalization of reality? To put the question in this way is to affirm before anything else that the design(at)ed space, as I have defined it here, implicitly falls under the general category of fiction. So, one important task is to explain what exactly makes the design(at)ed space—a concrete moment and manifestation of the material world—an entity within the fictional order.

Most theorists define fiction as an imaginary construction and thus opposed to the real world in which we live. Fiction is seen as a mainly textual, but also pictorial, cinematographic, etc. representation; it is understood as a nonveridical discourse and therefore necessarily situated in opposition to the literal, "truthful," or concrete manifestation of the ordinary things around us. Against the predominant view,[253] I contend that fiction and fiction-making can be seen as a product and a process manifested *also* in the parameters of the material real world. My claim is supported by philosopher Nelson Goodman's assertions in his book that bears a significant title for our discussion, *Ways of Worldmaking*, where he argues that we cannot distinguish between fiction and reality on the ground that fiction is fabricated and fact found:

> Fiction, whether written or painted or acted, applies truly neither to nothing nor to diaphanous possible worlds but, albeit metaphorically, to actual worlds. (…) The so-called possible worlds of fiction lie within actual worlds. Fiction operates in actual worlds in much the same way as nonfiction. Cervantes and Bosch and Goya, no less than Boswell and Newton and Darwin, take and unmake and remake and retake familiar worlds, recasting them in remarkable and sometimes recondite but eventually recognizable—that is *re-cognizable*—ways.[254]

[253] I make my argument with no intention to enter here into what many scholars admit to be a complicated debate.
[254] Nelson Goodman, *Ways of Worldmaking* (Indianapolis: Hackett, 1978), 104.

By this logic, the act of fiction-making can be seen not only as an act of producing discourses by copying or (re)inventing the real world in comparable representations, but to an equal extent—and this possibility is what interests me here—as a process that creates possible or "alternative" worlds *within the material real world*: fictional situations built with reality's own means. It is in this way that AR spaces are fictional spaces and, in fact, contribute to the redefinition of fictionality.

In the example of Jan Torpus' *Living-Room 2*, the environment of the built installation (the designed space) is as much a material, denotative presentation of a living room as it is a suggestion of an "imaginary" space that reminds us of our own childhood fictions—of "as if" worlds in Torpus's accounts. Thus, this space unmakes and remakes a familiar world only to recast it in the remarkable, recognizable, and equally "real," i.e. material, world of fiction. *Living-Room* is therefore equally a living-room and a "living-room" (with quotation marks, to suggest fictionality, the "as-if" world). In Janet Cardiff and George Bures Miller's *Conspiracy Theory / Théorie du complot*, the architectural environment designated for the walking experience is invested with fictional dimensions by assigning it the role of a "possible world" in which audio text and ordinary people, fact and fiction, private and public, real and virtual, converge and coalesce. The material space designated for the work (corridors, stairs, rooms) is physically tangible, it is right there in its everydayness, but also functions as a fictional stage for an imaginary "conspiracy." Interesting to note is that blurring the line between the fictional and the non-fictional achieves dramatic dimensions in this particular piece since the original architectural space devoted to experiencing the work *literally* became a fiction due to

renovations: the passages, accesses, and hallways as they were presented in the initial version of the work are now renovated, rebuilt, and thus visually changed.[255]

AR is indeed one particular way to efface the borders between factual and the fictional and so to contribute to redefining fiction, but AR (art) is not unique in this respect. Installation art, performance art, and locative media art, to name just a few, also engage in the same aesthetic strategy: they work with the material reality elements in both denotative and metaphoric (read fictional) senses. Philosopher Jacques Rancière's comments on the issue from a wider (not strictly artistic) perspective can illuminate and expand our own explorations of fictionality. Referring to the discursive encounter between the reality of the facts of history and the fiction of literature, Rancière argues that nowadays there is a blurring of the borders between the logic of facts and the logic of fiction. In these circumstances, he writes, fictionality should be seen,

> first of all [as] *a way of assigning meaning to the 'empirical' world of lowly actions and commonplace objects*. Fictional arrangement […] is an arrangement of signs. […] It is the identification of modes of fictional construction with means of deciphering the signs inscribed in the general aspect of a place, a group, a wall, an article of clothing, a face.[256]

From this perspective then, the design(at)ed space of AR is an "arrangement of signs" of "lowly actions and commonplace objects" that becomes a "fictional construction" once it is assigned a meaning through an artistic discourse or informational content to which the viewers relate. As Rancière further observes, "politics and art, like forms of knowledge, construct 'fictions', that is to say *material* rearrangements of signs and images, relationships between what is seen and what

[255] As a consequence, the work has temporarily been removed from the Montreal Museum of Contemporary Art's presentation space. This situation points to the problems related to preservation and conservation strategies for this type of works. See for details, DOCAM (Documentation and Conservation of Media Arts Heritage), Case studies: Janet Cardiff, Théorie du complot / Conspiracy Theory, 2002, http://www.docam.ca/en/case-studies/theorie-du-complot-conspiracy-theory.html (accessed December 2015).

[256] Jacques Rancière, *The Politics of Aesthetics. The Distribution of the Sensible*, Trans. Gabriel Rockhill (London and New York: Continuum, 2004), 36-37 (emphasis mine).

is said, between what is done and what can be done"[257] and, I would add, between what is presented as real and what is suggested as virtual. As we have seen, these rearrangements and relationships are not general associations, but specific indications. In this sense, we should remind the provision stated above that not just *any* space within the material world counts as "reality" in AR experience. As Rancière insists, "It is not a matter of claiming that everything is fiction. It is a matter of stating that the fiction of the aesthetic age defined models for connecting the presentation of facts and forms of intelligibility that blurred the border between the logic of facts and the logic of fiction."[258]

So, we can ask with confidence what are the artworks discussed here if not specific models for connecting and blurring the border between the logic of facts and the logic of fiction? Indeed, AR presents to the viewer specific "facts and forms of intelligibility" that belong ontologically and perceptually in equal measure to material reality and the fictional order. Similar to a theatre décor, a tableau vivant, a reality TV show, or—more relevant to our argument—an installation artwork, design(at)ed space is *as much fictional as it is real* (regardless of its degree of mediation, as I will later explain). They build discursive, "possible" worlds with the material means of the real world. We should point out that, etymologically, "fiction," from Latin *fingere*, originally had this meaning: "to shape, form, devise, feign," in a material sense.[259] Therefore, fiction can be seen as not necessarily unreal, or, per Goodman and Rancière, not only defined in opposition to the facts and materiality of the real world, but as part of it. AR is a good example in this sense, since the material elements of the real space presented for the viewer to experience in/as the work participate in the fictional process by "playing their

[257] Ibid., 39. (emphasis in the original).
[258] Ibid., 38.
[259] Douglas Harper, *Online Etymology Dictionary*, 2001-2012, http://www.etymonline.com (accessed December 2015).

own role." That is, they constitute a spectacle of their own, one defined by a slippage between ontological, epistemological, and aesthetic levels. Whether a portion of the street, a building, a hallway, or a specific room, each stands in their own perceptual materiality as an image *of* and *for* themselves. In fact, as Slavoj Žižek's succinctly remarks, "reality is the best appearance of itself."[260] And, as Žižek further comments, media always play a crucial role in creating such an effect. But, this is not a question of the virtualization of the real as Žižek implies, a position that brings him closer to the Situationists, who decried modern society's dependence on images[261] and to Jean Baudrillard's theory of simulacrum, for whom reality is just a by-product of the simulation.[262] Instead, what I suggest (and have hopefully clarified above) is that material reality can be transformed in certain circumstances (like AR experience) into a spectacle played with its own means: reality as a fictional appearance in its ontological self-identity (and not as a virtual projection). Yet, I should again emphasize, this is in no way to imply that the whole world-reality is an appearance, i.e. a fictional occurrence. These comments emerge from and apply to specific—although not restrictive—instances such as those provided by the AR experience.

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[260] Slavoj Žižek, *Welcome to the Desert of the Real* (London and New York: Verso, 2002), 11. The author identifies a generalized process of virtualization of the world, one that leads to the fact that "we begin to experience 'real reality' itself as a virtual entity" (11).

[261] In his book *Societé du Spectacle*, the leader of the Situationist movement, Guy Debord writes: "In societies where modern conditions of production prevail, all of life presents itself as an immense accumulation of *spectacles.* Everything that was directly lived has moved away into a representation. (…) The spectacle is not a collection of images, but a social relation among people, mediated by images" Guy-Ernest Debord, *The Society of the Spectacle*, Chapter 1 "Separation Perfected", nothingness.org, the library, http://library.nothingness.org/articles/SI/en/pub_contents/4 (accessed December 2015). The movement called International Situationists was formed in 1957 by international artists and political activists, coming from different groups like Lettrist International or London Psychogeographycal Association, the key figure being the French writer and film maker Guy Debord. Their journal *Internationale Situationiste* was published in Paris between 1958 and 1969; the organization itself survived until 1972, when it was auto dissolved.

[262] Jean Baudrillard, *Simulations*, Trans. Paul Foss, Paul Patton and Philip Beitchman (New York: Semiotext[e], 1983). According to Baudrillard, when it comes to postmodern simulation and simulacra, "It is no longer a question of imitation, nor of reduplication, nor even of parody. It is rather a question of substituting signs of the real for the real itself; that is, an operation to deter every real process by its operational double, a metastable, programmatic, perfect descriptive machine which provides all the signs of the real and short-circuits all its vicissitudes." (4).

A term that might illuminate and nuance my own arguments in this context, given its relevance in the discussions about the nature of the spectacle as a real-world manifestation, is mise-en-scène. I propose it here as an analytical instrument for both grounding the above assumptions about reality as fiction and explaining the historical and aesthetic fundamental affinities between AR real-world spatiality (the design(at)ed space) and installation art's own spatiality.

3.5. Spaces of fiction: Mise-en-scène, Installation art, and AR

In fields as diverse as theatre, cinema, TV, politics, video gaming, or mobile computing, mise-en-scène generally refers to a particular discursive and material occurrence, a specific space, an arrangement of elements, a visual theme, and a positioning or movement of actors and participants. Cultural theorist Mieke Bal defines mise-en-scène in a more elaborate (and, with regard to our discussion, more relevant) manner, as "an arranging of a limited and delimited section of real time and space."[263] In her view, mise-en-scène is a "'form,' 'medium,' or 'practice'" that is able to turn reality into "a spectacle receptive to the turmoil of liberated meanings, variously attached to concrete, visible, and audible phenomena and signs."[264] Thus, taking this definition as a guiding principle, we can see the design(at)ed space of AR (and the experience that defines it) as a mise-en-scène—a fictional space-time that takes place within and attaches specific meaning to material reality. Thus, the notion of mise-en-scène enables me to define more specifically the fictionality of the "reality" of AR situations. Adam Frank and Zack Booth Simpson's *Shadow* is a compelling example of the way in which AR arranges limited and

[263] Mieke Bal, *Travelling Concepts in the Humanities*, 97.
[264] Ibid.

delimited sections of real time and space, for perceptually and conceptually expanding them into the discursive realm, this time with AR technological means. The dark corner in the outdoor environment designated for experiencing the work becomes a mise-en-scène for a sort of uncanny "shadow theatre" where participant and virtual projection are equally actors in the staged performance. What is reality and what pretends to be reality—i.e. the real shadow of the viewer under the powerful spotlights and the animated shadow produced and activated by the technological system that "haunts" the participant—are blurred not only at the symbolic level, but also at the perceptual one. Likewise, in Julian Oliver's *Artvertiser* or the project *We AR in MoMA*, the designated areas of interaction—urban ad-filled spaces and the museum's art-enveloped galleries, respectively—become mise-en-scènes for a mobile device-driven media spectacle. These spaces are integral to everyday reality, but they somehow appear for the viewer as mise-en-scènes despite the fact that there is no proscenium or frame to mark them as such; they can be seen as mise-en-scènes as long as they are, to borrow Mieke Bal's words, "differently delimited sections of fictional time and space."[265]

Difference and delimitation should be seen here not as indicators of restrictions but as mechanisms for opening: they are real-world spaces designated as interaction zones by the respective project and specifically chosen for their intrinsic meanings which are now perceptually expanded into the virtual realm by the AR apparatus. That is to say, these designated spaces are mise-en-scènes since they represent equally a specifically defined material shelter and a symbolic—or, in this case, critical—platform for fictionalization. Here technology is not only a prop, but a catalyst for and the raison d'être of the fictional process. An advertising billboard, a street screen, or a room in one of the most famous museums of the world is not a-priori a mise-en-scène despite the visual, "theatrical" or symbolic value it may carry, but each of

[265] *Ibid.*

these became so—at least from an AR perspective—once a discursive indication is applied and a precise technological, performative action enacts that reality. It is significant to remind here that media theoretician Mette Ramsgard Thomsen calls the reality of AR "enacting reality."[266] Her terms should be understood here as referring to the theatrical reality of a "spectacle," a subjective temporary situation, a material and discursive manifestation of a fictional game in which reality is equally caught in its own imaginary self and perceptually enhanced with "the turmoil of liberated meanings" in the media realm. In this light, the design(at)ed space of AR represents—like a mise-en-scène—"a meeting between (aesthetic) art(ifice) and (social) reality,"[267] where and when augmentation takes place.

Nevertheless, seen from a larger historical and comparative perspective, the creation of real-world mise-en-scènes is not a new endeavor nor is it solely typical of AR projects. Installation art's development relies on the same spatial strategy, and it is precisely this aspect that makes it a crucial reference point in the genealogy of AR. As art historian Christine Ross notes, "in the field of art, AR environments are, effectively, a derivative of site-specificity installation art, in which the site is de/un/re-specified by the activation of computer-generated data."[268] Indeed, installation art's contribution to the crystallization of the AR aesthetic strategy and spectatorial experience consists principally in the ways in which installation art, like AR, designs and/or designates sections of reality by including them (with or without the use of technology) within the artistic discourse and therefore opening them up to the fictional order through the active participant.

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[266] Mette Ramsgard Thomsen, "Positioning Intermedia. Intermedia and Mixed Reality," *Convergence: The International Journal of Research into New Media Technologies* 8, no. 4 (2002): 40.
[267] Mieke Bal, *Ibid.*
[268] Christine Ross, "Spatial poetics: The (non)destinations of augmented reality art," *Afterimage* 38, no. 2 (2010): 19.

As a way to attest to the relevance of this historical argument, I call attention to two important claims I have made above about AR aesthetic strategies, which are confirmed by historians of installation art. First, the artwork and what is perceived as everyday reality are ontologically equivalent; second, aesthetically and perceptually the material real-world is both the context and the content of the artwork. These positions are shared by art historian Claire Bishop, who observes that "the space and the ensemble of elements within [an installation] are regarded in their entirety as a singular entity;"[269] and by art historian Erika Suderburg, who maintains that "the site of installation becomes a primary part of the content of the work itself."[270] If these aspects are applicable to installation art, the same is true of AR. Both artistic forms (AR and installation art) activate the ordinary spaces of material reality, inscribing them into a fictional order. In doing so, they recall Jonathan Crary's description of installation art as "unanticipated spaces and environments in which our visual and intellectual habits are changed and disrupted."[271] This is what defines installation art in the first place (and to an equal extent AR): an arrangement of elements in space that disrupts reality and places it under specific (i.e. aesthetic, cultural, social, political) conditions by creatively activating location (site-specifically), objectual meaning, and the viewer's spectatorship. Like or rather *as* a mise-en-scène, installation art provides the participant, to quote Mieke Bal again, "a spectacle receptive to the turmoil of liberated meanings, variously attached to concrete, visible, and audible phenomena and signs."[272] It is a fictional spectacle of the real world built, enacted, and experienced within the real world's own parameters.

[269] Claire Bishop, *Installation Art: A Critical History* (London and New York: Routledge, 2005), 6.
[270] Erika Suderburg, ed., *Space, Site, Intervention: Situating Installation Art* (Minneapolis and London: University of Minnesota Press, 2000), 5.
[271] Jonathan Crary, "Foreword," in Nicolas de Oliveira, Nicola Oxley and Michael Petry, eds., *Installation Art in the New Millennium* (London: Thames & Hudson, 2003), 7.
[272] Mieke Bal, *Travelling Concepts in the Humanities*, 97.

So, can we see installation art as the design(at)ed space par excellence? Perhaps yes, but what is important is not its categorization, but how the parallel AR-installation art can open different paths for investigating AR spatiality., To achieve this goal, a few examples of installation artworks will be provided as a means to demonstrate how installation's spatial strategy participates in the fictionalization of the real world as it does in AR, and to see the similarities and dissimilarities between these practices. For the sake of the argument, the first example of installation is similar to what I identify in the AR typology as the integrative type, in the sense that it is conceived as an environment able to offer the viewer a complete immersion or integration within the matrix of the work.[273] Dan Graham's "pavilion" works of the 1970s were conceived as sort of green-house-like constructions to be engaged by the spectator equally from the inside and the outside. The use of semitransparent mirrors (and sometimes video feedback) provides a kind of hallucinatory effect of bodily multiplication and interaction that demonstrates, as Claire Bishop notes, "how our awareness of the world is dependent on interaction with others."[274] Indeed, the play between reflection and transparence create a real-fictional space within which one is at the same time actor and spectator, subject and object, insider and outsider, an individual and a socialized participant. A more illustrative case is Graham's *Public Space/Two Audiences* (presented in 1976 at the Venice Biennale). The work consists of a room divided by a semi-reflective glass; the opposite walls of the room are, one of them, mirrored and the other left white. A double (or rather multiple) reflection is thus created between the glass and the mirrored wall, an effect of presence and remoteness that, significantly, is produced only when other viewers are present within the two spaces. Therefore, instead of an experientially and

[273] Immersion is understood here in a larger sense, as suggested by Linda Hutcheon, as "a sense of being 'transported' in psychological and emotional terms." Significant for our argument, she applies the term immersion to three different modes of engagement: reading (a novel), showing (a film or a play), and interacting (with a videogame). Linda Hutcheon, *A Theory of Adaptation* (New York: Routledge, 2006), 22-27 and 133-139.
[274] Claire Bishop, *Installation Art: A Critical History*, 72.

culturally detached perception of the work, the viewer finds himself/herself caught within its fictional game. Being not only a subject who watches, the viewer becomes (also) an object watched. Real-world materiality, "virtual" visuals, and metaphor are blurred in the perceptual dizziness of the mirrored-based spectacle.

Fig. 3.1. Dan Graham, *Public Space/Two Audiences*. 1976. Installation.

Like the immersive AR projects Torpus's *Living-Room 2* and de Nijs's *Exercise in Immersion 4.1* discussed above, Graham's work designs spaces of interaction in which the viewer's point of view is situated—unlike the Albertian "window" model—*into* and not outside of the projection space. Stepping out of the frame to embrace real space as a primary material for art and experience (or putting reality within the frame while dissolving the latter, like in Graham's case) is what defines both installation art and AR (especially in their "immersive" modes). However, I must note that beyond these similarities, in Graham's installation none of the sophisticated technologies from the AR examples are involved—only the metaphorically sophisticated presence of the mirror. And the presence of the apparatus, the interactive mode of spectatorial and locational engagement, the virtual images that converge with the real space are

three factors that make a crucial difference for defining the perceptual specificities of an AR artwork.

Another way to articulate or design(ate) fictional spaces within material reality in installation art practice is to reaffirm a certain distance between the fictional space and the spectator. These works show significant aesthetic and experiential similarities with what I called the projective type of AR. For example, Ilya Kabakov's *The Man Who Flew into Space from his Apartment* (1981-1988) appears as a "projective" environment since it presents through the interface of a door a "theatrical" space comprised of a room and a number of domestic elements, including a home-made catapult. The work stages a narrative about an alleged flight into space carried out by an ordinary citizen, now absent from the scene, as a metaphor for escaping from the communist Soviet "paradise." Various elements, such as tools, house objects, debris from the broken ceiling, documents pinned on the walls including technical sketches of the "flight machine" and "police reports" indicate to the viewer that what s/he perceives is plausible, although entirely absurd.

Fig. 3.2. Ilya Kabakov, *The Man Who Flew into Space*. 1981–88. Installation: six poster panels with collage; mixed media. Room dimensions 96 x 95 x 147 cm. Centre Georges Pompidou, Musée d'Art Moderne, Paris.

Speaking about the way in which Kabakov elaborates his installations as real-fictional environments artist and theorist David Tomas remarks that such spaces "operate on the basis of a trompe l'oeil logic." However, he comments, "their attachment to the real world creates a different kind of trompe l'oeil…. The 'magic' and 'ritualistic' transformations of Kabakov's installations are rooted in the materiality of the real world."[275] Indeed, the work constructs a fictional world (an imaginary apartment and an absurd story) that remains part of the material world. It tricks our senses not in the manner of a "classical" (painted) trompe l'oeil as an optical illusion, but as a narrative allusion: it tells what we might guess is a fictional story, but with reference to the political reality of the day employing ordinary reality's own material means. In this mise-en-scène, the physical and the discursive differences between the "inside" of the fictional world and the "outside" of our own "exterior" world are therefore blurred but not erased. Similar to some AR projects, such as Workspace Unlimited's project *Spac[E]scape*, the work functions as a spatial interlude, created by artistic intervention and viewer interaction, that is equally separated and linked, equally part and apart from the surrounding, "non-artistic" reality. Of course we have to note an important difference: the absence, in Kabakov's work, of the technological component that surely adds other more complex dimensions to this trompe l'oeil game.

The experiential and aesthetic kinship between installation art and AR—seen from the perspective of spatiality, fictionality and mise-en-scène, as I stated above—is evident also in the way in which some installationist artists approach the urban space in a manner that recalls AR's nomadic type. For example, Christo and Jeanne-Claude's *The Gates, Central Park, New York*

[275] David Tomas, "The Threshold of an Interface: Ilya Kabakov's *Looking Up, Reading the Words* (1997)," in: Olivier Asselin, Johanne Lamoureux, and Christine Ross, eds., *Precarious Visualities: New Perspectives on Identification in Contemporary Art and Visual Culture* (Montreal & Kingston: McGill-Queen's University Press, 2008), 193.

City, 1979-2005 takes New York's Central Park as a huge stage for a collective spectacle engaging participants in a mobile fashion. The installation filled the park's 37 kilometers of pathways with 7503 saffron-colored portals measuring almost 5 meters in height, spaced at regular intervals over the pathways. The perceptual transformation of the public environment offered a special experience to the participants, one that, in the absence of an evident or implied narrative reference (such in Kabakow's work, for example), was still able to construct a fictional world for individual and collective experience. As media theorist Glorianna Davenport notes, the experience of Christo and Jeanne-Claude's work "made each and every visitor feel special, as if s/he had journeyed onto a movie set and s/he—along with all her/his kinfolk—had been invited to take her/his place, center stage, as s/he navigated the now majestic pathways."[276]

Fig. 3.3. Christo and Jeanne-Claude, *The Gates, Central Park, New York City, 1979-2005*. 2005. Outdoor installation, Central Park, New York City.

[276] Glorianna Davenport, "When Place Becomes Character: A critical framing of place for mobile and situated narratives," Online at MIT: *Interactive Cinema/Media Fabrics*: Publications. http://mf.media.mit.edu/pubs/other/CharacterPlace.pdf (accessed December 2015).

It is perhaps also in this sense that we can understand Heidegger's idea of the artwork that "opens up a world." Like the Greek temple, exemplified by Heidegger, this installation opens up a world "in the sense of dedication and praise" (something more than "a bare placing").[277] The objectual presence of the gates is therefore not simply meant to ordinate a space and direct participants' trajectory, but to also create a sort of fluctuant space of "dedication and praise" and, indeed of collective entertainment, where various cultural references might be inscribed and celebrated. Like in mobile AR media applications or artworks, the user creates his/her own changing space where mobility facilitates multiple possibilities of perception and cultural inscription. This is the case with *Artvertiser* by Julian Oliver or with applications such as Layar and Wikitude, where the mechanisms of signification are produced and produce references in relation to the geographical position of the user and his/her subjective selection in the application's menu. The resemblance to mobile AR goes even further if we observe that, like many of the AR mobile apps or artworks, this installation too was temporary: dismantled soon after its installment, what remains is only the work's documentary (f)actuality.

As I hope these examples have shown, the perceptual and aesthetic parameters of both installationist spaces and what I call here AR's design(at)ed spaces share, at least in part, the same properties. This is to say that both installation art and AR practices are based on spatial strategies that in a way or another turn real material environments into fictional spaces, or more precisely, into mise-en-scènes. It is mainly but not exclusively in this respect that I think installation art and AR are closely related. As I have demonstrated above, fictionalizing reality means equally a concrete intervention within the material world (an arrangement of objects and spaces, by designing, or designating them) and an application of a discursive content to that specific arrangement. Thus, these spaces of the artwork are defined as much in terms of physical

[277] Martin Heidegger, "The Origin of the Work of Art," 169.

and media adequacy to a specific environment, as they are articulated by the complex rapports the work establishes with the cultural, historical, social, and political conditions of that environment. The next and final section of this chapter will thus address the real-world spatiality of AR—the design(at)ed space—in social terms. This is an important feature, since, as I stated at the beginning of the chapter, sociality is not only a theoretical premise for the AR-based interaction, but the very *condition* (one among others, as we have seen) that defines the design(at)ed spaces (i.e., "Reality") in AR and the AR experience as a whole.

3.6. Real world in the (AR) social mode: site and location

3.6.1. The social construction of space

If reality in AR is understood in spatial terms—a specific condition of perceptual reality, a design(at)ed space that acquires sense through and within the AR experience—social dimension constitutes a relevant frame of reference. Indeed, recent advances in AR research and applications, especially in the fields of locative media and mobile computing, have led to increased recognition of the importance sociality plays in the construction of perceptual experience and therefore of spatiality in AR. Media theorists Steve Benford and Gabriella Giannachi attest to this fact when they write that, in the circumstances such as those discussed here, "both place and space are indeed complex social *and* technical constructions."[278] In the same vein, media theorist Jason Farman considers the problem of embodiment in mobile technology practices, including AR; he argues that "space needs to be considered as something

[278] Steve Benford and Gabriella Giannachi, *Performing Mixed Reality* (Cambridge, Massachusetts and London, England: The MIT Press, 2011), 43.

that is *produced* through use. It exists as we interact with it—and those interactions dramatically change the essential character of space."[279]

Thus, by confirming that AR space is equally a material and technological manifestation and the result of social interactions, these scholars acknowledge its existence as a specific "spatial practice." The term is fundamental in philosopher Henri Lefebvre's understanding of the social construction of space and has relevance here as it informs my own explorations regarding the production of space in AR circumstances as a social phenomenon. The term "spatial practice" enables a particular perspective on AR that explains it not simply as a technology, but rather as a set of aesthetic, mediatic and social practices resulting in a different perceptual paradigm of space. For Lefebvre, spatial practice "consists in a projection onto a [spatial] field of all aspects, elements and moments of social practice."[280] It is a practice that is "observed, described and analyzed on a wide range of levels: in architecture, in city planning or 'urbanism' […], in the actual design of routes and localities […], in the organization of everyday life, and, naturally, in urban reality."[281] But, certainly, not only planning, urbanism, and architecture are forms of spatial practice, but also the spatial construction within the material reality conceived, performed, and enacted by installation art and AR projects. In the words of the architecture theorist Anthony Vidler,[282] these type of spaces are "effects of human activities," creating the conditions for or being created by community formations. Christine Ross makes an important argument about this aspect when she demonstrates that within the technological and perceptual circumstances of AR viewers are subjected to "a binding impulse." This is especially true in projection-based works and those destined for public spaces. She writes that the binding impulse

[279] Jason Farman, *Mobile Interface Theory*, 18.
[280] Henri Lefebvre, *The Production of Space*, 8.
[281] Ibid., 413-414.
[282] Anthony Vidler, *Warped Space: Art, Architecture, and Anxiety in Modern Culture* (Cambridge, Massachusetts and London England, The MIT Press), 68.

"will be confirmed by the activation of interactivity, the interactivity between users and between users and machines, which systematically implies the formation of communities."[283] Such form of connectivity is surely a specific expression of the technological and perceptual strategies of AR and other related media practices. But, as Ross explains, these are grounded in the development of community forms of public art, relational aesthetics, and mobile technologies.

If we look again at the examples discussed above, we will notice that some of the AR works base their spatialization strategies on this idea of participation as a collective practice. This is more evident in works such as *Under Scan* by Rafael Lozano-Hemmer, *Spac[E]scape* by Workspace Unlimited group, and *Artvertiser* by Julian Oliver where the openly public character of these works, as opposed to the more individual-focused orientation of the other works commented above (for instance, *Living-Room 2* by Jan Torpus and *The Golden Calf* by Jeffrey Shaw), creates a binding impulse among viewers and produces a kind of collective, entertaining consciousness. By this I mean that spectatorship functions in these works in a relational logic, where interaction, first practiced as an embodied, personal experience, becomes increasingly an exercise of what the art theorist Nicolas Bourriaud (who introduced the term "relational aesthetics") called the "collective elaboration of meaning."[284] Indeed, intersubjectivity, public encounter, and social exchange (indicated by Bourriaud as essential features of such relational artistic practices) are considered in these works to be of equal importance to the creation of a bodily real-virtual perceptual convergence and to the technological accomplishment. Indicative of this relationality, it is interesting to note how for example in Lozano-Hemmer's *Under Scan*, the participants enjoy the compelling effect of the work not only at the personal level (as an

[283] Christine Ross, "The Projective Shift Between Installation Art and New Media Art: From Distantiation to Connectivity," in *Screen/Space: The Projected image in Contemporary Art*, edited by Tamara Trodd (Manchester and New York: Manchester University press, 2011), 191.
[284] Nicolas Bourriaud, *Esthétique relationnelle* (Dijon: Les Presses du Réel, 1998), 15.

encounter with the "other" in the form of a projected video image within one's own shadow), but also in a collective mode, as a direct encounter with the others who are physically present next to them in the real world space and who interfere with their shadows by jumping and synchronizing movements to provoke the technological system to respond to their collaborative game. Whatever each participant's motivation might be, a sense of togetherness and reciprocity is surely present. Similarly, in Julian Oliver's *Artvertiser*, although the experience of the work is mainly personal (given the nature of the interface and the resulting effect that addresses one person at a time), there is a sense of communion and solidarity between people who experience the work; they share admiration not only for its visual effect, but also its critical attributes. The spaces of experience become therefore not only privately own and individually generated, but also publicly shared and collectively constructed. Thus, beyond each work's aesthetic intentionality or technological goals, the collective participation of the viewers on the field effectively defines and gives meaning to the material reality spaces of the AR experience (whether a public square in Lozano-Hemmer's *Under Scan*, street billboards in Oliver's *Artvertiser*, or various architectural interiors in Workspace Unlimited's *Spac[E]scape*).

It is important to specify, however, that the collaborative construction of space in AR (of the design(at)ed space as socially defined) pertains not only to the material world order, as an encounter of a number of participants within the agora, but also to the possibilities for connection, interaction, and cooperation within the larger field of the electronic networking systems (via the Internet, mobile phones network, GPS, Wi-Fi, or Bluetooth capabilities). In this sense, works such as *Spac[E]scape* or applications such as Layar or Wikitude provide a matrix for sociality and thus create spaces of collective encounter—both in the physical spaces of their installation and in the virtual realms of their networked connections. The spaces of interaction of

such works or applications therefore become communications platforms defined equally as materiality, sociality, and media connectivity. As Jason Farman suggests, they become "information interfaces much like the graphical user interface of a computer screen."[285]

It is as equally important to recall that AR spatiality is first and foremost about the specific perceptual redefinition of *the real world*. In this sense, Christine Ross is right to observe that "mixed, composite, or augmented reality is […] as much as Minimalism ever was, a 'real-world' perceptual paradigm."[286] It is a real world that, we should again emphasize, is equally an effect of a social "spatial practice" as it is an outcome of a material spatial construction (where surely technology and mediation play a key role). Ross' observation also points to a historical aspect, more precisely to the fact that AR is actually related to other previous artistic manifestations whose main aim is to intervene directly in reality and to physically, perceptually, or socially affect our relationship to the real world. Such strategic interventions were on artists' agendas since the beginning of the twentieth century avant-garde, although they became more evident and more diversified with the aesthetic and material investigations of the installationist, institutional critique, and minimalist practices post 1960s. With these artistic explorations a debate has emerged—on both practical and theoretical fronts—on the notions of "site" and "site-specificity" Two terms which have crucial significance in the aesthetic development and conceptual strategy of AR; their theoretical implications should be briefly explained so as to further historicize and specify the design(at)ed spatial "Reality" of AR.

[285] Jason Farman, *Mobile Interface Theory*, 43.
[286] Christine Ross, "The Projective Shift Between Installation Art and New Media Art...," 192.

3.6.2. Site (as) specificity

In her book on site and site-specificity, art historian Miwon Kwon notes that, in relation to the art practices of the late 1960s and early 1970s, site was defined primarily as "an agglomeration of the actual physical attributes of a particular location [...] with architecture serving as a foil for the art work in many instances."[287] In this context, site-specificity is most often described as the way in which artistic practice "incorporate the physical conditions of a particular location as integral to the production, presentation, and reception of art."[288] However, as Kwon observes, various artists subsequently challenged "the hermeticism of this system," complicating site by considering it not only as a physical arena but one constituted and defined through social, economic, and political processes. Artists such as Michael Asher, Daniel Buren, and Hans Haacke contributed to these artistic and conceptual "complications." Yet in more recent site-oriented art, Kwon explains, site is again redefined, often extending to more "public" realms:

> dispersed across much broader cultural, social, and discursive fields, and organized intertextually through the nomadic movement of the artist—operating more like an itinerary than a map—the site can now be as various as a billboard, an artistic genre, a disenfranchised community, an institutional framework, a magazine page, a social cause, or a political debate. It can be literal, like a street corner, or virtual, like a theoretical concept.[289]

As a consequence, the author argues, site-specificity, once turned into a spatio-political problematic, should be defined rather as a social relational specificity. In such conditions, the nature of the link between subject/object and location becomes a subject of transformation, the

[287] Miwon Kwon, *One Place after Another: Site-Specific Art and Locational Identity* (Cambridge, Massachusetts and London, England: The MIT Press, 2002), 3.
[288] Ibid., 1.
[289] Ibid., 3.

corollary being the intensification of the conditions for spatial indifferentiation and departicularization, which finally leads, Kwon maintains, to locational *un*specificity.

Kwon's analysis describes very well some of the recent transformations undergone by the concept of site in both practice and theory; however, it contributes significantly to relativizing the very idea of site. Many artistic practices have indeed destabilized and reinvented the ways in which we relate to a site—especially in the sense of considering it, as Kwon puts it, "a scene of political struggle."[290] But at the same time we cannot ignore the fact that the site remains, *volens nolens*, an essential player in the material order, with "actual physical attributes," related to a precise location (however mobile or mediated the experience may be). Indeed, as we have seen in the above examples, if some artists are preoccupied with reconfiguring reality and therefore site within the framework of a collective and politically conscious community program, they do so by *amplifying, not annihilating, the material reality* and thus by *reaffirming the importance of physical locality of the site*. Consequently, site-specificity is equally a mode of adaptation to material reality and an act of cultural, social, and political adequation. In this sense, art and performance theorist Nick Kaye's definition of site-specificity is particularly effective:

> A 'site-specific work' might articulate and define itself through properties, qualities or meanings produced in specific relationships between an 'object' or 'event' and a position it occupies. After the 'substantive' notion of site, such site-specific work might even assert a 'proper' relationship with its location, claiming an 'original and fixed position' associated with what it *is*.[291]

With regard to AR practice, I argue, site is the position and the context (defined *equally* by material, historical, social and political dimensions); it is a design(at)ed space of interaction in

[290] *Ibid.,* 7.
[291] Nick Kaye, *Site-Specific Art: Performance, Place and Documentation* (London and New York: Routledge, 2000), 1.

which the viewer experiences site-specifically the augmentation process as an event. Contrary to what Kwon maintains, in the field of AR, site and site-specificity remain as much discursive and displaceable by the community praxis as they are material and locational. And, especially in the mobile AR, they remain as much in the form of an itinerary as they persist as a map; they are as much products of a dérive as of a mapping.[292]

The conceptual shift of the ideas of site and site-specificity was accompanied by an increase of attention to another related pair of terms: location and localization. No less circumstantial than the concepts of site and site-specificity, the ideas of location and localization have gained some impetus now which is especially due to the popularization of the notion and practice of locative media via widely accessible, location-aware, portable communication devices. As a consequence, most theoretical studies in the field of technological development as well as more popular literature on technological development employ these terms with reference to the actual, material context of the application/work, instead of using the more specialized, if not restrictive, and debatable terms site and site-specificity. However, this is not a matter of strict terminological delimitations or exclusions (thence, the occasionally interchangeable fashion in which I employ these pairs of terms). What interests me instead is how these notions are operational with respect to the question posed at the beginning of this chapter: what does "Reality" stand for in AR?

[292] The term dérive (literally meaning drift) is used here in the sense the French artist and activist Guy Debord has used it as the action to explore the city on foot as to investigate its "psychogeography," and to discover those places that are conductive to specific emotions or which resonate with the desire that can be harnessed to subvert what Debord calls the "society of the spectacle." Cf. David Macey, *The Penguin Dictionary of Critical Theory* (London: Penguin Books, 2000), 92.

3.6.3. Location and localization

The terms location and localization are used in most circumstances without a proper definition, often taken with their implied meanings. Since it is not my intention to provide here a comprehensive definition, I will explain these concepts within the precise context of the AR practice. With regard to AR experience, location is understood here as the real-world geographical position on the ground, visible on a map, the formal zone of physical placement and technological displacement, and of cultural convergence and social connectedness, to which artists refer when they design(ate) the zone of interaction. For example, in *Conspiracy Theory / Théorie du complot*, the Museum of Contemporary Art in downtown Montreal is the location, but the designated spaces are the particular areas within the main hallway, the stairs, the corridor and the passage. In Marnix de Nijs' *Exercise in Immersion 4.1* the location is Rotterdam, the Institute for the Unstable Media V2_lab, while the designated space is the specific room within the industrial building where the work is experienced. In Oliver's nomadic *Artvertiser*, the location is various places along the city's main boulevards, but the designated spaces are the street ads and billboards. In other words, location is the context, while the design(at)ed space is the matrix. While location is a specific spatial background within reality defined through quantitative dimensions such as longitude and latitude, design(at)ed space is the "organization of the space in which the [work] is set," i.e. constructed and experienced as a mise-en-scène.[293] One is the local, historical, cultural, and social framework, the other is a particular nexus of (artistic) expression, experience, and meaning that takes all the historical, cultural, and social aspects as productive premises. Such analytical distinctions are in no way meant to establish hierarchies or barriers between these different definitions of spatiality. As I stated above, both empirically and conceptually, location, site, and the design(at)ed space are all fundamental components of the

[293] Mieke Bal, *Traveling Concepts*, 131.

AR aesthetic strategy and experiential effect. Each of these terms has its own role in defining the real-world spatiality of AR.

Generally speaking, a location becomes a location (and a site becomes a site) at the discursive and aesthetic levels, as far as it is produced by human intervention and (technological) interaction. In other words, a location enters into a specific geographical, cultural, aesthetic, and social order as it is prompted by the creation and activation of a design(at)ed space of human and/or artistic interaction that calls attention to that specific location and its physical and discursive potential. It is therefore this reassertion of space not only in terms of concrete materiality, but also, as Lefebvre shows, as lived, subjective, aesthetic, and perhaps ideological entity which defines the real-world space of AR. In this sense, AR equally confirms, interrogates, and expands the established definitions of the real-world spatiality.

We should therefore reassert the idea that the production of the real-world spaces in AR first and foremost a perceptual and spatial practice. But as I have explained above, it is one that involves us in our everydayness, which places everyday and artwork on the same perceptual and ontological level while establishing differences at the aesthetic and communicational levels. AR design(at)es spaces as *specific* manifestations of the real world and as *particular* moments of our individual and social actions. By saying that, we return, as a way to conclude, to the idea of mise-en-scène as a cultural practice. Following Bal, mise-en-scène is "a fictional realm of experiment" in our every day, "a cultural moment in which routine is slowed down, self awareness is increased, and satisfaction is gained from going outside ourselves."[294] This is in fact the way in which we perceptually identify "reality" in AR experience.

This chapter discussed these specific conditions of reality in AR experience. I understand reality in spatial terms, more precisely as a design(at)ed space, a notion that is related and

[294] Mieke Bal, Ibid., 131.

intersected with related conceptions of space such as place, milieu, *Umwelt*, fictional space, installation art, mise-en-scène. These terms offered not only a theoretical framework, but they work also as qualifiers for the idea of design(at)ed space, defined as the real-world environment that is fictionalized and which acquires sense as a specific experiential matrix through AR discursive practices. Any contribution to the fictionalization of the real-world in AR practice will always rely and is always determined by the use of technology, more precisely by virtual imaging systems. As media theorist Margaret Morse rightly remarks, "socially constructed reality is already fictional and […] virtuality is an aspect of that fictionality that has come to be more and more supported and maintained by machines, especially television and the computer."[295] This is true also, in recent years, of the mobile visualization technologies. Taking these observations as the point of departure, the next chapter will examine how the use of AR technology and of the various means of mediated expression and interaction define and construct AR spaces. Shifting the focus from the material to the virtual realm, I will discuss the defining role of the ideas of virtual, virtuality and illusionism in constructing—as much as the "reality" principle—the perceptual experience and the theoretical discourse pertaining to AR spatiality.

[295] Margaret Morse, *Virtualities: Television, Media Art, and Cyberculture* (Bloomington: Indiana University Press, 1998), 10-11.

Chapter 4

On the Other Side - Virtuality and Virtual Space

4.1. What is "Virtual" (for) in AR?

A good way to start investigating the properties and principles underlying the ideas of "virtual" and "virtuality" in AR is to return again to the definitions of AR as they are provided in both science and humanities scholarly writings, while maintaining a close attention to the way in which these two terms are employed. The consensus among different researchers is that AR is a system or a set of technologies that facilitate the perceptual convergence of reality and virtuality, of material objects and virtually generated images within the same interaction space. For example, computer scientist Ronald T. Azuma writes that unlike VR, which completely immerses the viewer inside a synthetic environment, "AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world." These virtual objects, Azuma goes on to note, "display information that the user cannot directly detect with his own senses. The information conveyed by the virtual objects helps a user perform real-world

tasks."[296] Engineer Paul Milgram defines AR by including it in what he calls the *Reality-Virtuality (RV) continuum*, a schema that covers a whole range of situations between reality and virtuality. As Milgram explains, a definition of AR "covers any case in which an otherwise real environment is 'augmented' by means of virtual (computer graphic) objects."[297] In a broader understanding of the term, Milgram notes, AR is seen as "cases involving any mixture of real and virtual environments."[298] The latter, the author writes, "must necessarily be completely modeled in order to be rendered."[299] Computer scientists Oliver Bimber and Ramesh Raskar summarize the definitions of AR by indicating that "some define AR as a special case of VR [Virtual Reality]; others argue that AR is a more general concept and see VR as a special case of AR."[300] In the field of humanities, media theorists Steve Benford and Gabriella Giannachi speak about "augmented reality in which *virtual worlds* appear to be overlaid on the everyday physical world."[301] Media arts scholar Vladimir Geroimenko describes AR as the "practice of anchoring *virtual assets* to the physical world, [which] allows artists to make use of virtual properties such as mutability and replication, while engaging with issues of embodiment, performance, and presence."[302] Lev Manovich sees AR as a dynamic phenomenon in which "*virtual layers* of

[296] Ronald T. Azuma, "A Survey on Augmented Reality," *Presence: Teleoperators and Virtual Environments*, 6, 4 (August 1997): 356. Available from: Human Interface Technology Lab (HITLab), University of Washington. http://www.hitl.washington.edu/projects/knowledge_base/ARfinal.pdf (accessed December 2015).
[297] Paul Milgram and Herman Colquhoun Jr., "A Taxonomy of Real and Virtual World Display Integration," in *Mixed Reality - Merging Real and Virtual Worlds*., eds. Yuichi Ohta and Hideyuchi Tamura, (Tokyo: Ohmsha and Berlin: Springer Verlag, 1999), 1-16. Online at Ergonomics in Teleoperation and Control Laboratory (ETC) at the University of Toronto, "Publications": Milgram, P. and Colquhoun, H (1999), 2: http://etclab.mie.utoronto.ca/publication/1999/Milgram_Colquhoun_ISMR1999.pdf (accessed December 2015), p. 2.
[298] Ibid.
[299] Ibid.
[300] Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality. Merging Real and Virtual Worlds* (Wellesley, Massachusetts: AK Peters, 2005), 2.
[301] Steve Benford and Gabriella Giannachi, *Performing Mixed Reality* (Cambridge, Massachusetts and London, England: The MIT Press, 2011), 43 (emphasis mine).
[302] Vladimir Geroimenko, "Preface," in *Augmented Reality Art: From an Emerging Technology to a Novel Creative Medium*, edited by Vladimir Geroimenko (Heidelberg: Springer, 2014), x (emphasis mine).

contextual information will overlay the built space," and whose perceptual result is an augmented space: "physical space overlaid with dynamically changing information."[303]

One important preliminary observation is that in most writings about AR, the notions of "virtual" and "virtuality" are taken for granted, if not simply equated with VR. This approach is not unlike the one referring to the pair of terms real and reality that are most often considered implicit and thus not properly or sufficiently explained (as it was shown in more detail in the previous chapter). In a way, the absence of a clear-cut description of what "virtual" and "virtuality" mean in the context of AR allows us to provide a more comprehensive definition of AR, one that sees it as a perceptual paradigm and as an artistic and communicational practice rather than as a strictly delineated technology. However, at the same time, the lack of a clear explanation of "virtual" and "virtuality" in theoretical writings about AR has introduced a certain relativism concerning the recognition of AR as a specific perceptual and aesthetic practice, therefore favoring equivocal definitions of AR. This means that AR is sometimes given too general a description, being understood as any manifestation that involves virtual information in relation with material reality, from street media screens to mobile computing (this is the case, among others, of Lev Manovich, and Benford and Giannachi). At other times, the definition of AR is somewhat too narrow, expressed mostly in technical terms, "virtual" being seen as necessarily immersive and AR as essentially HMD-based (this is the case of Ronald T. Azuma, Paul Milgram and others—with the important remark that their essays were written at an early stage of AR development, when it was experienced mostly in this way). Therefore, if in the previous chapter I signaled the need for explaining the aesthetic and functional dimensions of the terms "real" and "reality" in the more specific context of AR, the same is needed with regard to

[303] Lev Manovich, "The Poetics of Augmented Space," *Visual Communication* 5, no. 2 (2006): 225, 220. (emphasis mine)

the concepts of "virtual" and "virtuality." By making clear the particular nature of these entities within the specific framework of AR, I will be able provide a clearer explanation of the different aesthetic nature and experiential dimensions of the convergence process in AR and, consequently, of the difference entailed by the AR paradigm. As a way to tackle the issue, we should firstly see what "virtual" and "virtuality" mean in the context of AR. What are their particularities when they are applied to VR? What role do technology, artistic expression and effective use play in their definition? How can we define virtual space in the experiential situation of AR, which is mainly based on a concrete relationship with the material reality and with the real, socialized viewer? And how can we identify virtuality in a technological object that contains in its denomination the word reality?

Before proceeding, it should be pointed out that my explanation of the ideas of "virtual" and "virtuality" in AR circumstances is an interpretative rather than a normative endeavor, offering a specific rather than a general account. AR—as an artistic and media practice, as well as a cultural discourse—does not call for a "new" definition of the virtual, but for the recognition of its specificities among various other manifestations and among the numerous meanings assigned to it. What defines "virtual" and "virtuality" in AR is the particular perceptual and aesthetic relationship the "virtual world" entertains with the material reality in the convergence process, and not a set of distinct and restrictive technological or artistic features. For example, in this context, "virtual" is used with reference equally to the computer graphics in the form of vegetal textures that animate the visual field of the user in *Living-Room 2* by Jan Torpus; the video projections of various portraits within the participants' shadows (if not the shadows themselves) in *Under Scan* by Rafael Lozano-Hemmer; the 3D digitally-generated architectural scenes projected on the walls in *Spac[E]scape* by the Workspace Unlimited group; the three-

dimensional digital "sculpture" presented on the monitor in *The Golden Calf* by Jeffrey Shaw; the video stream and audio component played on the camera handled by the user in *Conspiracy Theory* and in *Alter Bahnhof Video Walk* by Janet Cardiff and George Bures Miller and the graphic user interface and the modeled animations accessible through the mobile hand-held interface in *Artvertiser* by Julian Oliver. Nonetheless, given this great variety, what is important to discuss is precisely what renders all of these video pieces, media streams and digital graphic animations *virtual* perceptual manifestations in the AR experience.

4.2. Virtual and virtuality: Different expressions of reality

4.2.1. Something that exists potentially but not actually

What can safely be assumed at this point is that the images—videos, photographs and digital graphics—that enter into the composition of the artworks discussed above are "virtual" because they have no materiality per se. Leaving aside the hardware, interfaces and scenography involved in their production and transmission, these images actually consist of pixels and magnetic signals which make them different occurrences from anything material, understood in the broadest sense, that is, as a certain state of the matter defined both through its immediate physicality and its look and feel.[304] However, pointing this out is tantamount to acknowledging the fact that the term "virtual" refers, first and foremost, to the ontological (im)material status of an image and not necessarily to the effect it conveys, more specifically to illusionism and/or immersion. Although closely related, these notions should not be confounded. And yet, too many authors misleadingly assert that "virtual" essentially means illusionist, immersive and—what is

[304] See Chapter 3 of the present study, section "On Materiality."

even more problematic—digital. Part of the following lines is dedicated to shedding light on this argument.

It is important to remember that the Latin etymology of the word virtual (from *virtus*, *virtualis* – "excellence, potency, efficacy") indicates that it refers to something that exists potentially but not actually. The meaning of "being something in essence or fact, though not in name" is probably known in the sense of being "capable of producing a certain effect."[305] The Merriam-Webster Unabridged Dictionary explains the word "virtual" as something "relating to, or possessing a power of *acting without the agency of matter*."[306] Along the same lines that distinguish the notion of "virtual" from that of material, theorist Anne Friedberg proposes a consistent definition of the term, this time from the perspective of media and cultural studies. For her,

> The term "virtual" serves to distinguish between any representation or appearance (whether optically, technologically, or artisanally produced) that appears "functionally or effectively but not formally" of the same materiality as what it represents. Virtual images have a materiality and a reality but of a different kind, a second-order materiality, liminally immaterial. The terms "original" and "copy" will not apply here, because the virtuality of the image does not imply direct mimesis, but a transfer—more like metaphor—from one plane of meaning and appearance to another.[307]

Indeed, "virtual" designs possibilities, but it never acquires the level of the "actual." "Liminally immaterial," it relies on appearance rather than on a material presence, regardless of how convincing virtuality's claim might be and irrespective of its associated materiality or physicality

[305] Cf. Douglas Harper, *Online Etymology Dictionary*, 2001-2012, http://www.etymonline.com (accessed December 2015).
[306] Webster's Third New International Dictionary of The English Language Unabridged, Springfield, MA: Merriam-Webster, 2003. (My emphasis).
[307] Anne Friedberg, *The Virtual Window. From Alberti to Microsoft* (Cambridge, Massachusetts and London, England: The MIT Press, 2006), 11. For an extensive discussion on the subject, see Friedberg, pp. 7-12.

(such as optics, hardware, wires and interfaces). Stating potentialities but having no credentials, "virtual" remains a "trope": it can never be a literal presence but only an image, a representation, an appearance. A thing that is not the real thing, but an ontologically different locus and manifestation of differently defined presences and meanings.[308]

4.2.2. The reality of the virtual

Despite the fact that "virtual" is ontologically—although not always effectively, i.e. as a perceptual effect—opposed to the material, we cannot affirm that "virtual" is something "unreal." We might assume, together with theorist Michael R. Heim, that "virtual" is "an event or entity that is real in effect but not in fact"—an observation that, although made with reference to some particular manifestations such as VR, can be extended to explain also the "reality" of the virtual in AR circumstances.[309] Not only is "virtual" not "unreal," but it is an essential element in understanding the real, more precisely, the material manifestation of reality, or, to employ the term proposed in this thesis, the design(at)ed space. As media theorist Jason Farman explains, "the virtual is not the opposite of the real; instead it is a component of experiencing the real. The virtual serves as a way to understand the real and a form of actualization that serves to layer and multiply an experience of that which is already realized."[310] Farman's comment is valuable

[308] An interesting point for our discussion is made by two computer engineers about the changing significance of the word "virtual" when translated into Eastern Asian languages: "Translations reflect the way how a concept is understood in certain culture and sometimes even what people's insight into it is. This is indeed true particularly in translations from English to Far Eastern languages, that is, from phonogram to ideogram. Something virtual, or virtuality are translated into a compound word made of two Chinese characters in Korean, Chinese and Japanese in common. The first character means something false or temporary and the latter means idea or thought. Then, is virtuality a false idea or a temporary idea? In addition, the translation of Virtual Reality into Korean and Japanese are compound words, by adding two more letters meaning reality. Virtual Reality in Chinese, on the other hand, is translated into different characters. In this case something virtual is thought to be something empty and something similar. Then, is Virtual Reality something hollow but similar to reality?" Jung Yeon Ma and Jong Soo Choi, "The Virtuality and Reality of Augmented Reality," *Journal of Multimedia*, Vol. 2, No. 1, February 2007, p. 33.
[309] Michael R. Heim, *The Metaphysics of Virtual Reality* (New York: Oxford University Press, 1993), 109.
[310] Jason Farman, *Mobile Interface Theory. Embodied Space and Locative Media* (New York and London: Routledge, 2012), 22.

insofar as it also points to the fact that the encounter between "virtual" and "real" in AR is always a question of actualization, of an experience necessarily developed "in progress," as an event. Take, for example, Jeffrey Shaw's *The Golden Calf*: The virtual "object" representing a calf serves to multiply the experience and the sense of what is real, of what is already there, equally material objects and humans. The golden statue of the calf does not exist physically in space, but it contains, in its image, something of the same space's anteriority, seen as a 3D photograph previously taken and mapped onto the digital body of the calf. In this sense, the virtual image is a form of actualization of something that the material reality lacks—actualization in both senses of making real and making temporally actual. Therefore, the virtual image is a form of expanding our understanding of reality, a means to articulate the meanings related to the ideas of representation, illusionism, the fragility of empirical experience, the intricate relationship between object and subject, corporeality and incorporeality, actual and symbolic, immediacy and anteriority and, as a matter of fact, between virtual appearance and material reality. According to this logic, we cannot help but agree with Anne Friedberg's more inclusive observation that "virtual images radically transformed the twentieth-century understanding of reality."[311]

Still, if we accept—at least as regards AR—that "real" and "virtual" are, perceptually speaking, mutually dependent—in the sense that the virtual reinforces our sense of the material and the material determines the perceptual outcome of the virtual—we should not forget that they are, after all, ontologically different. Thus, any unconditional identification between the appearance of the virtual and the manifestations of the material reality is problematic, to say the least, whatever the medium or the type of experience that would facilitate this association.

[311] Anne Friedberg, *The Virtual Window*, 4.

Plato's myth of the cave explains precisely this.[312]. In the myth of the cave, Plato imagines a number of prisoners chained in a cave, unable to turn their heads. All they can see is a wall onto which the shadows of real people are projected. Prisoners in this cave would mistake appearance for reality: knowing nothing of the real causes of the shadows, they would tend to believe that the shadows are in fact the reality, the real bodies. It is only when the prisoners are released and, therefore, able to turn their heads to see the reality that they may gain access to the real knowledge. If we re-read the same myth from our perspective, it becomes evident that, in contrast to the prisoners' experience in the cave, AR is not a question of mistaking virtuality for reality, but of accepting their perceptually comparable nature and their mutually-empowering convergence; an experience which leads neither to their total (ontological) identification, nor to their reciprocal exclusion. The AR user is the "released prisoner" who, situated outside the "cave," benefits now from the knowledge and experience provided by the AR situation on both the real and the virtual ontological levels. If we were to find a contemporary illustration of Plato's myth, it would be VR, with its totally-immersive systems; the latter is the closest realization of the cave metaphor, both perceptually and symbolically, one that leaves the viewer in a sort of epistemological "fog," within the closed limits of the artificial world.[313]

Indeed, unlike the experience provided by a secluded VR system, AR's virtuality (or its experience thereof) is in fact a "component of experiencing the real," as Farman notes, a way to expand the knowledge of the real. In AR, virtual images superimposed on a specific space in the material reality *inform* the design(at)ed space, in both senses of the term: they give form, animate

[312] *The Republic*, 517-519.

[313] The CAVE is actually the name of one of the most popular visualization systems for VR. The term is the acronym for the "cave automatic virtual environment," a room-sized cube where projections are directed to three, four, five, or six of the walls. High-resolution projectors display images on the screens via mirrors. The images are usually 3D graphics observed by the viewer through special glasses. A CAVE user's movements are tracked by sensors and the video adjusted accordingly. The CAVE usually also has an audio component.

or make visible certain areas of reality and they communicate factual knowledge about that section of reality. Take, for instance, the AR application *Layar*, one of the most popular mobile AR "world-browsers," which allows the user to select and visualize information on a number of interest points in a certain area, from a user-generated database, provided site-specifically. The system makes visible—in the sense of calling attention to—various places, some of which are geographically distant and, therefore, invisible for the user with the naked eye. This is obtained by superimposing pieces of information or virtual graphics onto the image of the real space streamed live via a smartphone camera, while giving indications of direction and distance. Furthermore, the virtual graphics provided on the screen of a *Layar* user's smartphone inform the user by communicating knowledge about the specific points of interest selected by the user (places, buildings, museums, restaurants, etc.), thus enriching what one sees and knows about a certain place. It is in this sense that we should read Lev Manovich's observation that in AR the user's experience of a spatial form in material reality is very much "affected when the form is filled in with dynamic and rich multimedia information."[314] In other words, a multimedia-enriched space is inherently a multidimensional space, in the sense in which a cluster of mediums working together enhance our understanding of the perceived world. Of course, in this "multiplicity," the role of the medium is essential, as is the role of mediation. In AR the very construction of the virtual image means mediation and, what is more, the very perception of reality is *a mediated act*. Of course, the idea of mediation should be seen here not only (or not necessarily) as the process of mediation through the senses, culture, or language, but rather in its more technical sense, as the transfer of different perceptual stimuli situated in the material and virtual realms, through the media interface, to the viewer. For instance, in the application *Layar*, the pieces of virtual information and animation that appear on the screen are, in fact,

[314] Lev Manovich, "The Poetics of Augmented Space," 219.

intermediate agents, means of action, or instruments for the transmission of a certain content. Moreover, reality itself, the design(at)ed space in which the user moves and acts, is mediated too, since it is perceived through the live video stream on the smartphone or tablet. The idea of mediation is a key aspect in appreciating the role of experience and of technology in defining what both virtuality and reality mean in AR. In this sense, we should remember that theorists such as Mette Ramsgard Thomsen consider that AR (or, as she calls it, Mixed Reality) is subjected to a "mediated experience."[315] On the same idea, art historian Christine Ross speaks about "extreme mediation" in the AR experience.[316] Perhaps the most "extreme" form of mediation—in experiential conditions related but not similar to AR—is represented by what is called the *Second Screen*. The latter is a set of applications (and the experience they provide) that allow users to interact with the content provided by TV shows, movies, music, or video games. Extra data displayed on a portable device (a smartphone or a tablet held by the user towards the "primary" screen) are rendered in direct connection with the content viewed on the main screen. The use of *Second Screen* facilitates the creation of a junction zone in which an already mediated content (e.g. TV broadcast) is re-mediated and augmented through the use of an informational device. Thus, applications are becoming a natural extension of television programming, both live and on demand, and the user an active agent in the broadcast content.[317] Of course, this cross-platform experience, like that of the related *Augmented Video* (that superimposes digital 3D graphics or pieces of information over a recording or a live TV transmission, like in the

[315] Mette Ramsgard Thomsen, "Positioning Intermedia. Intermedia and Mixed Reality," *Convergence: The International Journal of Research into New Media Technologies* 8, no. 4 (2002), 39-40.
[316] Christine Ross, "Augmented Reality Art: A Matter of (non)Destination," University of California, Irvine: Proceedings of the Digital Arts and Culture Conference 2009. http://escholarship.org/uc/item/6q71j0zh (accessed December 2015).
[317] Sophie Curtis, "Technology firms explore 'second screen' opportunity," *The Telegraph*, 08 May 2014. http://www.telegraph.co.uk/ (accessed December 2015).

broadcasting of sport events[318]) is clearly different from the AR experience *per se*, even if they are presented and discussed as AR on many occasions. Second Screen and Augmented Video are different from AR, as they are conceived to have no direct connection with the material reality—they lack a site-specific emplacement and a live experience *in situ,* where the user can have a direct relationship with the physical, cultural and social context of the location.

4.2.3. Virtual ≠ Digital

To further clarify the definition of the notion of virtual as it applies to AR, it is important to address the argument formulated above regarding the nonequivalence between "virtual" and "digital." Despite the general use of the term mainly in association with the digital media, "virtual" is not essentially and automatically the equivalent of "digital." As Anne Friedberg very aptly remarks, "before the digital age, there was virtuality—painterly, photographic, cinematic and televisual—and its aesthetics and visual systems cannot be reduced simply to information. (…) Once the term 'virtual' is free from its enforced association with the 'digital', it can more accurately operate as a marker of an *ontological, not media-specific, property*."[319] The works discussed here exemplify precisely the media unspecificity of the virtual in AR: we describe and perceive as virtual equally the analog slide images projected through the console that uses mirrors and semi-transparent screens in *Viewpoint* (1975) by Jeffrey Shaw and the sophisticated 3D digital graphics developed for a computer-based system, as in the project *Living-Room 2* (2007) by Jan Torpus. Similarly, we perceive as virtual the video images projected on the ground within the participants' shadows in Rafael Lozano-Hemmer's *Under Scan* (2008) and the sound component (voice recordings and audio effects) in *Conspiracy Theory* (2003) by Janet Cardiff

[318] For more details and examples regarding the technical and experiential implications of the augmented video, see Annex 3.
[319] Anne Friedberg, *The Virtual Window*, 11 (emphasis mine).

and George Bures Miller. Emphasizing the same argument in his book *Virtual Art, From Illusion to Immersion*, art historian and media theorist Oliver Grau unties the idiosyncratic links between "virtual" and digital technology.[320] More precisely, his effort is concentrated on discussing this problem by addressing "virtual reality" (from its historical form such as the 19th-century Panorama, to its contemporary electronic manifestation) as a conceptual problem, beyond technological determinations. As Grau writes, although "virtual" and "virtuality" (especially in the form of VR) are core concepts of the emerging "information society," they are not a new phenomenon related strictly to the medium of the computer. We can speak about virtuality with reference to various historical visual expressions: from the frescoes of ancient villas, to the Renaissance illusion rooms, from 19th-century moving panoramas to the 3D digital images projected in CAVE. It is true, Grau notes, that there is difference in the way in which virtuality functions under the conditions of computer-generated images with regard to the interface, the design, the interaction possibilities and the image resolution.[321] Indeed, contemporary technology is more capable of improving the definition and the spatial experience of both reality and virtuality, and this is an important aspect in understanding the perceptual and aesthetic dimensions of the idea of virtuality and of the virtual space in AR. But to what extent can we speak about space in the virtual "world," a world that we experience, after all, as an image?

[320] Oliver Grau, *Virtual Art: from Illusion to Immersion*, translated by Gloria Custance (Cambridge, Massachusetts, London, England: The MIT Press, 2003).

[321] See especially pp. 3-18 in Grau, *Virtual Art*. However, Grau's statement that "Virtual realities—both past and present—are in essence immersive" (p. 15) is twice misleading, since, on the one hand, it mistakes the material level (virtuality) for the representational one (the visual effect of immersion) and, on the other, it assumes that immersivity and virtuality are intrinsically related, while we know that not all virtual images are immersive (e.g. a graphical user interface seen on our laptop is virtual, but certainly not immersive). This latter case is what Grau calls simulation, although this term is no less problematic, as it does not explain the idea of virtuality.

4.3. E-scapes: The spatial condition of the virtual image

I should make clear at this point that what I refer to as "image" in the context of AR is not simply (or rather not only) a videographic / photographic recording, or a digital animation projected onto or emitted by a screen, but a more complex visual construction, an interactive product of the encounter between electronics, the user's body and the material world. My understanding of the concept of "image" is close to what art historian W. J. T. Mitchell calls pictures: "complex assemblages of virtual, material, and symbolic elements."[322] Thus, produced at the intersection between reality and virtuality, AR images are, as philosopher Nelson Goodman puts it, "ways of world*making*," not just world mirroring.[323] In this sense, in AR, "image" should be understood beyond the traditional definition of the image as a cut-out rectangle that maintains a distinction between fiction and reality, between the world and its (mimetic) representation.[324] Instead, AR asks for a more inclusive definition of the image, an image that is essentially spatialized. Indeed, *AR redefines the image in spatial terms*, but it does so in a rather particular way: on the one hand, by suggesting the illusion of a third dimension through simulations or animations and, on the other, by effectively acting out the depth through a perceptual incorporation of the surrounding material reality into the representational field, beyond the surface of the screen. Hence, the play on words in the above subtitle: e-scape as electronic landscape, as electronics *and* landscape and, at the same time, AR as a form of escapism, a diversion of the mind and body aimed at improving the plain reality or routine perception. The following lines will clarify these points.

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[322] W. J. T. Mitchell, *What do Pictures Want? The Lives and Loves of Images* (Chicago and London: University of Chicago Press 2005), xiii
[323] Quoted in Mitchell, *What do Pictures Want?*, xv.
[324] Roland Barthes, "Diderot, Brecht, Eisenstein," translated by Stephen Heath, in *Narrative, Apparatus, Ideology: A Film Theory Reader*, Philip Rosen, ed. (New York: Columbia University Press, 1986), 173.

AR projects are not the first technological and artistic experiments to perform the spatialization of the image. Especially VR—an important predecessor of AR—proposed and refined the creation of what have often been called image-spaces, created with entirely artificial means. A significant example is Char Davies' 1995 *Osmose*. The work offers the viewer a totally immersive experience in a 360-degree enveloping space. As stipulated in my analysis of the work in Chapter 2, the virtual, digitally generated environment through which the immersed user navigates consists of various world-spaces, most of them based on metaphorical aspects of nature (such as Forest, Tree, Leaf, Cloud, Pond, etc.).[325] Inspired by nature, the images are not strictly mimetic, but rather fragile and translucent abstractizations, providing the viewer with a powerful experience of spatial abyss and dream-like floating. Another VR artwork that engages the spectator into a "total" experience of a virtual space-image is Luc Courchesne's *Where are You/ T'es où?* (2005), also discussed in Chapter 2. The work is conceived as a multi-layered navigation through different imaginary spaces presented as a projection within a hemispheric screen (an "inverted dome") to the viewer, who is situated at the center of the hemisphere. What thrills the viewer is the acute sensation of being in *another* space, an artificial world in which the viewer can only hope to attempt to find his/her place (hence, the suggestive title of the work). These examples shed a revealing light on the argument made above about the very condition of virtuality as an immaterial entity. The virtual spaces created by these works have no physicality per se, that is, they cannot be defined as a place, as a material presence in the physical world. In the digital virtual worlds, writes Oliver Grau, "materiality—if one wishes to call it that—is limited to the individual pixel."[326] And, one might add, in the analog mode, it is limited to the

[325] Char Davies, "Osmose," *Immersence*, 1995-2008, http://www.immersence.com (accessed December 2015). See also Laurie McRobert, *Char Davies' Immersive Virtual Art and the Essence of Spatiality* (Toronto: University of Toronto Press, 2007).
[326] Oliver Grau, *Virtual Art*, 207.

optical manifestation of light. In this sense, we can think of virtual space as a sort of E-scape, an electronic construction, an "intelligent" entity that can be easily manipulated and transmitted. The latter aspect is crucial for defining the phenomenological and aesthetic condition of the virtual image-space in the realm of the new media, one that leads Lev Manovich to affirm that

> For the first time, *space becomes a media type*. Just as other media types—audio, video, stills and text—it can now be instantly transmitted, stored, and retrieved; compressed, reformatted, streamed, filtered, computed, programmed, and interacted with. In other words, all operations that are possible with media as a result of its conversion to computer data can also now apply to representations of 3-D space.[327]

A good illustration of the way in which virtual image-space is treated as a media form, this time in the particular context of AR, is the application called *T(ether)*. The latter is, according to its developers, "A Spatially- and Body-Aware Window for Collaborative Editing and Animation of 3D Virtual Objects."[328] The project, developed by the Tangible Media Group at the MIT Media Lab in 2012, uses spatially aware interfaces (tablets equipped with tracking systems) that allow people to interact intuitively with virtual forms rendered in 3D on the display. The display of the tablet acts as a window affording users a simultaneous view of both real material space and the three-dimensional virtual space and forms. The visualization solution is based on a 1:1 mapping between real and virtual coordinate space, allowing for an immersive exploration of the two worlds. The system provides input through capacitive touch on the display and a motion-tracked glove. When placed behind the display, the user's gloved hand becomes visible in the virtual world (through a schematic rendition of the hand's anatomy), therefore enabling the user to interact with the virtual objects directly. Noteworthy is that *T(ether)* permits

[327] Lev Manovich, *The Language of New Media* (Cambridge, Massachusetts and London, England: The MIT Press, 2001), 251-252.
[328] MIT Media Lab, *Tangible Media Group*, Projects: http://tangible.media.mit.edu/project/tether/ (accessed December 2015).

the user to connect with others, locally or remotely, to collaborate and interact within the shared 3D real-virtual space. The way in which the *T(ether)* user modifies the objects, brings them closer or sends them away, or the way in which he/she "meets" other remote people within the same perceptual field shows not only how fluctuant its dimensions are but also how manipulable the virtual space actually is. Just like any other media file. The title of the application, *T(ether)*, becomes even more significant for the aspects mentioned here, as it points equally to the idea of manipulability and to that of the spatialization of the virtual image (as representation and as practice). At one level, it suggests the concept of tethering that refers to "how we connect to always-on communications devices and to the people and things we reach through them, who/which in a certain sense now live through them, always ready-to-mind and hand."[329] At another level, it evokes the idea of theater not only through the sonority of the title, but also by creating an unstable balance between fiction and reality in the electronically expanded mise-en-scène provided by the playful features of the application. Yet, on another level, the title might imply the idea of ether, the substance that was once considered to be the medium that supports the propagation of electromagnetic waves.

Fig. 4.1. *T(ether)*, project developed by the Tangible media Group at the MIT Media Lab. 2012. Mobile AR application.

[329] Sherry Turkle, "Tethering," *Sensorium. Embodied Experience, Technology, and Contemporary Art*, edited by Caroline A. Jones (Cambridge Massachusetts and London England: The MIT Press, 2006), 221.

If we compare *T(ether)* with VR experiments—equally preoccupied by rendering interactive 3D spaces—we should note once again that the important difference is that this AR project is a system that works *with* reality and not away from it. Moreover, in contrast with lab-based VR, this is a handier and more accessible platform—the interface is a user-friendly, off-the-shelf device and not one of the cumbersome machines of the nineties, typically used for VR applications. Not to mention the difference regarding their operative power and costs. These aspects related to the increased accessibility—both technical and cost-wise—of the recent "virtual machines" (of any kind) are important arguments for the users to recognize and understand virtuality not as something "out of this world" (as we have been accustomed by the hermetic, bulky, and prohibitive VR systems of the nineties), but rather as something pertaining naturally to our immediate material reality.

AR systems and applications such as *Layar*, *Wikitude*, or *T(ether)* make virtual space seem like a natural extension of the material world, although the acknowledgement of the differences at the ontological level between the two raises legitimate questions about the spatiality of spaces in pure virtual worlds. Manifested as a mediatic flux of pixels and light (a media type, as per Manovich), virtual space has no fixed dimensions—in the sense of clearly defined geometrical coordinates, like the material world has. Based on these assumptions, some authors, such as architect and theorist Anthony Vidler, suggest that virtual space (seen in its digital form) reveals a condition of "no-space":

> For what is spatial, after all, about an endless string of 0's and 1's, a string that for the purposes of display has to be looped around a screen; an endless line, without direction,

> displayed on a screen without depth? While the *representation* of information might well have spatial cognates, information itself seems to have no inherent spatiality.[330]

The idea that virtual images of space have actually no spatiality is shared by other researchers. For example, Margaret Morse writes that "the gathering places and sites of experience in electronic culture are increasingly situated in what amounts to *nonspace* and in which humans not only interact with human agents but also with the semiautonomous agency of machines."[331] These remarks are actually in line with Lev Manovich's own observation according to which "there is no space in cyberspace."[332] Still, despite these—not incorrect—assumptions, virtual space remains a space: not physically, at the material level, but at the perceptual level. This is to say that while virtual space has no inherent spatiality, it still appears, to the viewer, "functionally or effectively but not formally," as a space.[333] It is a space that functions as a phenomenological claim, not as an ontological construction. Then again, if we acknowledge the existence of virtual space only in its perceptual dimensions, it is important to observe that this does not mean simply or strictly a representation of space in the sense of a framed perspectival construction of space (like in paintings, photographs or films that follow a realist convention). As media theorist Lars Qvortrup shows when explaining the phenomenological conception of space in the electronic virtual worlds, virtual space is "a representation—however, not of space *per se*, but of space *experience*."[334] It is in this sense that I understand virtual space in this context. Virtuality, or more properly virtual space, is a space-image that manifests itself at the phenomenological level,

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[330] Anthony Vidler, *Warped Spaces. Art, Architecture, and Anxiety in Modern Culture* (Cambridge, Massachusetts, London, England: The MIT Press, 2000), 236.
[331] Margaret Morse, *Virtualities: Television, Media Art, and Cyberculture* (Bloomington, Indianapolis: Indiana University Press, 1998), 17.
[332] Lev Manovich, *The Language of New Media*, 253.
[333] Anne Friedberg, *The Virtual Window*, 11.
[334] Lars Qvortrup, et al. (eds.), *Virtual Space: Spatiality in Virtual Inhabited 3D Worlds* (London: Springer-Verlag Limited, 2002), 6. Qvortrup employs the term "electronic cyberspace" with reference to virtual worlds.

as a perceptual phenomenon which acts without the agency of matter. It is *space defined as an experience, as a visual effect*. And this effect, as I will argue in the following sections, is given by immersion and a mixed form of illusionism.

4.4. Spaced-out: immersing the body in the image

In order to examine how "virtuality" unfolds in AR situations as to create the convergent space-image, a close examination of its effects—more precisely of immersion and illusion—is necessary. Immersion is a representational technique and a perceptual phenomenon based on reducing as much as possible the critical distance the viewer might have to the image or the work he/she is experiencing. Although immersion is a term most often associated with virtual images, it can be related to and experienced in real-world environments as well, as I will later show. Speaking from the perspective of the virtual image, Oliver Grau writes that the main operation of an immersive image, "is to install an artificial world that renders the image space a totality or at least fills the observer's entire field of vision."[335] Immersion came as a natural development of an entire tradition based on perspectival illusionism, more precisely on the efforts to converge the representational image with the viewer's "natural" perception. From 19th-century magic lanterns and panoramas,[336] to contemporary IMAX cinema[337], 4K television[338] and VR, various

[335] Oliver Grau, *Virtual Art*, 13.

[336] The Magic Lantern is an early type of slide projector developed starting with the 17th century that uses a concave mirror at the back of a light source to direct a painted or photographic image imprinted on a glass sheet onward into a lens at the front of the apparatus towards a projection screen (see: "A History of The Magic Lantern," The Magic Lantern Society, http://www.magiclantern.org.uk Accessed December 2015). "The Panorama is an art form which encircles the spectator with an illusion of continuous space, often in a painted 360º format. Patented by the Englishman Robert Barker in 1787, this spectacular visual entertainment flourished throughout the 19th century, mostly in Europe and the United States. The Panorama, Cyclorama, Diorama, Cosmorama and other multitudinous variations on the sensational venue were popular places to spend leisure time and embark upon imagined travels to unfamiliar and significant places in space and time." ("A Concise History of Panorama," The Velaslavasay Panorama, http://www.panoramaonview.org Accessed December 2015).

artistic and technological means were employed to obtain the "total" absorption of the viewer into the artificial world of the image and of narration. In this sense, immersion is perhaps the most radical expression of a type of visuality based on the modernist assumption that the (artistic) sensory experience should be separated from the material environment of the viewer, a paradigm that is, as we can see, still functional today. Certainly, it is VR that perfected—technically and experientially—this paradigm, therefore becoming effectively synonymous with the idea of immersion. The works by Char Davies and Luc Courchesne discussed above illustrate this idea very well. Fusing the viewer's body and the image into a 360 degree artificial space, immersion operates with a unity of time and space—that of the image and that of the viewer. In its most common manifestations, immersion leaves no space for the viewer to perceive the external world.[339] Having no clear delimitations—by a frame or a proscenium—the typical VR immersive image-space absorbs the viewer and projects him/her into a completely alternative world.[340]

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[337] IMAX (an acronym for Image MAXimum) is a motion picture film format and a set of cinema projection standards created by the Canadian company IMAX Corporation. It is considered the most immersive movie experience, being a combination of many proprietary technologies and architecture: high resolution cameras, specific digital re-mastering processes, an advanced projection system, a powerful sound system and customized theatre design. For more details see: "The IMAX experience" at https://www.imax.com/ (Accessed December 2015).

[338] 4K TV is a digital video format, known as Ultra high definition television. This image technology quadruples the number of pixels found in a full HD picture. These pixels are usually arranged in a 3,840 x 2,160 configuration, compared with the 1920x1080 pixels in a full HD TV. The extra resolution of 4K images adds more detail, more depth and more color resolution to the picture, resulting in images that look incredibly life-like. For more details see: John Archer, "What is 4K TV and Ultra HD?" 12 August 2014, *Trusted Reviews*, http://www.trustedreviews.com/ (Accessed December 2015).

[339] Scale is an important factor in ensuring a better spatial experience, that is, the identification between the space of the body and that of the image. A 1:1 scaling provides not only an improved perceptual spatiality of the virtual world, but it also plays an important role in the production of meaning, since images, together with their messages, stories, or informational content operate differently when they are experienced on a small or on a full-scale framework, respectively.

[340] Cinema is immersive, too, although in a different way than VR. Cinema offers an experience that is defined by a clear rupture between the space and time of the spectator and the space and time on the screen and this is due, among other factors, to the character of the interface. The cinema screen is clearly delimited from the surrounding environment, as well as distanced from the viewing body, and the informational flux between the image and the viewer takes place in only one direction (it is non-interactive). Thus, although cinema has the power to transport the

In AR, however, immersive experience does not take place in an entirely artificially constructed image (of the VR-type), but also in the real world environment, with which the viewer maintains a continuous contact. In this sense, immersion in AR should not be seen in the restrictive sense in which the term is used especially in relationship with the VR experiments. I claim that despite the different experiences they offer to the viewer, *all AR projects are in one way or another immersive* (and this constitutes one of the particular ways in which AR redefines the spatialization of the image.) Before explaining this view, it is important to mention that this assertion is in no way meant to relativize either the typology of AR proposed in the previous chapters, or the effective experience different types of AR projects might entail. Surely, we have examples of AR projects that use immersion as their main effect, through 3D graphics and interface design (such as HMDs) that specifically permit such an experiential outcome: *Living-Room 2* by Jan Torpus, and *Exercise in Immersion 4.1.* by Marnix de Nijs are illustrative examples in this regard. In these works, immersion is used in a manner that recalls and establishes the most obvious historical linkage with the visual strategies typical of VR experiments. The body is almost entirely integrated in the electronic system by the use of full-body motion interfaces, complex visual, audio and haptic devices that are able to enhance the experience of the user. However, besides this category of projects (that I call "integrative"), the other two types of augmentation experiences (identified here as the "projective" and "mobile" type of AR) are—at least in part—based on immersion as well. This is due to the fact that the spatial immersive experience is a process that takes place equally in the virtual realm (through various effects that suggest the third dimension) and in the material reality (through the direct integration of the body in the real world of the design(at)ed space). In this sense, the spatial

viewer's senses and imagination into a different realm, it disrupts the full identification of the body and the image, unlike the VR experience.

condition of the image in AR—and the immersive experience thereof—is given not only through illusionist effects and simulations in the virtual realm, but also by incorporating the real material space within the image itself. The image—if we are to keep calling it that way—in AR is the product of an experiential body that finds and founds a place, in both reality and virtuality. That is, it acts and activates spaces with both electronic and material means. Jason Farman's observations about the way in which space is produced in mobile technology as a multiplicity of perception and inscription are relevant in this sense. Spaces, he writes, "are experienced as a collaboration between information, representation, and materiality."[341] For example, Google Glass facilitates the experience of a space by equally establishing contingent relations of the body with its immediate location and by entering into symbolic and synergistic relationships with other types of information and virtual representations made available through the interface (the glasses and the 3G or 4G smartphone paired with them). Thus, the interaction space of the Google Glass wearer is not only the place where one walks, for example, but a multi-dimensional, real-and-virtual environment in which the body plays the central role. Think also about the way in which "image" provides an as-if world in the AR application *T(ether)*: the virtual forms are not perceived as belonging exclusively to a different, artificial realm. Following a one-to-one mapping procedure, the virtual space of the image is congruent with the material space of the room: it effectively permeates the room with electronic data normally absent from an ordinary experience of the same space. This makes the virtual image-space a sort of species of the real world. In this sense, philosopher Paul Virilio affirms that "next to actual space, which has been the space of history, there is now virtual space, and the two are interdependent."[342] This is what media philosopher Mark B. N. Hansen also suggests when he writes that "no longer a

[341] Jason Farman, *Mobile Interface Theory*, 13. See especially Chapter 2 "Mapping and Representations of Space."
[342] Paul Virilio, *Crepuscular Dawn* (Los Angeles: Semiotext(e), 2002), 67-68.

wholly distinct, if largely amorphous realm with rules all its own, the virtual now denotes a 'space full of information' that can be 'activated, revealed, reorganized and recombined, added to and transformed as the user navigates ... real space'."[343] This observation is certainly relevant here as it supports two important aspects of my argument: the redefinition of image in spatial terms and the mutual determination at the perceptual level between virtual image and the material reality in AR (while acknowledging, as Hansen does, the ontological differences between the two).

If the main effect of an immersive image (in the most typical sense of the term, i.e. that provided by VR) is to "install an artificial world" (as per Grau), the same is true with installation art (in the conventional sense of the term): to "install" an arrangement of a limited and delimited section of real time and space. That is, to create a mise-en-scène or a design(at)ed space—a fictional space and a fictional action time that takes place in and attaches a specific meaning to the material reality, and which presupposes an embodied viewer.[344] We can infer, then, that immersion in AR is a strategy, an action and an experiential effect that is shared with certain types of installation art—those that engulf the spectators and ask for their direct participation (installation art, we should remind, is the other important historical predecessor of AR, along with VR). Indeed, immersion, and the "total" experience of the viewer is considered by most art history scholars to be one of the defining features of installation art. For example, Nicolas de Oliveira et al. speak about the "immersive condition" of installation art, one that provides "a pliable time-frame and a flexible or portable site."[345] Similarly, Mark Rosenthal considers that in installation art, "the work and the space [have] melted together into an approximation of a life

[343] Mark B. N. Hansen, *Bodies in Code: Interfaces with Digital Media* (New York: Routledge, 2006), 2.
[344] See Chapter 3 of the present study, especially pp. 36-39.
[345] Nicolas De Oliveira, Nicola Oxley, Michael Petry, *Installation Art in the New Millennium. The Empire of the Senses* (London: Thames & Hudson, 2003), 30. This observation has interesting implications especially for mobile AR projects.

experience." Thus, he writes, "rather than existing as self-contained structures in which the only spatial concerns were illusory or internal, these works engaged with real places, at times intervening in the physical space."[346] Immersion is considered one of the main dimensions of installation art also by Claire Bishop, who maintains that installation art "addresses the viewer directly as a literal presence in the space. … [It] presupposes an embodied viewer whose senses of touch, smell and sound are as heightened as their sense of vision."[347] There are myriads of good examples of installation artworks that are based on the viewer's total immersion in their matrix. But I want to show that the immersion effect of AR situations not only partakes of the immersion effects of installation art but also has its AR specificity. To make my point, I would like to briefly discuss a specific installation, Peter Campus' closed-circuit video installation entitled *Interface* (1972), given that its particular way of immersing the viewer (both physically and virtually as its title suggests) makes it an AR situation *avant la lettre*, therefore helping to specify AR's own working strategy.

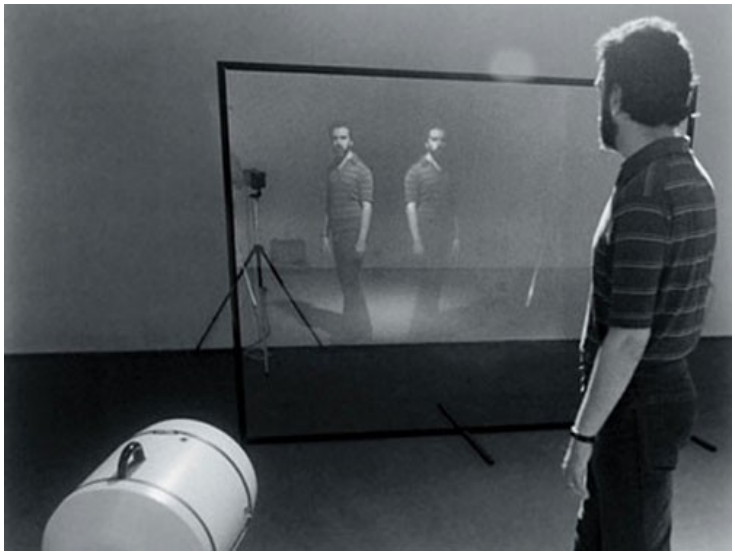

Fig. 4.2. Peter Campus, *Interface*. 1972. Closed-circuit video installation.

[346] Mark Rosenthal, *Understanding Installation Art: From Duchamp to Holzer* (Munich, Berlin, London, New York: Prestel Publishing, 2003), 25 and 62.
[347] Claire Bishop, *Installation Art: A Critical History* (London and New York: Routledge, 2005), 6.

The installation that occupies an empty room contains three main elements: a camera, a projector and a large transparent glass screen. The projector and the camera are situated at opposite ends, with the screen in the middle. As the viewer enters the interaction zone, two simultaneous, full-size images of the viewer's body appear on the screen: one is the reflected mirror image, while the other is the live video image of the same body captured by the camera from behind the glass and projected onto the front surface of the screen. Depending on where the viewer stands in the interaction zone, the two near-life-size images can appear spatially superimposed or side by side, but always in a reverse position, in the uncanny virtual-real space of the image. Commenting on this particular work about the role played by the screen to create such spaces, art historian Kate Mondloch writes that "Campus' screen [is] an arbitrary division (or perhaps more accurately, an arbitrary pocket of virtual space) inside the real exhibition space."[348] Thus, as Mondloch argues, "*Interface* enables visual *continuity* in terms of the spectator's spatial perception, thereby destabilizing the screen's conventional role of depicting representations that are visually and/or conceptually *discontinuous* with the spectator's own space."[349] Against the conventions of the cinema, TV, or other screen-based media, *Interface* manages to melt or converge body, real and virtual space within the same image, or more precisely, within image-space. In this sense, Campus's work (like the others discussed above) makes evident that immersion means not only reducing the critical distance between the viewer and the image, but also, in order to take full effect, the suspension of disbelief, especially as regards virtual representations. Suspending disbelief is our ability as users to overlook the limitations of the medium, as well as to accept the premises of a perceptual game of deceiving the eye. A game that is best rendered by illusionism and realism.

[348] Kate Mondloch, *Screens. Viewing Media Installation Art* (Minneapolis and London: University of Minnesota Press, 2010), 72.
[349] Ibid.

4.5. Illusi/on-off: means for deceiving the viewer in AR

4.5.1. The visual rhetoric of illusionism and realism

Besides immersion, another important perceptual dimension of virtuality in AR, one that is essential in creating the experience of the real-virtual convergence, is illusionism. If virtuality is about the (im)materiality of an image, illusionism concerns the representational aspect, more precisely the effect transmitted by an image. An effect which is based on a mimetic or—in the absence of a real-world reference point—a "convincing" rendition of an object and of its spatiality (where "convincing" means the adequate and skillful scopic representation of the subject-matter, beyond its strict associations with elements in the real world). This effect pertains to a specific visual rhetoric; a specific way in which images *persuade* the viewer, as well as the means utilized to perceptually link the material reality with its counterpart in the virtual realm (be they video images, digital animations, or localized pieces of electronic information). For, what are the fictive "vegetal" forms floating across the room in Torpus' *Living-Room 2*, or the large replicas of architectural spaces virtually opened for the user in Workspace Unlimited group's *Spac[E]scape*, or the image of a 3D model of a golden calf in Jeffrey Shaw's homonymous work if not attempts to constitute reality with credible substitutes? Or, what are the virtually-generated animated shadows that haunt the viewer's body in Adam Frank and Zack Booth Simpson's *Shadow*, the photographs and videos that parasitize the street billboards in *Artvertiser* by Julian Oliver, or the pieces of information delivered via the *Layar* mobile application if not forms of visualizing or inventing reality, its factual content and visible form? For the sake of my argument, it is important to re-emphasize here that imitating or rendering material reality in the virtual realm means presenting it as a space-image, as a *re-presentation*,

that is, as an experience, and not as a material entity. All the virtual components of the AR projects exemplified above (animations, photos, videos or graphics) are perceptual entities that claim a presence (actuality, immediacy) which they actually lack. They pretend to be the objects they depict, but in fact they are only images; an image that can be defined, following philosopher Jean-Luc Nancy, "as a thing that is not the thing: it distinguishes itself from it, essentially."[350] It distinguishes itself since, as I have explained above, by being virtual, this kind of image remains ontologically different from the thing it represents. The veracity of such an image—its claim to reality—relies not on its material identity, but on the effect it produces, on the immersive, illusionistic-realistic visuality it creates.

Illusionism is a key component of AR design and practice, precisely given its role in creating the perceptual experience of the real-virtual convergence, no matter how problematic this convergence and continuity between the two realms might be. In AR, it should be noted, illusionism is what defines equally the virtual images that superimpose material reality and the very act of this superimposition. However, to better understand how illusionism works in the specific circumstances offered by AR, we should address a number of key theoretical aspects of the concept of illusionism and of other important related terms, while examining a selection of representative examples of AR projects. Illusionism is, according to art theorist W. J. T. Mitchell, "the capacity of pictures to deceive, delight, astonish, amaze, or otherwise take power over a beholder."[351] The idea of deceiving is important as it points to what illusionism is first and foremost: a game to play, a mocking jest, deceit and deception. The etymology of the word indicates precisely this aspect: "illusion" comes from the Latin *inludo*, *inludere*, the prefix *in-*

[350] Jean-Luc Nancy, *The Ground of the Image*, Translated by Jeff Fort (New York: Fordham University Press, 2005), 2.
[351] W.J.T. Mitchell, *Picture Theory* (Chicago and London: The University of Chicago Press, 1994), 325.

plus *ludere*, "to play" (the sense of "deceptive appearance" being of a later, medieval, date).[352] In our case, it means playing with both *reality appearance* (what we perceive as reality in AR, i.e., the design(at)ed space) and *the appearance of reality* (what the apparatus presents to our senses as the virtual imitation or interpretation of reality). In this sense, the illusionist image is a replica given to the real, in both possible senses of the term: as an imitation and as a way to give an answer to reality.[353] That means, it is not (only) a way to open a window to the world (as Alberti has apparently indicated), but a way to problematize the relationship with material reality. Illusionism is, after all, a way to integrate art in life and, conversely, to integrate life in art. This was the goal of an entire tradition in philosophy and artistic production (at least in the Western cultures since Plato) that tried to mediate, if not conciliate, "true reality" with "mere appearance."[354] A tradition designated with a term that—like illusionism—is no less problematic: realism.

In its historical interpretation, realism is seen as a movement in arts whose aim "was to give a truthful, objective and impartial representation of the real world, based on meticulous observation of contemporary life."[355] W. J. T. Mitchell proposes another definition that emphasizes the social role of representation. Realism, he writes, "is associated with the capacity of pictures to show the truth about things [...] offering a transparent window onto reality, an embodiment of a socially authorized and *credible 'eyewitness' perspective*."[356] Examples of realist artists most authors propose range from Gustave Courbet, Jean-François Millet, Édouard Manet and John Constable to Diego Velázquez and Dutch "Golden Age" painters such as

[352] Douglas Harper, *Online Etymology Dictionary*, [illusionism] http://www.etymonline.com/ (accessed December 2015).
[353] Anca Oroveanu, *European Theory of Art and Psychoanalysis* (Bucharest: Meridiane, 2000), 110 (my translation).
[354] Linda Nochlin, *Realism* (Harmondsworth: Penguin Books, 1971), 13.
[355] Ibid.
[356] W.J.T. Mitchell, *Picture Theory*, 325. [emphasize mine].

Johannes Vermeer and Pieter Claesz; also mentioned are photography and cinema, including Italian Neorealism and Cinéma vérité. Of course, realism is also an important component of image-making in the digital age, its improvement representing a constant preoccupation for both developers and artists working in the field. Lev Manovich proposes a valuable definition of realism from the perspective of computer technology:

> "Realism" is the concept that inevitably accompanies the development and assimilation of 3-D computer graphics. In media, trade publications, and research papers, the history of technological innovation and research is presented as a progression toward realism—the ability to simulate any object in such a way that its computer image is indistinguishable from a photograph. At the same time, it is constantly pointed out that this realism is qualitatively different from the realism of optically based image technologies (photography, film), for the simulated reality is not indexically related to the existing world.[357]

Leaving aside the questions of indexicality and of the truth associated with the image (both extremely important theoretical issues in the debate about illusionism and realism, but with less relevance in the present discussion), the important questions we should address—important as they can make us understand the virtuality of AR situations and the way in which the visual effect of convergent space is created—are whether, from a perceptual and aesthetic point of view, AR is a form of realism or a form of illusionism? Or perhaps both: a mixed form of illusionism and realism? And what is the relationship virtual image entertains with material reality in AR from the perspective of visuality, that is, of its perceptual realism or illusionism?

[357] Lev Manovich, *The Language of New Media*, 184.

4.5.2. Between illusionism and realism: visuality at the limit

To answer these questions, we should have a closer look at one phenomenon that both bridges and collides illusionism and realism: trompe-l'oeil. Illusionism, briefly defined, is the technique to create a visual situation that skillfully deceives the eye, while realism is, in short, the close investigation of the real world and its transposition into artistic forms. The trompe-l'oeil pushes the effect of illusionism (the optical fake) to the limit, while providing, as a realist visual interpretation, a credible "eyewitness" perspective. Thus, *tromper-l'oeil* can be seen as the most sophisticated way to deceive the viewer's perception and as an operation that challenges one's empirical knowledge of reality. As art historian Hanneke Grootenboer very aptly points out in her book *The Rhetoric of Perspective*, "trompe-l'oeils display objects so realistically painted that the distinction between reality and representation is beyond our perception—at least for a split second."[358] Grootenboer's observation is made with reference to painted trompe-l'oeil, although her observations can be read in a larger perspective, beyond any specific medium. Of course, it is painting that provided, at least historically, the most renowned examples of trompe-l'oeil: in easel painting we can mention, precisely for their paradigmatic stance, Samuel Van Hoogstraten's *Feigned Letter Rack Painting* (c. 1670) and *Trompe l'oeil Still Life* (1664), which eloquently reproduce objects affixed on a panel; or Cornelius Gijsbrechts' *Reverse Side of a Painting* (1670), a sort of ultimate painting "manifesto": the reproduction of the reverse side of a painting that imitates in minute details the wooden stretcher, the canvas and the nails. Equally illustrative are the architectural trompe-l'oeils (big-scale wall or ceiling paintings) such as Baldassare Peruzzi's *Sala delle Prospettive* (c. 1515) at Villa Farnesina in Rome, or Andrea Pozzo's *The Apotheosis of St. Ignazio* (1688-1690) at the Church of Saint Ignatius Loyola in

[358] Hanneke Grootenboer, *The Rhetoric of Perspective: Realism and Illusionism in Seventeenth-Century Dutch Still-Life Painting* (Chicago and London: The University of Chicago Press, 2005), 4.

Rome—painterly ensembles that reproduce in detail fake urban vistas that visually "open" the opaque walls, or, in the second example, flying characters that falsely stretch the heights of the church's cupola towards an "endless" sky.

Fig. 4.3. Baldassare Peruzzi, *Sala delle Prospettive*. c. 1515. Mural painting, Villa Farnesina, Rome, Italy.

These examples show that in trompe-l'oeil, illusionism and realism meet and complete each other as they both, as Hanneke Grootenboer points out, "constitute effects of perspective, as well as illuminate the relation of image to meaning and to modes of looking and interpretation."[359] And this, I would add, regardless of the epoch or the technical/technological means involved. Nevertheless, it should be emphasized that the encounter between realism and illusionism in the form of trompe-l'oeil does not entail their mutual identification or erasure. Realism and illusionism are affiliated notions, yet they remain non-identical, and AR, as we will see, provides sufficient arguments to make this difference evident. The difference between these two terms, and the role trompe-l'oeil plays in cutting across them raise questions that various theorists have addressed by considering diverse theoretical frameworks. For example, for

[359] Ibid., 5.

Hanneke Grootenboer, trompe-l'oeil, as a form of illusionism, represents a radical departure from other realist genres, since it lacks their basic qualities: it lacks narrative, the presence of human beings, the passage of time, and finally, it lacks any indication of pictorial depth.[360] Although well articulated and compelling in its logic, this position is limitative as it takes trompe-l'oeil in its stricter sense: as an easel *painting*, belonging to *a specific era*, which responds to strict standards related to the medium (e.g. the presupposed lack of depth). As we have seen in the examples discussed here, while remaining highly illusionistic, the AR experience presupposes and employs realism's "basic qualities": a narrative, the presence of human beings, the passage of time and visual depth (although, to be clear, we shouldn't see these two dimensions as equivalent). From a different perspective, one that emphasizes reality itself as a counterpart to illusionism, art historian Hal Foster sees trompe-l'oeil (or superrealism, as he calls it), as a "subterfuge *against* the real." More than a tricking of the eye, writes Foster, trompe-l'oeil delays the real by sealing it behind the surface. Nourished by Lacanian theories and postmodernist discourses, Foster's argument can actually explain not so much the relation between illusion and realism as that between art and the real (subject), in what he identifies as a "return of the real," of actual bodies and social sites in recent times.[361] AR's most important achievement, compared to forms of trompe-l'oeil such as VR, is precisely the return of the real in the form of a return *to* the real. Much more relevant for the present argument is W. J. T. Mitchell's position, which defines the difference between illusionism and realism as the distinction between spectacle and surveillance. "Spectacle is the ideological form of pictorial power; surveillance is its bureaucratic, managerial, and disciplinary form."[362] Like spectacle, illusionism exerts a certain power over subjects, an opinion also shared by art historian E. H.

[360] Ibid., 45.
[361] Hal Foster, *The Return of the Real* (Cambridge Massachusetts and London, England: The MIT Press, 1996), 141.
[362] W. J. T. Mitchell, *Picture Theory*, 327.

Gombrich, who writes addressing the illusions of cinema: "We do not have to mobilise our imagination; we are the passive, though willing, victims of an inescapable illusion."[363] On the other hand, Mitchell writes, surveillance is a form of making real, of objectifying the subjects in a more direct way. However, he admits, what we are witnessing today is an overlapping between the two in television news, in film, or in forms of art that include a public sphere. And, it should be added, this overlapping is also present in AR. Indeed, in AR both the idea of spectacle (the mise-en-scène, optical deception and the participative acts of the viewer) and the idea of surveillance (the permanent interpellation of the viewer by the system which extracts data about the position and delivers localized information) are present not only as interpretative categories but, in fact, as essential elements in the very functioning of the virtuality of the AR project, and of the convergence space it creates.

4.5.3. Trompe-l'oeil 2.0.

Provoking the perceptual limits and surprising the viewer with credible statements are the goals of any trompe-l'oeil, regardless the technique employed. Media theorist Bo Kampmann Walther is right to observe that "the celebrated trompe-l'oeil is a technical culmination of this striving for perfection that can be regarded as a re-form of augmented reality: an illusion within illusion itself."[364] Like its trompe-l'oeil predecessors, AR seeks to *tromper*, i.e. to deceive, to trick the eye of the viewer. It deceives, on the one hand, by making permeable the perceptual limit between the virtually represented objects and the material spaces we inhabit, and on the other hand, by establishing an experience of (an approximately) live temporality between on- and

[363] E.H. Gombrich, *Art and Illusion: A Study in the Psychology of Pictorial Representation* (Princeton: Princeton University Press, 2000), p. xxvi.
[364] Bo Kampmann Walther, "Reflections on the Philosophy of Pervasive Gaming—with Special Emphasis on Rules, Gameplay and Virtuality," in *Throughout. Art and Culture Emerging with Ubiquitous Computing,* edited by Ulrik Ekman (Cambridge Massachusetts and London, England: The MIT Press, 2013), 257.

off-screen worlds. But, even more than the historical trompe-l'oeil which is inevitably condemned to immobility (of the image and of the body), in AR the virtual image perceptually invades the real space of the viewer, creating synergetic effects in relation with the mobile body of the viewer. An example of an AR work that illustrates the perceptual and aesthetic possibilities of trompe-l'oeil in a way that is particularly relevant for the present argument is *Hans RichtAR* by John Craig Freeman and Will Pappenheimer, an AR installation/mobile AR application included in the exhibition "Hans Richter: Encounters" at Los Angeles County Museum of Art in 2013.[365] The work recreates the spirit of a 1929 exhibition held in Stuttgart entitled *Film und Foto* ("FiFo"), for which avant-garde artist Hans Richter served as film curator. Featured in the AR environment is a re-imaging of the "FiFo Russian Room" designed by El Lissitzky (along with his wife, Sophie Lissitzky-Küppers), where a selection of photographs, film stills and actual film footage was presented. The users access the work through tablets made available at the exhibition entrance. Pointing the tablet at the exhibition and moving around the room, the viewer discovers that a new, complex installation is superimposed on the screen over the existing installation and gallery space at LACMA. The work effectively recreates and interprets the original design of the "Russian Room," with its scaffoldings and surfaces at various heights, while virtually juxtaposing photography and moving images, to which the authors have added some creative elements of their own. As one of the artists has observed, by manipulating and converging real space and virtual forms, AR is able to "destabilize the way we construct representation."[366] Indeed, by inserting digital trompe-l'oeil elements that come to

[365] John Craig Freeman, "Hans RichtAR @ Hans Richter: Encounters, LACMA," John Craig Freeman's Blog, 2013, http://johncraigfreeman.wordpress.com/2013/05/02/hans-richtar-lacma/ and Amy Heibel, "Revisiting the FiFo Russian Room in Augmented Reality," *Unframed*, Los Angeles County Museum of Art - LACMA's Blog, 2013, http://lacma.wordpress.com (both accessed December 2015).

[366] Amy Heibel in dialogue with John Craig Freeman and Will Pappenheimer, "Revisiting the FiFo Russian Room in Augmented Reality" *Unframed*, Ibid.

complete the real world environment in a convincing although deceiving way, the work makes a statement about visuality that complicates the relationship between the visible/knowable object and its representation and interpretation in the virtual realm. Complicating actually means showing the capacity, but also the fragility of both realism and illusionism to establish a continuum, a perfect convergence between reality and (re)presented virtuality, whatever the means employed. If realism, according to Nochlin, is an objective investigation that seeks fidelity to visual reality,[367] in illusionism, "the imaginary is given the appearance of the real," as Oliver Grau maintains.[368] Illusionism (based on mimesis as Grau suggests, or not) "is constructed through precision of details, surficial appearance, lighting, perspective and palette of colors. From its isolated perfectionism, the illusion space seeks to compose from these elements a complex assembled structure with synergetic effects."[369] To obtain this synergy and to maintain the fidelity between representation and world by luring the viewer with illusionist effects is trompe-l'oeil's—and as I have been arguing here, AR's—most evident space-image effect.

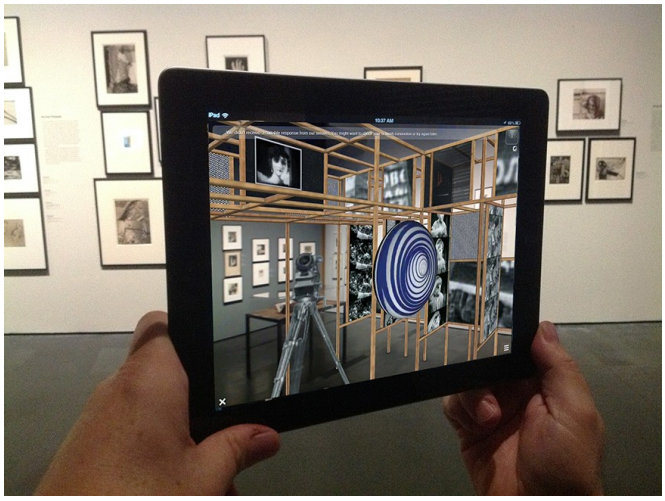

Fig. 4.4. John Craig Freeman and Will Pappenheimer, *Hans RichtAR*. 2013. Mobile AR application included in the exhibition "Hans Richter: Encounters" at Los Angeles County Museum of Art, 2013.

[367] Linda Nochlin, *Realism*, 20.
[368] Oliver Grau, *Virtual Art*, 16.
[369] Ibid.

If historical trompe-l'oeil discloses beautiful but inexistent objects or cityscapes under the opaqueness of the walls or canvases, in AR, not only do virtual illusionist images open virtual spaces, but they also unwrap dynamic, interactive sites, bringing up images, objects and pieces of information that carry further references, sometimes very much like hyperlinks in a website. Think, for example, of the way in which Workspace Unlimited group's *Spac[E]scape* provides virtual access to rooms situated at hundreds of kilometers away, as well as to information about those places, while facilitating interactions with the avatars of other remote online real participants. Similarly, in the project *Hans RichtAR*, films, photographic documents and animations flow and "activate" the room as they are activated by the user, in direct symbiosis with the built installation, thus opening up the referential matrix of the installation by providing historical indications as well as enriching it with the new content proposed by the artists. Still, in as much as it opens virtual spaces, the illusionist image of the trompe-l'oeil (whatever its kind) also acts to conceal, to obscure the physical reality under appearances. Being an appearance, a superficial presence, trompe-l'oeil conceals the real nature of the objects it represents; it makes us believe that what is represented is the real object, while in fact the latter is only a floating, fabricated, deceiving *image* of that specific object. It is a triumph of art over nature, as Vasari would say, or of the sign over the referent, as Baudrillard would have it.

Much of this effect of deceit is given by the fact that trompe-l'oeil erases the medium, making it transparent and, therefore, refusing to assume the medium's role as a medium (in its basic sense, as the material and technical support for an image).[370] To make the medium transparent is the ambition of any perspectival representation (AR included): to rationalize the

[370] W. J. T. Mitchell and Mark B. N. Hansen explain that one of the modern definitions of the term medium refers to "a person or thing which acts as an intermediary," whether a "material used in artistic expression," a "channel of mass communication," or the "physical material... used for recording or reproducing data, images, or sound." In W.J.T. Mitchell and Mark B.N. Hansen (eds.), *Critical Terms for Media Studies* (Chicago and London: The University of Chicago Press, 2010), xi.

represented space, to use geometry to control the 3D space beyond the surface of the canvas or display (think, for instance, how in AR applications like Layar, Wikitude or Junaio, the pieces of information are smoothly arranged in space according to perspectival rules). In fact, according to Albrecht Dürer (quoted by Panofsky), the term *perspectiva* is a Latin word that means "seeing through."[371] On the other hand, the transparency of the trompe-l'oeil is also given by the concentrated efforts to annul any sign that might disclose the hand of the artist or, in the case of AR, the *modus operandi* of technology. Of course, this is always something relative, since, as we have seen in our examples, the concealment of the *modus operandi* and the perfect integration of the virtual forms with the real space have been accomplished with various degrees of success. A third strategy for achieving transparency is, according to media theorists Jay David Bolter and Richard Grusin, "to automate the technique of linear perspective."[372] This quality of automaticity, they write, "has been ascribed to the technology of the camera obscura and subsequently to photography, film, and television."[373] Certainly, digital graphics or videos used in AR are part of the same family of automation techniques. By laying claim to reality or the natural and by creating a sense of immediacy,[374] automation seems to complete and perfect previous ambitions to conceal both the process and the artist. The two theorists are right to observe that "when interactivity is combined with automaticity and the five-hundred-year-old perspective method, the result is one account of mediation that millions of viewers today find compelling."[375] Of course, the interface plays an extremely important role in efficiently

[371] Erwin Panofsky, *Perspective as Symbolic Form*, Translated by Christopher S. Wood (New York: Zone Books, 1991), 27.
[372] Jay David Bolter and Richard Grusin, *Remediation: Understanding New Media* (Cambridge Massachusetts: The MIT Press, 1999), 25
[373] Ibid.
[374] Bolter and Grusin explain the idea of immediacy as follows: "It is the notion that a medium could erase itself and leave the viewer in the presence of the objects represented, so that he could know the objects directly" in *Remediation*, 70.
[375] Ibid., 30.

compelling the viewer and in rendering the medium transparent. As we saw in the second chapter of this study, AR relativizes in a significant manner the traditional role of the interface as a threshold and that of the frame as a cutting-out element between reality and virtuality by creating instead an artificial spatial continuum between virtual representation and the real material world. The space behind the surface of the interface's display (i.e., the real material world) is as much part of the perceiving experience as is the electronically generated (or recorded) virtual image that perceptually overlaps the real space. As the medium is transparent, so is the interface that defines it: HMD, projection or a mobile (handheld) device.

Of course, obtaining the best visual effect and a live temporality is always dependent on the location where the augmentation process takes place, as well as on viewer's physical presence on the spot (and, in this sense, AR reiterates in a subtle way the old debate about the subordination of time to space). A trompe-l'oeil, explains Hanneke Grootenboer, "insists on the bodily presence of the beholder in order for its deception to be enacted, and for that reason its effect cannot be caught in a photographic reproduction."[376] Even more than in the painterly trompe-l'oeil, in AR the bodily presence is crucial, since the virtual images' very existence is determined by viewers' interactive participation and their precise situatedness. If any trompe-l'oeil presupposes a privileged spot (the place where the illusion has maximum effect, something that is especially evident in the architectural trompe-l'oeil), in AR the very content of the image—the view on reality and the virtual superimposition on it, that is, the augmentation effect—is directly related to the precise position and orientation of the body in the real space. To accurately overlap the virtual image in the perceptual field of the moving viewer so as to obtain the trompe-l'oeil effect, various positional devices such as GPS, compass, landmarks, or fiducial markers are used. One important thing about AR trompe-l'oeil is that the point of view is handed

[376] Hanneke Grootenboer, *The Rhetoric of Perspective*, 45.

over to the viewer. So is the power over the narrative or discursive development of an artwork or application.

Thus, we can argue that the trompe l'oeil experienced in the artistic and technical parameters of AR offers also a different *temporal* effect for the viewer. If historical, painted trompe l'oeil operates within a sort of arrested "now" (given by the inherently static condition of the painting), the AR trompe l'oeil provides a renewed now-ness. This is determined by the permanent changes taking place in the visual field of the viewer. On one hand, there is the view of the material space in which the user moves: an inevitably changing landscape. On the other, there is the virtual image that is constantly renewed and adapted to reflect and accommodate the momentary position and orientation of the user in a specific location, as well as the actualized coordinates of the material space. Therefore, by creating an actualized connection between the two worlds, the user has a certain sense of immediacy. This effect of immediacy is explained by Bolter and Grusin as a "belief in some necessary contact point between the medium and what it represents,"[377] and, it should be added, between representation, the physical features of the space and the direct, real time actions of the user. The latter clause is important since, as Christine Ross argues, "perception in real time is an indispensable prerogative of any AR design."[378] However, as Ross points out (and as I will later explain), there is always a sense of perceptual delay intrinsically related to the effort to obtain a perceptual real time, one that questions any possible "rhetoric of temporal indexicality."[379] That perceptual delay questions any expected visual continuum and perfect spatial coherence between reality and virtuality.

[377] Bolter and Gruisin, *Remediation*, 30. See also their definition of "immediacy" at pages 70-71.
[378] Christine Ross, "Real Time, Lived Time: AR Art, Perception, and the Possibility of the Event" in Olivier Asselin, Johanne Lamoureux, and Christine Ross, (eds.) *Precarious Visualities: New Perspectives on Identification in Contemporary Art and Visual Culture*. Montreal & Kingston: McGill-Queen's University Press, 2008, 328.
[379] Thomas Y. Levin, quoted in Ross, "Real Time, Lived Time," 329.

Thus, while we, as trompe l'oeil subjects, validate its effect, we always also invalidate it. If we believe in it for a moment, at least, we also make it a subject of doubt and verification. It is in the nature of trompe-l'oeil, after all, to be discovered and to have its deceiving effects unmasked. Like realism, which will always betray its artificiality, trompe-l'oeil and illusionism will always turn into disillusion. Hanneke Grootenboer is right to observe that:

> the trompe l'oeil is a practical joke that provokes our eyes to the point of insult, and of doubt: the deceit undermines our reliance on our perceptions. The moment we are snared by the trompe l'oeil's lure, we enter a realm of illusion that forces itself upon us as a truth, whose artificiality we detect belatedly.[380]

But while in traditional trompe-l'oeil the trick is "condemned" to be unveiled after a split second, due to the inherent limitations of the medium of painting, in AR, the use of multiple perspective and real-time adjustments of the image according to viewer's position in space, the illusion, as it were, becomes flexible so as to make the trick if not harder to be revealed, then more persuasive in its effect, something that the viewer can repeat or play with as/he realigns him- or herself in space. We should remember that, as art historian David Summers points out, "perception, conception and deception are all variants of the same root, *capio*, *capere*, to take, and much art has been exercised in making us *mis*-take what we are looking at."[381] That is why much of the thinking about art in the Western world—at least those arts such as painting and theater that found their meaning on mimesis and illusionism—was always preoccupied with a deep distrust, not simply of images, but of "art" in general. Most famous is Plato's banishment of art from his ideal city because, he believed, art is one step removed from life, and therefore, two steps removed from truth. Nevertheless, there has always been a constant preoccupation for

[380] Hanneke Grootenboer, *The Rhetoric of Perspective*, 4.
[381] David Summers, *Real Spaces: World Art History and the Rise of Western Modernism* (New York: Phaidon, 2003), 433.

realism and illusion in the Western (art) world, and AR is part of this tradition. A lifelike image was and still is considered a "perfect" image. The recent preoccupations with various forms of capturing and reproducing reality confirm precisely this tradition. This is reflected, on the one hand, in the increasing popularity and commercial availability of more accurate and sophisticated visual instruments (full HD / 4K video cameras, 3D video cameras, advanced digital editing software, UHD, OLED, LED, Plasma and Curved TV screens, 3D TV, or ultra high definition television 4K and 8K); on the other hand, the quest for realism is reflected in the increasing preference for capturing reality "as it is" in reality shows and other real-time media manifestations such as docu-soaps, reality TV (type *Big Brother*, *Survivor*, *Pop Idol*, *American Idol*, *The X Factor*, *Got Talent* format etc.), recent waves of international cinéma vérité, mockumentary and docu-fictions, various applications for mobile devices and the ever-expanding use of surveillance cameras and CCTV.

AR shares with these manifestations the same preoccupation for realism and for engaging the image-making and its perception in the deceiving and re-enchanting game of illusionism. However, in AR, illusionism is seen not as opposing real-world experience, realism is not just a way to seek fidelity to visual reality, immersion does not automatically contradict mobility, and, most importantly, virtuality is not seen as a replacement of reality. AR does not replace material reality with a hypothetical form of hyperreality (a sequence of signs, artificially generated, that simulates the material reality, like in VR for example) but it effectively enhances it—perceptually, instrumentally, culturally, socially, etc. After all, as cultural theorist Bill Brown rightly remarks, "the medium turns out to have amplified (not annihilated) 'palpable material reality'"[382] (I take "medium" in this fragment in a generic sense, to describe the mediated experience of AR). Thus, AR redefines the role of virtuality making it not only a complement of,

[382] Bill Brown, "Materiality" in *Critical Terms for Media Studies*, 55.

but a necessary condition for understanding reality itself (a point that was extensively discussed above). Is this an epistemological issue? It could be, to the same extent that it is a perceptual and an aesthetic one. What is important to emphasize here by way of conclusion is that by converging reality and virtuality, not only does AR elaborate on and expand a whole tradition of representationalist verisimilitude, but it also emphasizes the role of mobility—that is, of the body—in obtaining a functional merging between virtual and material realms. This is—among other things—what contributes to making AR a different perceptual and aesthetic paradigm.

Conclusion

AR—Even better than the real thing?

The central argument of this study has been that AR represents a different perceptual and aesthetic paradigm. This claim is based on the fact that AR allows the perceptual overlay of virtual information (including photographs, video images, 3D graphics, text, sounds) on top of our material reality, in real time, site-specifically and interactively. As I emphasized in the previous chapters, AR should be seen neither as a material environment that is simply overlaid with data, nor as a situation in which the body has random access to virtual information, but as an expanded experience of the real world activated within the media sphere by the (mobile) user in a precise location. AR links material reality, virtual images and the active user live in what I call a *convergent space*—a type of experiential space that has a double nature, as it relies equally on the immanent materiality of the "here" and the virtual immateriality of the "there". Thus, to the question formulated in the introduction—if the convergent space represents a different aesthetic and perceptual paradigm—I have provided an extended affirmative answer, throughout this study.

The difference brought by the visual regime proposed by AR is firstly evident in the way *AR redefines the image, more precisely, the traditional notion of the image* as mimesis and as a window-like representational field. I claim that, unlike other media art manifestations, in AR the term "image" applies not only to the visuals provided in the established electronic formats (photographs, video streams, or digital animation) superimposed on the material reality, but rather to a more complex real-virtual visual construction, an interactive product of the encounter between technology, the body and the material world. In this sense, AR redefines the image in spatial terms in a rather particular way: not only by suggesting a third dimension through

illusions and animations, but also by including the real material space into the perceptual field of the screen.

Of course, AR is not single-handedly responsible for spatializing the image. As Mark B. N. Hansen remarks, "the task of art as process in the informational age [is] to frame information in order to produce new images and, we must now add, new forms and spaces as well."[383] Indeed, there are other technological and artistic practices that spatialize the image (for example VR, which turns the image into an immersive environment), but what is particular—and this is the second aspect of the paradigm shift associated with AR—is that AR creates a disruption of the difference between representational space and the space of action by creating *a different spatial relationship, called convergent space*. To explain this specific spatiality, I have introduced the term design(at)ed space. This is the real-world environment that is either *designed* from the ground as a setting for the work (as in Jan Torpus' *Living-Room 2*, Jeffrey Shaw's *The Golden Calf*, or John Craig Freeman and Will Pappenheimer's *Hans RichtAR*), or a *designated* area within the architectural and urban configuration that serves as a matrix for the AR experience (this is the case of Adam Frank and Zack Booth Simpson's *Shadow*, Workspace Unlimited's *Spac[E]scape*, Janet Cardiff and George Bures Miller's *Conspiracy Theory / Théorie du complot*, Julian Oliver's *Artvertiser,* or applications and devices such as *Streetmuseum*, *Historypin* and Google Glass). What is important to emphasize is that this design(at)ed space is not an *a-priori* space, but rather, as philosopher Henri Lefebvre puts it, "a spatial practice."[384] Or, to be more precise—and here I borrow from theorist Elizabeth Grosz's considerations on space and time—it is "what we make of the world rather than simply what we

[383] Mark B. N. Hansen, *New Philosophy for New Media* (Cambridge Massachusetts and London England: The MIT Press, 2004), 164.
[384] Henri Lefebvre, *The Production of Space*, Translated by Donald Nicholson-Smith (Malden MA, Oxford UK, Carlton Victoria-Australia: Blackwell Publishing, 1991), 8.

find in the world."[385] In this sense, AR's spatiality is a product of the user's activity: the product of the moving body in space and of the location now expanded by the user in the virtual sphere.

A great role in redefining the image and the experience of space in AR is played by the interface—a crucial instrument in the spatial convergence process. *The different role assigned to interfaces* represents the third important aspect of the AR paradigmatic shift. Although AR uses a great variety of visualization tools and interaction means, in recent times, the most typical interface is the screen, especially the handheld one. Screen is generally seen as an ambivalent place; it is the locus of negotiations between the real world and representation, between materiality and virtuality, between mobility and immobility (on and in front of the screen). However, AR complicates even further the screen's ambivalent status, transforming it into a context-aware, user-centric device, designed to offer a perceptual blend of reality and virtuality. This effect is obtained by rendering the screen perceptually frameless, phenomenologically "transparent" and, therefore, better integrated into the environment. Moreover, AR tends to equate screen and image in the sense of reducing the perceptual distance between the on- and off-screen images and thus acquiring a greater degree of perceptual continuity between reality and virtuality. To better explain the role of the interface in the convergence process, I have proposed an AR typology that identifies three distinctive attributes of augmented space and augmented experience: integrativity, projectivity, and mobility. These attributes correspond to each specific type of AR display: head-attached, spatial display, and hand-held. The implications and applications of this typology have been explained considering the interface not only in its objectual dimensions, as an apparatus, but also as an idea, as a concept.

[385] Elizabeth Grosz, *Architecture from the Outside: Essays on Virtual and Real Space* (Cambridge Massachusetts and London England: The MIT Press, 2001), 171.

Fourthly, I have shown that AR's perceptual spatial convergence permits *a different spectatorial involvement,* more precisely, *a different experience of spatial sociality* that transcends the model of traditional person-to-person meetings in the agora, the typical social-media encounters exclusively online, and wireless access or phone-based communication in the public space. In some cases, AR permits all these types of experience at the same time. Take, for example, the AR mobile application Layar, the latter being not only one of the most popular, but also one that is most often employed by artists in their projects. Layar allows the user to access information provided on different levels of interest (such as tourist attractions, restaurants, museums, photographs, or artist's videos, animations etc.) precisely in situ and, at the same time, allows the user to check who among his or her "friends" in the virtual world are available to meet in that specific location. The user does not act in parallel spaces—on the site *or* online—but in a hybrid space, in which the real and the virtual converge and collapse, in which the physical location meets and overlaps with the virtual flux of information, delivered at the eye's level and at arm's length (in the literal sense). Thus, the public sphere becomes a hybrid space that combines reality and virtuality, where the two terms dispute their primacy with apparently equal chances. What is specific for AR is not (only) that it fosters such encounters, but that it creates a convergent space where the communicational and perceptual difference between real space (location) and virtual realm (site) is seriously blurred.

Any utilization of a Layar application or the experience of an artwork based on the same application is able to prove that an augmented image (and, implicitly, the convergent space thereof) provides neither visual flawlessness nor perfect synchronicity between reality and virtuality. In fact, this fluctuation between the effect of continuity and discontinuity is something that characterizes AR in general. This is due mainly to technical shortcomings (such as real-time

inadequacy or real-virtual registration errors) that are not completely eliminated, at least at the present stage of technological development. It is true that many criticisms of the AR visualization systems (either practical applications or artworks) are directed to this particular aspect related to an imperfect alignment between reality and digital information in augmented images. Not only can AR applications function when having an estimated (and acceptable) registration error, but, I argue, such visual imperfections testify to a distinctive aesthetic aspect of this medium. The alleged flaws can be assumed—especially in the artistic AR projects—as the artist's "trace" or as the tool's "stroke" that can reflect the unique interplay between illusion and its subversion, between the transparency of the medium and its reflexive strategy, and in fact, between the continuity and discontinuity of the convergent space. In any case, significant efforts are made by engineers and scientists (and, as a matter of fact, by artists and members of the general public) to minimize the misalignments between virtual images and the physical world the applications are seeking to augment. What contributes considerably to this is the improvement of the interface as a key player in the augmentation process.

Still, despite any functional imperfections, it is important to acknowledge the fact that AR brings a different experience to the viewer by connecting—in a seamless (or at least convincing) way—reality and virtuality, image and space, machine and user, thing and event, location and network within one and the same convergent space. This is what makes AR a different perceptual paradigm and what indicates a distinctive regime of visuality. Certainly, as I have repeatedly stated, the AR experience is special mostly because of the technologies involved, but as an artistic practice it has important links with other previous or contemporary art forms and technological practices.

One of the driving concerns of this study was to put AR against the wider backdrop of contemporary media productions. Indeed, AR belongs to a more general *zeitgeist* marked by changes in technological conditions and in the philosophy of production and use. Thus, AR can be placed under the all-encompassing umbrella of these new manifestations, called ubiquitous or pervasive computing (the practice of embedding processors in everyday places and objects so they can communicate information), locative media (technologies and applications that are aware of the location where they are physically situated), or Web 2.0. (a rhizomatic, collective and unrestricted way to access the production and consumption of digital information in situ and/or online). Of course, these manifestations are part of a phenomenon of the coemergence of culture and technics that, as cultural theorist Ulrik Ekman points out, "does not yet belong to a well-defined period or to a field with clearly drawn contours."[386] This explains in part the distorted senses attributed occasionally to the term AR in various publications (scholarly or popular) and the inconsistent manner in which the term is applied to a great variety of artistic projects which has sometimes nothing to do with the idea of seamless perceptual convergence. This study has attempted to rectify these inadvertencies by *proposing a more comprehensive and consistent definition of AR*, from various relevant perspectives: aesthetic, artistic, mediatic and perceptual. Such a contribution is equally necessary and difficult to accomplish, given the fact that AR is still *in statu nascendi*, that is, it is still a practice which may be seen as "the becoming of what is not-yet, the grounds of the future as they exist in the present."[387] To illustrate this, it should be emphasized that since I started this research, roughly in the mid-2000s, *AR has evolved a lot*—as a technological means, as an artistic instrument and as a collaborative platform. AR development has moved from lab environments to the streets, from sophisticated and expensive equipment to

[386] Ulrik Ekman (ed.), "Introduction," *Throughout. Art and Culture Emerging with Ubiquitous Computing* (Cambridge, Massachusetts and London, England, The MIT Press, 2013), 15.
[387] Sean Cubitt, *Digital Aesthetics* (London: SAGE Publications, 1998), x.

wearable devices and free downloadable applications, from an elitist concept and instrument in the engineering research field to a trendy gadget in the hands of every user. The collective mentality is keeping up with the pace: not very long ago, AR was a weird term whereas now it is one of the most popular ideas and one of the hottest topics of research, even though it has so far remained largely under-theorized. Its increasing popularity is due to the different experience AR brings to the viewer, a change that has important consequences, as we have seen, at the aesthetic and artistic levels as well. Neither purely material, nor merely virtual, AR is something in between, something that extends—if not dislocates—the previous conceptualizations of image, space, visuality, spectatorship and technology: from contemplation and submergence to mobility and convergence.

Annex 1:

Historical landmarks in the development of mobile Augmented Reality technology

The following short history summarizes the key moments in the development of mobile media technology. It is relevant in this context since many of these innovations contributed to the advancement of AR as a technology and as a visualization system, especially with regard to its mobile capabilities. Some of the examples mentioned below show that several concepts and practical applications have been in gestation for many years, becoming functional only in the very recent period. It is also interesting to note that while at the time of their appearance, a number of applications and experiments were praised as the most promising developments in media communication and computer technology, they moved quite quickly into the shadow of obsolescence. This is a typical phenomenon for a domain that not only evolves at a fast pace, but is obviously prone to abjure previous working allegiances. The following inventory is inevitably incomplete and the list remains open, given the rapid development of an ever expanding and diversifying range of new applications.

One of the first important moments in this history was the setting up of the first operational packet switching network, called ARPANET (the acronym for Advanced Research Projects Agency Network), by a branch of the U.S.A. Department of Defense in partnership with four universities, in 1969. This was the predecessor of the contemporary global Internet, defined as "at once a world-wide broadcasting capability, a mechanism for information dissemination, and a medium for collaboration and interaction between individuals and their computers without regard for geographic location."[388] The year 1982 marked the development of what was arguably the first commercially available laptop, The GRiD Compass 1100, devised as a clamshell, a design solution that provided the model for later devices.[389] In 1993, the first smartphone was introduced on the market. This quite complex device was the IBM Simon Personal Communicator, which worked as a phone, a pager, a calculator, an address book, a fax machine,

[388] "Internet History" exhibition, Computer History Museum, http://www.computerhistory.org/internet_history/ and Barry M. Leiner et al., "Brief History of the Internet," Internet Society: http://www.internetsociety.org/ (both accessed December 2015).

[389] SIGCIS [Special Interest Group for Computers, Information and Society] of the Society for the History of Technology. http://www.sigcis.org/ (accessed December 2015).

and an e-mail device.[390] Another important moment in the history of mobile media occurred in 1993, when the initial operational capability of the Global Positioning System (GPS) was reached. Initially launched as a military service, it became a widely used aid in transportation systems worldwide, finding its applicability also in map-making, land surveying, communication, commerce, scientific research, entertainment and the arts.[391]

The idea of making the Internet available for mobile users was put into practice by Steve Mann, who is credited with creating Wearable Computing. In 1994, Mann started to wear a webcam and, for almost two years, he broadcast images to viewers on the web almost every minute of his waking hours. They, in turn, could send him live feeds and messages in real time.[392] The invention of Bluetooth technology, in 1994, by engineers at Ericsson Mobile Communications contributed further to the development of mobile media. Bluetooth is a short-range wireless communication technology that connects a wide variety of mobile and fixed devices using short-length radio waves.[393] Another important moment in this history was the development of the first digital camera with built-in transmission capabilities. Introduced in 1994 by Olympus, the DELTIS VC-1100 was able to upload digital photos over cellular and analog phone lines through a connected modem. Philippe Kahn is alternatively credited with inventing the camera-phone in 1997, when he designed a cell phone that could capture, upload and transmit photos over the cell phone network.[394]

The launch of the "first mobile AR system" by Steven Feiner et al. in 1997, called the *Touring Machine*, represented an important direct contribution to the evolution of mobile AR. In order to obtain an effect of real-virtual perceptual convergence, Feiner's system used a see-through HMD [Head Mounted Display] with an orientation tracker, a hand-held, 2D display with a stylus and a touchpad, a backpack holding a computer, a differential GPS system and digital

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[390] Ellen Messmer, "BellSouth Cellular Ships Personal Communicator," *Network World*, Vol. 11, No. 10 (August 22, 1994): 13.

[391] See Appendix: "GPS History, Chronology, And Budgets" in Scott Pace, Gerald Frost, Irving Lachov, David Frelinger, Donna Fossum, Donald K. Wassem, Monica Pinto, *Global Positioning System: Assessing National Policies*, Santa Monica, Calif: RAND, 1995, 237-271.

[392] Steve Mann, "An historical account of the 'WearComp' and 'WearCam' inventions developed for applications in 'Personal Imaging'," Published in *IEEE Proceedings of the first International Symposium on Wearable Computers [ISWC]*, October 13-14, 1997, Cambridge, Massachusetts, 66-73.

[393] Bluetooth SIG, Inc., www.bluetooth.com (accessed December 2015).

[394] For the Olympus development see R. L. Carter, *DigiCam History*, http://www.digicamhistory.com/1994.html (accessed December 2015); about Kahn, see: Philippe Kahn, "Photography changes the way we communicate," in *Click! Photography Changes Everything*, Smithsonian Photography Initiative (SPI) http://click.si.edu/Story.aspx?story=159 (accessed December 2015).

radio for wireless web access.[395] Two years later, in 1999, Tobias Höllerer et al. designed an experimental wearable AR system that enabled users to experience hypermedia information integrated with actual outdoor locations, such as documentary stories about the site, and spatialized multimedia models of earlier buildings.[396]

As regards interface design, an important moment in the history of mobile AR was the release of Benefon Esc! NT2002 in 1999. This is considered to be the first GSM phone with a built-in GPS receiver. Other sources present NavTalk Pilot as the first GPS-equipped cellular telephone (introduced in 1999 as well).[397] These innovations opened the path for GPS-based applications that have widely been used in the field of mobile AR in recent times. In the same year, 1999, the term Wi-Fi was coined by the Wi-Fi Alliance. The term describes any "wireless local area network" (WLAN), a technology that ensures the interoperability of high-speed, wireless, local area networksing (LAN), based on a standard called 802.11 introduced two years earlier by the Institute of Electrical and Electronic Engineers (IEEE).[398]

In 2000, Bruce Thomas et al. presented the *ARQuake*, an extension of the popular desktop game *Quake* into an outdoor/indoor mobile AR application. The game was based on a GPS tracking system, a digital compass and vision-based tracking of "fiducial" markers, while the participants, carrying the computer system in a backpack, used an HMD interface and a simple two-button input device.[399] This was followed shortly thereafter, in 2001, by the creation of the first prototype of an AR browser by Rob Kooper and Blair MacIntyre. The rather cumbersome hardware—involving an HMD and a complicated tracking infrastructure—was able

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[395] Steven Feiner, Blair MacIntyre, Tobias Höllerer, Anthony Webster, "A Touring Machine: Prototyping 3D Mobile Augmented Reality Systems for Exploring the Urban Environment," Proceedings of the *ISWC '97 (International Symposium on Wearable Computing)*, Cambridge, MA, October 13–14, 1997, 74–81.

[396] Tobias Höllerer, John Pavlik, Steven Feiner, "Situated Documentaries: Embedding Multimedia Presentations in the Real World," Proceedings of *ISWC '99 (International Symposium on Wearable Computers)*, San Francisco, CA, October 18–19, 1999, 79–86.

[397] For Benefon Esc!, see Daniel Wagner, "History of Mobile Augmented Reality," The Institute for Computer Graphics and Vision (ICG), Graz University of Technology, Austria. https://www.icg.tugraz.at/~daniel/HistoryOfMobileAR/ (accessed December 2015). For NavTalk Pilot, see Richard B. Langley, "GPS and E-911: An Update on the Technology," Geodetic Research Laboratory, Department of Geodesy and Geomatics Engineering, University of New Brunswick, Fredericton, N.B. http://gauss.gge.unb.ca/papers.pdf/GPS+E-911.pdf (accessed December 2015).

[398] See "The Wi-Fi Alliance: An In-Depth Look," The Wi-Fi Alliance - Knowledge Center/Articles, http://www.wi-fi.org/ and "What is WiFi Technology," *WiFi Notes*, http://www.wifinotes.com/what-is-wifi.html (both links accessed December 2015).

[399] Bruce Thomas, Ben Close, John Donoghue, John Squires, Phillip De Bondi, Michael Morris and Wayne Piekarski, "ARQuake: An Outdoor/Indoor Augmented Reality First Person Application," *Proceedings of the Fourth International Symposium on Wearable Computers* (ISWC'00), 2000.

to deliver a 3D spatialized information space that merged the physical world and the World Wide Web, thus earning the name of *Real-World Wide Web—RWWW*.[400] Another step in the evolution of mobile AR was the implementation, in 2004, of the first video see-through AR system on a consumer cell-phone. Developed by Mathias Möhring et al., the system could detect and differentiate various 3D markers, correctly integrating rendered 3D graphics into live video streams.[401] The same preoccupation for a better perceptual convergence of the material world with virtual information led to the introduction, in 2006, of a model-based hybrid tracking system for outdoor AR in urban environments. Conceived for a handheld device, the system enabled accurate, real-time edge-based tracking and the accurate localization of real buildings.[402]

Besides improving interface and tracking systems, mobile AR can also play an extremely important role in virtual data management. Thus, various solutions have been implemented, some applications relying on existing databases, others on the users' contributions. One of the most innovative and popular platforms/applications is Nokia's prototype *MARA*. Launched in 2006, it is a multi-sensor mobile phone that annotates the images captured by its camera with graphics and text in real time. This application was later (2008) developed into another service, called *Point and Find,* capable of delivering complex information whenever the smartphone is pointed at real objects.[403] Another example is *Wikitude*, an application (issued in 2008) which combines GPS and compass data with Wikipedia entries on the real-time camera view of an Android smartphone.[404]

The most widely utilized application, employed by the majority of artists, is *Layar*, an AR browser released in 2009 that layers real time information (the equivalent of web pages in normal browsers) over the actual image streamed live to a mobile phone display. An important feature is the Layar Creator, which permits the user to enhance flyers, postcards, packaging or

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[400] Rob Kooper and Blair MacIntyre. "Browsing the Real-World Wide Web: Maintaining Awareness of Virtual Information in an AR Information Space." *International Journal of Human-Computer Interaction*, Volume 16, Issue 3 (December 2003): 425 – 446.

[401] Mathias Möhring, Christian Lessig, and Oliver Bimber, "Video See-Through AR on Consumer Cell-Phones," Proceedings of the Third *IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR 04)*, 2004, 252-253.

[402] Gerhard Reitmayr and Tom W. Drummond, "Going Out: Robust Model-based Tracking for Outdoor Augmented Reality," Proceedings of 5th *IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR 2006)*, 2006, 109-118.

[403] See *MARA* (The Mobile Augmented Reality Applications), Nokia Research Center, http://research.nokia.com/ and *Nokia Point & Find*, Nokia Europe/Services and Apps, http://europe.nokia.com (both links accessed December 2015).

[404] See Wikitude http://www.wikitude.org/ (accessed December 2015).

any other item with interactive content, including video messages, Web and social links, photo slideshows, music clips, etc.[405] *Nearest Tube* is an application developed in 2009 for Apple's iPhone 3GS handset and conceived as a local guide that can direct users to the nearest Underground station in London.[406] In the same year 2009, *Google Goggles* was introduced. It is a service developed by Google for Android devices that allows both GPS-based search *in situ* and search based on object recognition. It currently supports photo-based web searching for posters, books, DVDs, landmarks, logos, contact info, artwork, businesses, products, barcodes, and plain text.[407] *Junaio* was also launched in 2009. It is a German AR platform created for iPhone and Android phones and tablets that augment the view of the environment as seen through the video camera with relevant information, based on either location or image recognition (the use of markers helped overcome the accuracy limitations of GPS systems).[408]

The quest for a higher accuracy of the real-virtual perceptual convergence continued, in 2009, with the development of the iPhone version of Parallel Tracking and Mapping [PTAM] software by the Active Vision Group at Oxford University, a system that permits the visualization of an augmented environment through a phone camera, with no need for any prior information about the location (such as markers or known natural feature targets).[409] A great improvement in accuracy came with the creation of an AR prototype for mobile phones based on both GPS and image recognition systems, a collaborative work between the Computer Vision Laboratory, ETH Zurich and the Swiss company Kooaba, presented to the public in 2010.[410]

Between 2009 and 2011, several mobile AR applications ("apps") were launched, having different aims and objectives and targeting different users. To give some examples, *7scenes* is a "mobile storytelling platform" and a museum-guide application,[411] while *Zagat nru* ("near you") is an application that lists restaurants, nightlife and shopping destinations based on Zagat, the restaurant reviewing and ranking website. Another important, spectacular application, launched in 2010, is *Streetmuseum*. It is an iPhone and Android application that makes use of the Museum

[405] See Layar: Augmented Reality Browser http://www.layar.com/ (accessed December 2015).
[406] Accrossair company website http://www.acrossair.com/apps_nearesttube.htm (accessed December 2015).
[407] See "Google Goggles," Google Mobile Labs , http://www.google.com/mobile/goggles (accessed December 2015).
[408] See: http://www.junaio.com/ (accessed December 2015).
[409] Active Vision Group, Department of Engineering Science, University of Oxford, http://www.robots.ox.ac.uk/~lav/ (accessed December 2015).
[410] See: The Computer Vision Laboratory, ETH Zurich http://www.vision.ee.ethz.ch/ and Kooaba http://www.kooaba.com/ (both links accessed December 2015)
[411] See: http://7scenes.com/ (accessed December 2015)

of London's extensive art and photographic collections, as well as of Google Maps and geo-tagging facilities, to allow users to see historical photographs inserted seamlessly in their original locations in various parts of the city, via their mobile devices. The application offers a locational experience of looking through a "window through time," providing, at the same time, important information about the location and the historical picture. Somewhat related to *Streetmuseum* is *Historypin*, a website and a mobile application created by the nonprofit company We Are What We Do, in partnership with Google, and implemented in 2011. Based on crowdsourcing, rather than on a museum's collection, *Historypin* lines up old photos (shared by users) with a current view of the street—seen either on a desktop or on a mobile platform, *in situ* (using GPS services). Users are able to compare the transformations of the landscape by changing or switching between the scenes, which are usually annotated with meta data.[412]

In recent years, important advances have been made in developing interface systems. One example is Kinect, a motion-sensing peripheral introduced in 2010, with a version for Windows released in 2012. Kinect is a sensor-based set of technologies that enable humans to interact naturally with computers. Developed initially for video games, it facilitates interactions with a wide range of applications that respond to peoples' natural movements, gestures, and voice commands.[413] In 2014, the software company Metaio came up with Augmented Reality for Smart Watches.[414] A "Smart Watch" is a computerized wristwatch with a functionality that is technologically enhanced beyond timekeeping. Since then, various companies have launched their own models of smart watches that run various mobile apps and use a mobile operating system. Starting in 2010, different versions of AR glasses have been created. AR glasses propose a rich, hands-free informational experience, in real time, of the immediate material environment, annotated with virtual data provided in the users' visual field through an eyewear-like interface. Examples: Google's *Project Glass* eyewear; the *SMART Glasses* Technology developed by Vuzix Corporation and Nokia; *Golden-i,* developed by Kopin Corporation; EyeTap, invented by researcher Steve Mann. A step further in diversifying AR eyewear devices was taken with the launching of *Google Glass* in 2014. However, on January 15, 2015, Google announced that the Google Glass prototype production had stopped, but that the company remained committed to

[412] Historypin, Mobile app: http://www.historypin.com/app/ (accessed December 2015).
[413] "Kinect for *Windows*," Microsoft official website, 2015. https://www.microsoft.com/en-us/kinectforwindows/ (accessed December 2015).
[414] Metaio – The Augmented Reality Company http://www.metaio.com/ (accessed December 2015).

the development of this product.[415] In 2015, Microsoft announced the *HoloLens* – a *Windows 10*-based AR unit, with high-definition "holographic" 3D optical head-mounted display and spatial sound.[416]

[415] "Google Glass sales halted but firm says kit is not dead." *BBC News*. January 15, 2015. http://www.bbc.com/news/technology-30831128 (accessed December 2015).
[416] Jessi Hempel, "Project HoloLens: Our Exclusive Hands-On With Microsoft's Holographic Goggles," *Wired* 21.01.2015. http://www.wired.com/2015/01/microsoft-hands-on/ (accessed December 2015).

Annex 2

How do tracking and registration systems work?

A crucial role in obtaining a seamless integration of virtual information into the right place in the material environment is played equally by the interface and by the tracking and registration systems. In AR, the tracking system's role is to register the viewer's position and orientation in space, as well as the physical features of the environment, and then to instruct the system to render an augmented view from the user's new position, while fitting the virtual elements into the changing reality as accurately as possible.

If we look back at the history of tracking technology, we will come across the work of computer scientist—and AR pioneer—Ivan Sutherland and his visionary ideas about the necessity of a closer connection between human movements/eyesight direction and digital output. In 1965, Sutherland published a very influential essay, "The Ultimate Display," in connection with his research in immersive technologies, in which he wrote:

> "The computer can easily sense the positions of almost any of our body muscles. So far only the muscles of the hands and arms have been used for computer control. There is no reason why these should be the only ones, although our dexterity with them is so high that they are a natural choice. Our eye dexterity is very high also. Machines to sense and interpret eye motion data can and will be built. It remains to be seen if we can use a language of glances to control a computer. An interesting experiment will be to make the display presentation depend on where we look."[417]

The experiment Sutherland dreamed of has actually become a reality; certain systems and applications that use the vast range of tracking techniques available today (in both VR and AR fields) are capable of displaying images depending on where one looks. While they are not yet ready to speak the "language of glances," as Sutherland envisioned, these systems permit nevertheless quite a close connection between material space, the human body and virtual images.

Tracking technologies were initially developed in relation to VR experiments, and they remain a significant feature in this field. Building upon achievements in the VR area, AR

[417] Ivan E. Sutherland, "The Ultimate Display," *Proceedings of the International Federation of Information Processing Societies (IFIPS) Congress*, New York, USA , May 1965, vol. 2, 506-508.

research has expanded the capabilities and connective dimensions of tracking systems so as to address the more unstable and dimensionally larger environments in the real world. Consequently, technical challenges have become considerably higher. The difference consists mainly in the fact that in VR the completely artificial environment is easier to control and adapt to the approximate position and orientation of the user's body. Possible errors are less discernible (and better corrected) when there are no "objective," fixed material reference points. On the other hand, since virtual objects in AR supplement rather than supplant the real world, maintaining the illusion of the two worlds coexisting within one and the same visual field requires a more accurate registration and alignment of the virtual images to the real world. The slightest error in registration or calibration is more easily detected by the viewing subject. Besides tracking the viewer's position and orientation in space, an effective AR visualization system requires also precise knowledge and a careful mapping of the environment in which the augmentation takes place, whether this is a geometrically limited space (in the case of indoor applications) or a geographically extended area (in the case of mobile, mainly outdoor applications).

Thus, to overcome these complex challenges, a great array of tracking and registration systems—operating on very different technical principles and yielding various performance results—have been experimented with and implemented in the last two decades. Amongst the numerous solutions that have been advanced, mechanical, electromagnetic and optical tracking systems are considered by many authors to be the most efficient, especially for indoor applications. As for outdoor mobile applications, GPS has become, in recent years, the prominent tracking technology.[418] However, much like display solutions, tracking systems (of any type) have both qualities and downsides in terms of efficiency, accuracy, optical quality and responsive capabilities. For instance, GPS-based systems can cover large geographical areas, but their disadvantage consists in the limited accuracy of GPS measurements—10 to 30 meters—something that may be acceptable for general use, but becomes a problem for a system predicated on accuracy and tight control. Another example would be the marker-based tracking systems, which are very effective in delivering a rigorous augmentation, but are unproductive for outdoor, nomadic applications. That is why AR frequently uses hybrid tracking systems that

[418] See Siyka Zlatanova, "Augmented Reality Technology," GISt Report No. 17, Delft University of Technology, Section GIS technology, Faculty of Civil Engineering and Geosciences. Delft, December 2002. www.gdmc.nl/zlatanova/thesis/html/refer/ps/GIST17.pdf (accessed December 2015).

combine two or more solutions in order to compensate for the weaknesses of individual tracking technologies and, therefore, to strengthen the visual effect.

Regardless of the solution employed, the tracking and registration process follows two general principles, called "outside-in" and "inside-out." As computer scientists Oliver Bimber and Ramesh Raskar explain:

> "The first type, outside-in, refers to systems that apply fixed sensors within the environment that track emitters on moving targets. The second type, inside-out, uses sensors that are attached to moving targets. These sensors are able to determine their positions relative to fixed mounted emitters in the environment. Usually these two tracking types are employed to classify camera-based approaches only—but they are well suited to describe other tracking technologies as well."[419]

It is important to observe that not all systems involve tracking human motion, regardless of whether the sensors are positioned on the fixed environment where the augmentation scene takes place or on the moving user (outside-in or inside-out). When the tracking system does not address the user directly, it tracks reference points situated in the environment, most commonly referred to as *fiduciary markers*. Hence, from this point of view, there are two main classes of tracking systems: marker-based and markerless. The role of markers is to give indications about where and how the virtual object will be overlaid in the material environment. These markers are typically graphical signs (specific geometric icons, barcodes or QR—quick response—codes) printed on a 2D surface and placed on different objects or even on the user's body. The camera (mobile or not) senses the marker through image recognition technologies and uses the markers' data to "trigger" information from the system and overlay it instantly into the visual field of the viewer.[420]

The second category, markerless augmentation, is considered more practical (albeit more sophisticated, technically speaking), since it does not require adding markers to a scene in advance. Instead of using markers, the AR system may use two other types of tracking. The first is *digital compass tracking*. Currently the dominant solution, especially in mobile AR applications, this system uses location technologies (such as GPS, compass, accelerometer,

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[419] Oliver Bimber and Ramesh Raskar, *Spatial Augmented Reality. Merging Real and Virtual Worlds* (Wellesley, Massachusetts: AK Peters, 2005), 4.

[420] See, for instance, *ARTag*. This is a 2D marker and computer vision system for Augmented Reality, developed by Mark Fiala while he was working for the National Research Council of Canada's Institute of Information Technology. See http://www.artag.net/ (accessed December 2015).

inclinometer) to orient the spatial relationship of the user's camera to material objects and geographic positions in order to create a hybrid, real-time perceptual output of the material world and virtual information. The second markerless system is based on *image recognition technologies* (also known as *natural feature tracking* systems): the vision software "recognizes" the natural features of the object (its shapes and colors) or photos, posters, and texts onto which corresponding virtual information is superimposed. The complicated algorithmic processing and its dependence on relatively iconic objects or locations limit the usefulness of this tracking system, although rapid progress is being made to perfect and popularize this solution.[421]

Another possible technical operation in the process of augmentation, directly related to tracking and registration techniques, is the process of *occlusion*. While occlusion plays a crucial role in some AR systems, it is not a prerequisite for all applications. For example, mobile AR applications, in particular, do not rely on occlusion. In this context, occlusion refers to the idea of visually removing parts of the real scene or of the virtual environment to permit a better integration of virtual images into a specific setting. The process of occlusion is explained by computer scientists David E. Breen and his colleagues in the following terms:

> "Computer vision algorithms are used to acquire data that model aspects of the real world. Either geometric models may be registered to real objects, or a depth map of the real scene may be extracted with computer vision algorithms. The computer vision-derived data are mapped into algorithms that exploit the power of graphics workstations, in order to interactively produce new effects in augmented reality. By combining live video from a calibrated camera with real-time renderings of the real-world data from graphics hardware, dynamic virtual objects occlude and are occluded by static real objects."[422]

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[421] For a comprehensive survey of tracking technologies, see, among others: Joike Verlinden, "Pixels Want to be Freed! Introducing Augmented Reality, Enabling Hardware Technologies," in *AR[t] Augmented Reality, Art and Technology*, no. 1 (April 2012): 8-11 and 42-59, Jannick P. Rolland, Larry D. Davis and Yohan Baillot, "A Survey of Tracking Technology for Virtual Environments," in Woodrow Barfield and Thomas Caudell, eds., *Fundamentals of Wearable Computers and Augmented Reality* (Mahwah, NJ: Laurence Erlbaum Assoc. Inc., 2001), 67-112; Feng Zhou, Henry Been-Lirn Duh and Mark Billinghurst, "Trends in Augmented Reality Tracking, Interaction and Display: A Review of Ten Years of ISMAR," *Proceedings of the International Symposium on Mixed and Augmented Reality ISMAR 2008*, Cambridge, UK, 15-18 September 2008.

[422] David E. Breen, Eric Rose, Ross T. Whitaker, "Interactive Occlusion and Collision of Real and Virtual Objects in Augmented Reality," *European Computer-Industry Research Centre GmbH (Forschungszentrum)*. Online at *CiteSeer*^{x}, Scientific Literature Digital Library and Search Engine, http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.38.113/ (accessed December 2015).

Thus, occluding in AR entails a complex set of technical procedures that aim to obtain a credible perceptual effect in combining real and virtual data either by hiding the more remote virtual objects behind closer real objects or by covering objects in real-world images with virtual objects. In this process, the two worlds must be accurately coordinated by comparing and synchronizing the depth, form, color and position of the actual scene with those of the virtual objects.

This brief foray into the technicalities of the augmentation process reveals one important aspect, namely, that AR—as a technological process and as an experience—relies both on adding information to the perceptual field and on extracting data from the user's environment or from the body's interaction with that environment. As Lev Manovich explains in his essay "The Poetics of Augmented Space," real space is transformed into data space by "extracting data from it (surveillance) or augmenting it with data (cellspace, computer displays)."[423] Thus, image display, data rendering, tracking, registration and occlusion are the methods and solutions used for controlling and manipulating the material *and* the virtual worlds in such a way as to obtain the experience of a convergent space.

[423] Lev Manovich, "The Poetics of Augmented Space," *Visual Communication* 5, no. 2 (2006): 222.

Annex 3

Augmented Video

Augmented video is a media visualization solution that permits the realistic superimposition of virtual graphics or pieces of information onto the video recording or the live video stream of a real scene. Augmented video is used in different circumstances, from TV broadcasts to video artworks, with the goal of adding informational or metaphorical content and enhancing one's perception of a main image. While augmented video is closely related to AR, there are several important differences between them. The most important concern the fact that an augmented video experience does not take place *in-situ*, and that it is not necessarily (although it may be) developed in real time. This annex briefly describes these particularities, with the goal of better explaining and contextualizing the concept of AR *vis-à-vis* other related media and artistic manifestations.

For example, the artist Julian Oliver has proposed a series of visual experiments that are relevant for explaining the way in which augmented video functions. *The Atocha 24 Insertions* (2009) is a video artwork that presents images of an old Art Deco market building in the heart of the city of Madrid, soon to be torn down, onto which 3D digital forms inspired by the architectural elements of the building have been superimposed in a realist manner. The work interprets the volumes and the functions of the building via virtually-generated graphics that occupy and animate different areas of the constructed space, thus responding to and highlighting the real meaning and look of the architecture. This way of "interpreting" the building, by merging existing and virtually generated forms, is not so much tautological as inductive, because it speaks, on the one hand, about the importance of architectural settings as witnesses to a specific epoch and, on the other, in a more critical key, about the fragility of history and memory in a fast-paced consumer society. Technically speaking, the video employs a combination of technologies and visualization strategies. Julian Oliver gives important details in this respect: "I took footage of the site without a tripod or image stabilization on a Canon HF10 in Shutter priority mode (TV 50) with a WD-H37C wide angle lens. I later match-moved it using PFHoe for Linux. Using Blender 2.49 for Linux I created the sculptural elements, cleaned up the camera

track, added masks and composited them into the video using Blender's own VSE."[424] Two other works by Julian Oliver, *Four Interrupted Carparks* and *Six Composite Acts* (both from 2010), are also relevant for illustrating the technical, visual and conceptual possibilities offered by augmented video and understanding what makes them different from the AR experience. Like in the previous example, these works interpret real architectural sites by using 3D graphics that perceptually expand the visual appearance of the respective spaces. Rather than working directly on-site, like in AR, the artist chose to perceptually augment the spatial configuration of an architectural place in a delegated manner, that is, by superimposing virtual images onto a captured video of that specific location, off-site and in a non-real-time manner. The resulting video recording presents virtual sculptural elements integrated in space in a realist manner, while following all the rules regarding proportions, shadows and spatial orientation. As the camera moves around the real space, the viewer can perceive the shapes from all angles, experiencing a sense that he/she is watching the recording of an actual—albeit bizarre—scene in which real and virtual elements merge and collide. There is, undoubtedly, something surrealist in this amalgamation of real, banal spaces (a parking lot entrance and, respectively, the backyard of a building) and out-of-this-world shapes that complement, or rather invade and disturb those spaces. While the effect is compelling, indeed, it is nevertheless confined, as intended, to the perceptual dimensions of a video projection.

Another artist that uses the visual potential of augmented video techniques is Keiichi Matsuda. His artistic preoccupations are partly focused on proposing alternative solutions for addressing the increasing role technology is playing in shaping our everyday movements. In an attempt to respond to these imperatives, Matsuda has created a project entitled *Augmented (hyper)Reality: Augmented City* (2010).[425] Despite the fact that the term AR appears in the title, the work is actually an augmented video project which presents a fictional narrative (provided as a 3D video that necessitates specific eye-glasses) in which characters act, react, meet with each other and deal with their daily life issues via a set of buttons and interfaces that appear as virtual projections freely suspended at arm's length from their bodies. Fictional as it is and implausible as it might seem, the story in this project shows an interesting dimension of the convergence between the real and the virtual and—why not?—a possible path for the development of human-

[424] Julian Oliver, Projects: http://julianoliver.com/output/category/projects; Also at http://vimeo.com/5341989 (accessed December 2015).
[425] Keiichi Matsuda, http://www.keiichimatsuda.com/augmentedcity.php (accessed December 2015).

computer interaction. In this sense, Matsuda's work is a visionary—although rather commercial-looking—interpretation of such possibilities by regarding the material space around us not simply as a physical background, but as an interface or a data depository.

In the field of television, augmented video has been used in different ways in recent years, the simplest being the realistic insertion of an electronic billboard into the broadcast image of a real scene, especially in sports transmissions. These billboards provide information about the score, or the position of the players in the field, seamlessly inserted in the main image. In order to align the billboard into the physical configuration of space, the system requires calibration according to camera angles and zoom settings. Another, more spectacular way of employing augmented video technology in television production is the real-time, seamless combination of people and real objects with computer-generated virtual studio environments. The key aspect resides in the ability to synchronize the view of the real camera moving in physical space with the virtual image rendered from the same perspective. The difference between this solution and the "classical" special effect of the chroma-key background is that this technique allows the simultaneous movements of the person, the camera and the virtual setting, in real time[426]. Among the most surprising and widely acclaimed applications of an augmented video visualization solution was made available during the live transmission of the 2008 U.S.A. presidential election by the news channel CNN. The CNN correspondent Jessica Yellin's image, located at the presidential candidate Barack Obama's campaign headquarters in Chicago, was captured and beamed into the CNN press center in New York City, live. Thirty-five cameras, disposed in a ring, picked up her 3D image and inserted it in a realistic manner into the main videoframe transmitted from the studio in New York, according to the position and orientation of the viewing angle of the main studio cameras.[427] An equally spectacular augmented video image was delivered by BBC during the Euro Elections of 2009. BBC's Jeremy Vine presented the vote results from a virtual studio with the help of digital maps projected onto the floor and the walls (activated through a tangible interface), while bar-shaped and circled charts, rendered in a realistic 3D manner, sprang up from beneath his feet. A few months later, during the BBC coverage of the UK elections of May 2010, the same TV anchor examined the changing British

[426] See Brian M. Collins, "The Reality of Virtual TV Studios," in *Virtual Reality* journal, Volume 2, No. 1/ June, 1996, pp. 140-146.
[427] Marguerite Reardon, "CNN's human 'hologram' on election night," CNET News, November 5, 2008, http://news.cnet.com/ (accessed December 2015).

political landscape while being immersed in a realistic, moving 3D rendition of the House of Commons.[428] Since then, augmented video TV has become widespread, as more and more television stations are employing this technique to deliver a closer integration of the media message into the real scene.

Given this capability of perceptually enhancing a video or television image, augmented video is sometimes called AR. I argue that this is incorrect. While AR offers the user a variety of movement and expressive possibilities, augmented video has a limited interactive capability, restricted to the use of remote-control devices and to channel selection. Moreover, unlike AR, the experience provided by augmented video relies on site-unspecificity: the video or TV broadcast can be experienced anywhere, having no specific or direct connection with a particular location. Directly related to this aspect is the fact that, unlike AR, augmented video provides no spatial convergence between the material world and virtual images. These are important elements that render augmented video as a different category from the visual paradigm offered by AR.

[428] BBC Election 2010, "Jeremy Vine examines the changing political landscape." http://news.bbc.co.uk/2/hi/uk_news/politics/election_2010/8667467.stm (accessed December 2015)

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