Considerations for Extended-Reality, Augmented-Reality and Mixed-Reality Design

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Abstract

This article describes emerging digital media environments with a focus on extended-reality (XR) spaces that take our visual awares beyond the flat two-dimensional screen or computer monitor. These media environments include digitally-generated content in the form of characters such as the avatar, the robot or cyborg. These digital entities express or embody a variety of audiovisual communication forms; data streams, animations, algorithms and programs. The evolution of digital media includes the increased use of 360 degree viewing environments. We move toward the hyper-realistic rendering of avatars and robots who exist in three dimensional space of our "real world". Unlike previous media characters depicted in movie or video projections, these new media forms seem to "make real" images and characters. They embody our digital files as separate spatial entities in the real space alongside us. Rather than accessing virtual worlds through the portal of the computer screen, we are evolving toward an augmented or mixed-reality environment. We now visualise our data and bring our digital files into the "real" space with us using sophisticated techniques in 3D computer graphics, laser and holographic technologies. The article discusses extended reality against a humanist background which considers the history of media and the ethical questions raised by such technology. This inquiry focuses on philosophical questions that may be relevant not only to scholars but also to the designers, producers, programmers, educators and researchers of virtual and cyber environments across a wide range of fields.

Keywords: Mixed-reality, Virtual reality, Augmented reality, 3D computer graphics, holography, avatar, telepresence, robotics, epistemology.

INTRODUCTION

Global interconnectivity has boosted the study of human biology, neuroscience and intelligence; the research and manufacture of objects and programs using artificial intelligence, genomics and robotics. We humans now coexist with artificial and mixed-reality entities, such as robots; artificial intelligences and characters in both real and virtual spaces. Onscreen and online, we mingle with a variety of artificial forms of life and intelligence. Twentieth century science fiction is today's virtual reality.

How do we understand the forms of virtual "life" that are available to designers within these enriched media platforms? What aspects of our selves are represented or simulated by virtual and mixed-reality environments? To explore these questions we will define virtual worlds and apply classic late twentieth century philosophical and technical theory to explore aspects of design in mixed-reality.

Let's examine how notions of truth, location, identity and authenticity operate inside virtual and augmented or "mixed-reality" environments. How are aspects of the human "self " limited or extended in the mixed-reality realm? We will outline several conditions that govern the relationship between the human user and their mixed-reality environment. We will look at Milgram and Kishino's taxonomy of the virtual and refer to aspects of Artificial Intelligence research. We also discuss Baudrillard's theories of "simulation" and of the "hyperreal" for insight into our perception of virtual worlds. (Milgram and Kishino, 1994; Baudrillard, 1983)

Margaret Wertheim suggests virtual cyberspace is a concept which has evolved over millennia or religious and scientific thought. Wertheim compares today's virtual worlds to Plato's spheres and to medieval concepts of hell and paradise. (Wertheim, 1995) These concepts may condition us to accept Virtual graphic effects as part of a kind of synthetic or cybernetic universe existing parallel to the "real" world. This paper suggests that the human user must often navigate and interact with a range of immersive audiovisual programs and effects inside the virtual world. In this context, the boundaries between the real and the virtual may simply become confused.

The many definitions of virtual reality are based on a range of different technologies and theories. According to Guttentag (2010, p. 638), Virtual Reality (VR) includes three key key design components, 'navigation', 'immersion' and 'interaction' which are commonly included by authors in the field. Gutierrez et al. (2009, p. 55) define VR using categories of physical immersion and psychological presence. Engineers Milgram and Kishino developed a continuum based on the tools of image-reproduction to help us understand the variation between real and virtual visual techniques using screens and projections. **"**Virtual reality is defined as that which is not real but which may display qualities of the real." (Milgram and Kishino, 1994, 18; Sherman and Craig, 2003, p. 25)

So we may agree that virtual reality is defined as a set of appearances which relate to objects that are not real but which may have realistic qualities or appear to be real. (Migram and Kishino, 1994, Sherman and Craig, 2003) Paul Milgram and Fumio Kishino developed a taxonomy of virtual displays and point out that while "real objects…have an actual objective existence. Virtual objects …exist in essence or effect, but not formally or actually." (Milgram and Kishino, 1994, p.8) Their taxonomy focuses on the visual perspectives allowed by a mixed-reality display that combines live and virtual experience. Media analysts can use this model to assess and create various kinds of display technique or to assess user perspective and engagement. (Ivanci et al, 2013, Ivancic et al, 2016, Anderson et al, 2013).

According to Milgram and Kishino, a Virtual Reality (VR) environment "is one in which the participant-observer is totally immersed in, and able to interact with, a completely synthetic world. Such a world may mimic the properties of some real-world environments, either existing

or fictional; however, it can also exceed the bounds of physical reality by creating a world in which the physical laws ordinarily governing space, time, mechanics, material properties…no longer hold." (Milgram and Kishino, 1994, p.1) From the user perspective, this means that seemingly magical visual effects can take place, comparable to the wondrous screen special effects, only now these may occur in the "real world" outside the parameters of the screen. Furthermore, the immersive and interactive aspects of 3D graphic interface mean that users can not just "view" but also participate in the action, performing and initiating gestures.

Multi-user environments evolved from computer games but have gone beyond a rules-based, goal-driven, win/lose game scenario. They exist on the web as social spaces designed for social and economic networking. Esports and games like Minecraft and Fortnite function as social media sites with continuous or "persistent" streaming online in real-time, twenty-four hours a day. In a similar way, chatbots, robots and AIs or Artificially Intelligent entities may be programmed to be "on" constantly or to interact at intervals depending on their function.

Virtual and augmented reality systems are used as simulation test-beds where people can develop brands and business ideas; interacting with products and systems before implementing them in the "real world." (Lehdonvirta and Castronova, 2014, Cardoso, 2019) Virtual and augmented systems are also new tools for medical practitioners, biologists and neuropsychologists who use interactive imaging and robotics for research, rehabilitation, training and therapy. (Rogers, 2019, Sveistrup, 2004; Holden, 2005)

Arts and entertainment industries offer an addictive range of virtual indulgences and gamification opportunities. While virtual pornography is already a huge market, old-fashioned point-scoring is often the focus of "serious" gameplay for training and education. (Rubin, 2019, Walz, 2015) Visual offerings go beyond the screen in a range of formats and interfaces including high definition 360 video, 3D graphics, holographics, biometric data capture, haptics and robotics. For example, the Tesla suit offers the user fully physical haptic, sensorial feedback based on biometrics and motion capture. (https://teslasuit.io/)

WHY IS RESEARCH INTO VIRTUAL DESIGN IMPORTANT?

How are we to understand and manage the new conditions available to media designers of these sophisticated virtual environments? Media theorists suggest that global, online platforms and virtual worlds will become common work and leisure places of the future. (Manovich, 2001; Boulter and Grusin, 2000; Everett and Caldwell, 2003) One problem in the field concerns the epistemology of virtual media.

We now interact daily with chatbots, robots, avatars and wearable devices. My simple swipe card gains me access to my office building but also gives my boss access to my comings and goings. Data from my wearable pedometer contributes to my medical records. I use a chatbot to help me locate online shopping items while robots assist behind the scenes to manage my airport luggage. These graphic audiovisual media tools are an interface between us and larger systems including our bank, city or state officials, medical experts, employers, colleges and so on.

Media can now be viewed, worn or even implanted inside the body to manifest data files in both real and virtual spaces. In this context, we need to understand the correspondence between human and artificial forms of life and intelligence. The psychological, ethical and technical question of who animates who in the virtual world is becoming more pressing. Machine learning and neural networks are subfields of Artificial Intelligence that govern how we structure, distribute and model data. As we "train" our AIs and robots using such techniques, we perhaps need to ask how we are also training the humans who use them?

In 1985, British theorist Donna Haraway defined citizens of industrial nations as already "cyborgs" whose intimacy with the products of microelectronics leads to a newly ambiguous set of boundaries between humans, animals and machines. Techno-performance artist Stelarc generates artistic experiments by internalising various technologies and 3D printed organs to illustrate the potentially violent and sublime merging of data, hardware and his own human flesh. Stelarc's works seem to prove the assertion of William Mitchell that wireless transmission and miniaturization contribute to a world of increased interconnectivity. Data is increasingly the motivating force behind our physical and mental health; our engineering, architecture and governmental activity (Mitchell, 2003, Haraway, 1991; Stelarc in Smith, 2005.)

Jean Baudrillard argued in the 1980s that new media technologies change our perception of reality. His premise is based on an historical survey of media production methods that *represent* reality and those that *simulate* reality. Baudrillard recognised that computer-driven media simulations generate a complex layer of illusion. In his book *Simulations* (1983) he asserts that media simulations which place computer-generated elements into a "real" world context may confuse our ability to distinguish, both visually and conceptually, between real and fantasy elements. (1983, p. 97).

The central question is: How do we understand the forms of virtual "life" and "territory" that are available to designers within this enriched media platform? How do we define and authenticate what or who is *virtual and real* within this context? This inquiry may be relevant not only to scholars but also to the designers, producers, programmers, educators and researchers of virtual and cyber environments across a wide range of fields. Such study is helpful to assess the future of a society that may be destined for a variety of artificial intelligence forms, including robots. It is also apt to observe the larger issues around mixed-reality environments as they may represent a test-bed for future virtual cultures.

DEFINITION OF THE VIRTUAL AND THE REAL

It is useful to define what is "real" inside virtual environments. Augmented reality is "a form of virtual reality (VR) technology where computer-generated images are superimposed upon real, physical environments by means of a viewing device" (Kim,E.S. in Wong et al. 2019, p. 89). AR uses display and projection techniques to generate real-time, visual content into the user's real space, often with additional computer-generated information layered on top. (Kralky, 2014, p. 44) This complex visual environment, forms a kind of "shared space" where real objects and cyber content are layered and mixed in the real visual field. Several design paradigms are useful

here including the Collaborative Virtual Environment (CVE) (Snowdon et al, 2001) and the Distributed Virtual Environment (DVE) paradigm. These describe "software systems that connect geographically dispersed users into a shared virtual space and support the interaction between the users and the shared world. DVEs have many applications in medicine, robotics, interactive distance learning, and online communities." (Khosrow-Pour, 2020, Casas et al, 2009, Dethridge and Schofield, 2016, Dethridge and Quinn, 2016.)

It is important for designers to observe how AR "tricks one's brain into perceiving elements that are not really there." (Varnum et al, p.1) It is useful to observe the design element of real-time appearance, as augmented reality is "the technology that simultaneously combines real and virtual objects that are interactive in real-time and are registered in a three-dimensional space" (Casas et al. 2019, p. 208).

Other theorists emphasise the aspect of Augmented reality that supports or enhances real world communication. In this scheme, Augmented reality is "a system that supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world" (Rodrigues et al. 2018, p. 15).

This paper does not revise these theories and methods but focuses on mixed-reality which includes all aspects of virtual and augmented systems. We are interested in "the result of blending the physical world with a synthetic one, including the paradigms of augmented reality and augmented virtuality" (Wong, 2019, p. 65).

MIXED-REALITY IS AUGMENTED-REALITY (AR) AND ALSO EXTENDED-REALITY (XR)

Mixed-reality is also referred to as "Augmented-reality" and as Extended-reality (XR) , which may also include 3D objects, robots and 360-degree videos or viewing platforms. Extended-reality is a relatively new term, compared to hundreds of definitions for VR and AR. In the field of education, a handbook on virtual training defines extended reality as "encompassing all realities such as 3D objects, 360-degree video, augmented, virtual, and mixed realities" (Lim et al. 2019, p. 4).

Mixed-reality applications can be defined as expressions of a multi-layered information platform or meta-platform. No longer is the screen the central portal to access digital files. We are discussing a mixed-reality or extended-reality environment where virtual objects and entities (or characters) may interact in the same real space as the user. For example, the industry formation known as the Internet of Things describes a mega-system or meta-system, a system of systems, which brings together a range of other systems including robotics, blockchain financial applications and 3D graphic, audiovisual and communication tools. (Alkhabbas et al., 2017)

These clusters of system applications are driven by data-bases and high-powered computer servers on a matrix of networks that can be private but are usually distributed globally. Shared virtual environments are often organized as "serious" games where the user operates a dashboard

with rules and objectives. They may also be seen as social and business environments where commentary and exchange transactions are encouraged. (Jung et al, 2018; Negroponte, 1995)

Within entertainment applications, users may deploy a range of VR and AR devices such as the Oculus, the HIVE or Magic Leap to engage with information streams including text, photography, movies, interactive animations, drone photography, 3D rendering and chat. This allows for a wide range of personal and collaborative activity so that the user is effectively plugged-in not only to a media environment but to a social or activist environment which connects them to action and people in the real world. (Cardoso et al, 2019)

The display device (the phone, computer, heads up display or screen) acts as both a psychological and physical link between the real and the virtual worlds. What are the historical, technological and social factors driving this development?

TECHNOLOGY AND HUMAN CONSCIOUSNESS

Like his contemporaries Michel Foucault, Gilles Deleuze and Félix Guattari, Baudrillard is concerned with epistemology, or the science of how we know what we know. (Deleuze and Gauttari, 1977; Foucault, 1980) Baudrillard surveys the history of European art and the image, focusing on various pictorial modes in the experience and expansion of visual space. He focuses on the shift by Renaissance European artists from the flat 2D imagery of ancient art to the illusionistic penetration of the "trompe l'oeil" 3D picture plane. In late twentieth century industrial cultures, Baudrillard observes that imagery generated by computer simulation can breed dangerous confusion around computer-generated images and situations. This media condition results from "the seductive power of endless stimuli" (Baudrillard, 1983, p. 139).

Baudrillard's theory of simulation points to the need for designers to focus on the way their creations are framed or contextualised. Renaissance painters put heavy wooden frames around a painting to signal the border between the illusion and the real world. The same painters then got rid of the frame and painted large murals of plants or architecture in trompe l'oeil style that tricked the eye. These murals were additions to grand houses and tricked the viewer into believing the painted garden really was part of the real landscape or that the painted image of a marble arch and column really *was* a marble arch and column.

Humans delight in the irony of discovering that what we thought was real in fact is not. At other times, we may indulge in the artifice and allow ourselves to be deluded into a kind of magical thinking where for example, a mere depiction of the deceased loved one somehow represents an aspect of that person. In future media configurations, there is the possibility that our ability to depict virtual realities outstrips our ability to process or truly comprehend them. Baudrillard's theory may encourage us to focus on the quality of virtual media environments and artificial entities; keeping a sharp perspective on the logic and ethics of the transactions between real and virtual entities and spaces.

Baudrillard's vision resonates with Marshall MacLuhan's two famous maxims: 1) the medium is the message, and 2) electronic media technologies are like extensions of our nervous system. (MacLuhan, 1974, p. 34) It seems clear that virtual and augmented technologies allow us to project aspects of our consciousness into the world. How might we consider technology as an object psycho-social projection?

Before the age of "fake news," Baudrillard puzzled over how we are to distinguish authentic photographic documents and images from artificially generated ones. This remains a problem for digital media designers. Baudrillard's theory suggests that by creating more realistic, or in his terms, hyperrealistic, models, we may lose touch with actual reality. This in turn may lead to an epistemological confusion, which is the basis of Baudrillard's theory. We see and somehow believe the evidence of our senses despite the fact that they refer us to an unreal, or in Baudrillard's terms, a hyperreal zone. As a result Baudrillard insists, we confuse simulation with reality; we confuse the map with the territory. (Baudrillard 1983, p. 3)

This discussion of epistemology forms a background for central questions: How do we understand the forms of virtual life and territory that are available to designers for research within this enriched media platform? There are several key convergence points which may help us understand the scope of this discussion.

TECHNOLOGICAL CONVERGENCE

Convergence relates to the physical linkages of various technologies and applications within larger and larger systems using artificial intelligence, blockchain and robotics. For example, in the agricultural industry, fruit may now be grown, harvested, stored, weighed, shipped and delivered within a single system, with all transactions logged on that same system. Such a system may include GPS satellite; video and robots to grow the crop and blockchain applications to record the sales prices on a ledger. This means there's an increased aggregation of media content across such meta-platforms, which in in turn may link to a range of other secondary applications and tools across the Internet of Things (IOT.) Multiple sensors and devices are interconnected to provide for independent machine-to-machine communication and transactions that were previously the domain of discrete or separate departments and processes. (Alkhabbas, 2017, Cardoso et al, 2019, Cipolia-Ficarra, 2014)

The virtual 3D world offers a publishing tool where artists and creators distribute virtual goods or information. Users of game platforms traditionally share and exchange digital information; movies, images and objects that they can win, purchase or create inside virtual game platforms like Fortnite. They create a personal archive or database to be negotiated or shared with others inside the game world.

Crypto currencies have evolved from cyberpunk style game environments to facilitate a new kind of digital economy where users can exchange real money for digital products and services. In the first decade of the twenty-first century, the shared user platform *Second Life* pioneered a prototype of virtual economies where users can purchase virtual clothes, furniture, cars and real

estate using a virtual "Linden" currency they purchase online using real American dollars. (Rymaszewski, 2007) The success of this virtual economy suggested the potential for economic exchange of virtual goods and services that are purchased and circulated between real and virtual environments. Internet applications such as Blockchain and crypto-currencies like Bitcoin and Etherium suggest computer code as a new form of economic exchange value. A growing body of research now considers the impact of Blockchain and crypto-currency exchange on various legislative and commercial real-world environments and territories. (Wright and De Filippi, Vigna and Casey, 2018, Xiwei et al., 2019)

EXTENSION OF REALITY IN MIXED-REALITY SPACES

We are focused here on ambiguities in the relationship between humans, artificial intelligence and artificial life forms like robots. Clearly we are moving toward an epoch in which humans share a mixed-reality mediascape that crosses over both virtual and real entities and spaces. For example, players of the popular mixed-reality Pokemon Go game, walk the (real) streets using their mobile phones to guide their search for mythical Pokemon creatures. Pokemon Go users employ the basic Google Map of the real world that is augmented with a graphic overlay that shows the location of various Pokemon characters and rewards. This game effectively integrates a real world experience of walking around town with a virtual fantasy, all in the same space. The Pokemon Go programmers overlaid the Google map of the world with characters and effects from a fantasy virtual world to produce effects whereby the digital could be manifest in the real world. According to industry analysis firm Sensor Tower, Pokemon Go made 795 million dollars worldwide in 2019. (Lavorato, 2019) What does the worldwide success of this mixed-reality game suggest about the evolution of mixed-reality media?

Our definitions of real and virtual may become distorted in this context of simulated reality. For instance, on large Esport platforms like League of Legends, people from widely disparate geographical realms meet and collaborate in a shared space of 3D or 360 degree graphic dimensions. In addition, the programs may provide a range of maps and navigation aids that allow a user to shift positions at will between macro and micro depictions of the world using maps and camera techniques that show highly specific local detail.

Mixed-reality platforms allow the industry user to combine graphics, movies and audiovisual effects and programs within a realtime, realspace environments. For example, an architect can use the phone to project graphics onto the wall of a real building to illustrate the position of a door. A carpenter can use mixed-reality applications to superimpose a technical diagram onto the actual timber model of a window frame. The use of mixed-reality for industry, training and education has great potential benefits. Because mixed-reality applications allow humans to be more flexible in their use of digital files, they allow great creative collaboration. How are we to classify virtual objects in the mixed-reality world; are they "global" or "local"? Maybe we class them as "global" when their users; the files and the objects under discussion are geographically dispersed around the world? The products of this mixed-reality industry formation may be classed as a form of mixed global/local knowledge peculiar to the *mixed-reality* culture.

While our virtual worlds run parallel to our own world, distance and time are immaterial in the virtual space which obeys different laws of physics. A player in Fortnite can set the virtual sun and moon to rise and set several times each day. The complexity of these worlds is hard to define however the hyperreal dimensions seem manageable due to the variety of tools provided for their exploration.

These days, Baudriallard's sense of the hyperreal is matched by the way we are, as an industrialised culture, hyper-networked. I can project all kinds of messages and digital products to my network of contacts worldwide. I can exchange virtual objects, files and images which make the mixed-reality space feel as easy to negotiate as my local neighbourhood. Or is it?

As real and virtual worlds converge within any mixed-reality simulation, we may observe conditions of some confusion in the way we perceive ourselves and others. In these new environments, physical and digital characters and objects co-exist and interact in real time. How might designers understand the psychology of the person who is using virtual technology in conditions of mixed reality? Lev Manovich emphasises that under conditions of immersion in virtual screen media, the real world fades away, "you are hardly aware of your physical surroundings..." (Manovich, 2001, p. 79)

Within this context, we may for example observe in the passion of the addicted gamer a form of convergence between their individual self and the virtual, 3D graphic self or avatar who represents them online. In virtual, online spaces, the avatar is usually a hyper realistic image which may or may not represent true aspects of self. As a user in a game world like Fortnite or League of Legends, "I am my avatar." The user selects from animations that simulate body functions—including dancing, sport or battle. Some applications allow exchange, financial transactions and extensive communication with other users. The intimacy between user and avatar in game worlds suggests that in future we may relate closely to a personalised robot who processes our data and functions in the space next to us.

ETHICAL CHALLENGES IN THE MIXED-REALITY ENVIRONMENT

Autonomous programs already populate the internet and are able to interact with other programs and users. Known as "bots", these programs can mimic humans and are already common in customer service centres and in computer games. (Rectenwald, 2019, Sugiyama, 2019)

Gamers are already familiar with non-player characters (NPCs) or characters which are generated by the game-producers to fulfil essential functions in various fictional scenes, such as battles or to provide information about frequently asked questions. Gary Hayes suggests the relationships we form with our avatars, bots and robots represent an important stage in the evolution of human culture. Hayes examines a range of online forums to gather information about artificial entities and bots which occupy human spaces or pose as "human" inside virtual worlds. Hayes is concerned that programmers often fail to label such bots as A.I. entities which causes confusion and irritation among inhabitants of virtual environments. (Hayes, 2008, p. 1).

Engineers suggest it may be possible to program ethics into robotic systems however this may not be such a safe option. "The risks that a robot's ethics might be compromised by unscrupulour actors raise doubts over the wisdom of embedding ethical decision making in real-world, safety critical robots." (Winfield, 2019)

In mixed-reality contexts, the user is a subject who is imagining and defining their function in an environment where the real and the virtual are in a state of flux. How might designers respond to this set of challenges?

It is clear that we need to understand the boundaries between humans, avatars and robots as this raises ethical issues around digital identity. Is a bot or an avatar to be treated as a human? Must one always signal one's true human identity when acting as an avatar in a virtual environment? Should all bots and A.I.s be clearly labelled as such? Can I inhabit or act within a mixed-reality world as my friend's avatar or is that unethical? Is my digital self liable for the same legal rights and privileges as my real self? How do we protect child avatars? The issue of intellectual and creative property rights is also crucial in this context. Who owns the data around my avatar and around my digital creations?

We are already well aware that administrators in data collection agencies like Google and Facebook can "mine" our private data, skimming it for specific content and matching it with advertising and commercial interests. (Heller, 2019, Rectenwald, 2019) We know that virtual game environments and shared social networks contain surveillance devices capable of recording activity, location and chat data by users. Chris Dodds points out that our understanding of the "digital persona" is a model of the person established through the collection and analysis of data relating to the behaviour of their avatar in online virtual environments. (Dodds, 2007)

Mega data and social networking companies like Facebook and Google are already under pressure to justify their role as compilers and re-distributors of private user profile information. (Heller, 2019) With the increase of companies establishing a commercial presence in virtual environments such as game worlds, issues such as private and corporate privacy, surveillance and espionage are gaining more attention. The collection and distribution of data beyond the virtual environment raises serious questions around data privacy. Demographic information about users of virtual and mixed-reality applications may be aggregated from the user base and shared with third parties. This means that while your "real" life may appear to remain anonymous, information pertaining to your virtual or digital self may not. (Heller, 2019, Rectenwald, 2019)

As designers perfect the realism of the 3D graphic interface and artificial life forms, there is an increased convergence or inter-mingling between human and cybernetic forms of expression. This cybernetic intimacy between us and our machines has bred deep concern that artificial intelligence and robots will take over jobs and facilitate surveillance states.

A recent Chinese government report reveals a national focus on shaping itself as a manufacturing and cyber superpower using "the new generation of AI technology in all aspects of the industrial sector…to build a public support system for industry … intellectual property service platform,

intelligent network infrastructure, cybersecurity, and …to improve the environment for the development of AI." (Triolo et al, 2017, p. 1) The Chinese government has certainly taken AI surveillance to an alarming level of efficiency. In 2019, the American government made sanctions against Chinese use of AI in ethnic law enforcement as a human rights abuse. (Doffman, 2019.)

All nations perhaps need to focus on government policy to ensure that democratic boundaries are placed around the use of data surveillance and the use of artificial intelligence and emerging cybernetic entities such as robots who are now referred to as NELFs on the Internet of Things (IoT). Japanese researcher Shigeki Sugiyama discusses machine learning and the problem of human consciousness in relation to AI research. He concludes that despite all the careful modelling of big data; of cloud and "fog" computing, AI is definitely still a work in progress; that there is no way machines are able to act independently of humans; that they lack consciousness and are "careless," not like humans at all. (Sugiyama, 2019, p. 15)

According to Baudrillard, simulation entails deception when the image is not framed or disclaimed as an artificial reproduction of reality. In his view, forms of simulation are problematic when they are not signalled as such. (Beaudrillard, 1983, p. 16) This may suggest a need for the owners and programmers of augmented or virtual systems and robot or bot characters to clearly designate them as program-generated entities and not human-generated. It may call for an ethics of transparency where humans may eventually need to register or license their avatar's or robot's identity.

Perhaps we should revise the freedoms that users currently enjoy in virtual worlds. Future research may be needed to investigate the ethical standards governing social covenants in virtual culture. Virtual and mixed-reality Worlds deliver lush, hyperreal and sensual visions via the computer interface which represents a portal into alternate reality. In future however, the senses and visions of the virtual will be mixed-in seamlessly with the real. It is possible that because humans are easily convinced that the virtual is somehow "real" we are blind to the psychological and socioeconomic conditions governing the mixed-reality interface.

There is a sub-genre of dystopian science fiction in which characters mistake virtual characters and scenarios for a kind of warped "reality". For example, in movies like The Matrix or Inception or Blade Runner 2049, there is no perceptible boundary between real and virtual dimensions. Characters fall in love with gorgeous, empathic robots and chase computer-generated bad guys. Such stories often feature the use of an edible or downloadable psycho-chemical link that the protagonist uses to merge with the computer. These movies seem to signal a post-human cyborg epoch that may be fast approaching or perhaps they are warning of what we must avoid: "an epoch in which the screen disappears and we carry the computer inside us, via microchips and mini-circuits, which, like pacemakers and cochlear implants, are designed to enhance our abilities to function." (Dethridge, 2016, p. 189)

CONCLUSION

Our digital reflections now include a variety of sophisticated graphic audiovisual instruments, lasers and holographs. These media forms open up new dimensions in our ability to organize a subjective view of self. While our self-perception may shift as a result, it is clear that our approach to the interface itself is likely to change. For the last forty years, the first generations of computer users have slumped at desks with arms on keyboards while fixating on the screen ahead. This interface was a cross between the typist's desk and the fighter pilot cockpit. The computer screen is no longer the main portal used by humans to access data. Sophisticated 3D computer graphics, laser and holographic technologies we are now able to bring a variety of digital "files" into the space so they co-exist in "mixed-reality" or "extended-reality" space alongside us.

As a result of this rapid media evolution, humans are experiencing new "mixes" of digitally-generated content inside a variety of spaces. We use machine learning; complex programming and robotics to reproduce both real and virtual entities and objects such as the avatar, the robot or cyborg which are the natural expression of a mixed-reality culture.
(Haraway, 1991, Stelarc in Smith, 2005, Mitchell, 2003)

In extended-reality XR environments, the user may experience vivid representations of other humans or entities that have a hyper-real nature. That is, they appear to function as "real" human entities or appear to be "really" there. We have seen humans fall in love with blow-up dolls or marry avatars they only know from online exchanges. To put it simply, we humans are capable of confusion across many cognitive categories. The future challenge may be for designers to form an epistemology that can accommodate the ambiguities inherent in the mixed-reality media landscape. This leads us to further exploration of the forms of character and psychology that are available as design elements in virtual worlds.

Extended-reality, mixed-reality and virtual worlds provide a powerful platform for the hyper-networked generation of digital natives who were born with computers in the nursery. Twentieth century telecommunications has evolved into twenty-first century streaming; we are always interconnected to the matrix of systems that governs the socio-economic needs of developed industrial nations. Currently our devices are held in a space adjacent to our bodies; in our hands or in our laps. We communicate with systems via a dashboard, a joystick or a mouse and keyboard. It seems we are accelerating toward a future in which the software will be integrated with the human user in even more intimate proximity, as wearable or even implanted devices. Will we attain a new sense of intimacy and responsibility in response to these shifts? Will it be possible to "un-plug" if the software is then part of us?

We are registering here a few of the myriad forms of physical and digital assemblages that are available to designers of virtual and extended-reality or mixed-reality spaces. The interactive and immersive qualities of virtual media have extended human experience beyond the tangible four walls of our daily experience into a seemingly limitless dimension of imaginary possibility. This all suggests that in future, designers may need to form an epistemology or order of knowledge which can include awareness of the ambiguities inherent in virtual environments. Most

importantly, the human tendency to suspend disbelief and to "believe our eyes" means we are easily tricked by the illusions made possible by sophisticated imaging and haptic sensing technologies.

Perhaps the awareness of "fake news" has been positive in that it raises healthy scepticism about the global outpourings of various media platforms. "The larger ethical issues of surveillance, privacy, intellectual and creative property rights are also a priority." (Dethridge, 2016, p. 190) How are designers to respond to this ethical quagmire? Should we devise certificates of authenticity or digital badges which offer legitimacy or ownership of data or virtual property?

It seems clear that while our capacity to develop and implement complex systems is evolving rapidly, we may not be developing a critical capacity and awareness to cope with the systems we create. This is evident for those hooked in to social networks or organisational communication chains. Like frogs in hot water, the new "normal" is to be dealing with the always urgent and confounding complexity of keeping up with daily emails or responding to social media inquiries and exchanges. The origin of the term "robot" is associated with words for "forced labour", "serfdom" and "forced worker" in Czech and other Slavic languages (Etymology Online, 2019). Is it the artificial intelligence known as robots we are programming to perform tasks or is it we who are really the robots? Are we programming ourselves as well as the robots to respond to the needs of the larger meta-systems that organise our lives? In machine-learning are we training the machine or training ourselves to be like machines?

Perhaps we may admit we no longer share a single reality but experience a diversity of media-generated environments that are run by larger systems. The future challenge may be for designers to form an epistemology that can accommodate the ambiguities inherent in the mixed-reality media landscape. In Baudrillard's terms, the human tendency is to read the simulation and the "reality" as if they coexist on the same plane. The "seductive stimuli" of simulated worlds will continue to raise serious issues for media epistemology; how we know what we know and how much of it is "real". (Baudrillard, 2002, p. 17)

Our ancient faith in the authenticity of the sculpted form; the painted, photographic or televised image means we are likely to believe what we see in virtual worlds. (Sontag, 1977, p.18) An image or product generated in the opposite geographical hemisphere can be "here," now in an instant using powerful imaging technology and a local 3D printer. I can program an online bot to resemble my partner and compose or recite poetry in his voice. We may easily suffer confusion when such systems include not only hyperreal imagery but also artificial entities such as avatars and robots who may pose somehow as "human." The location and identification of what or who is real or virtual in becomes a problem for designers to grapple with.

3D virtual technologies allow for display imagery of unprecedented audio-visual realism. When such technology is used to generate perspectives, simulations or re-enactments across scientific and legal contexts, we may need to focus clearly on the location of truth and authenticity. Within virtual and augmented environments, perspectives can be varied and therefore confusing. (Schofield, 2007, Hall, 1994) Let's remain aware of the way hyper-real images and effects can trick the brain into thinking a virtual subject or object is "really" there. We need to distinguish

carefully between actual reality and the pseudo-photographic 3D graphic images to achieve an uncanny and deceptive fusion of the model and reality.

Mega-platforms like the Internet of Things allow robots and artificial intelligence entities to communicate independently and organize industry processes in agriculture and manufacture. We are building a hyper-networked space where "humanoid" robots, industrial robots and online chatbots are also present. How may developers and designers ensure that bots, AIs and other artificial entities are accommodated in extended-reality in a way that is ethical?

We have traced some of the design opportunities and constraints of the extended-reality or mixed-reality media environment. In Baudrillard's terms, virtual worlds allow for aesthetic experience attaining a new hyperrealism, where media models or simulations of reality trick us into believing that what we see is "really" there. They seem to exist in real time on the same plane as actual reality. Clearly we can celebrate the technical, artistic value of highly interactive systems for business, health, industry and pleasure. Whether the humans of 2030 will agree to be programmed like robots in these increasingly complex systems of systems is up for debate and the answer is partly the responsibility of designers and policy-makers today.

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