Designing XR

This page intentionally left blank

Designing XR: A Rhetorical Design Perspective for the Ecology of Human+Computer Systems

BY

PETER (ZAK) ZAKRZEWSKI
Thompson Rivers University, Canada

United Kingdom – North America – Japan – India – Malaysia – China

Emerald Publishing Limited
Howard House, Wagon Lane, Bingley BD16 1WA, UK

First edition 2022

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-80262-366-6 (Print)
ISBN: 978-1-80262-365-9 (Online)
ISBN: 978-1-80262-367-3 (Epub)

ISOQAR certified
Management System,
awarded to Emerald
for adherence to
Environmental
standard
ISO 14001:2004.

Certificate Number 1985
ISO 14001

INVESTOR IN PEOPLE

Never hope to realize Plato's Republic. Let it be sufficient that you have in some slight degree ameliorated mankind, and do not think that amelioration is a matter of small importance.

… without a change of sentiments what can you make but reluctant slaves and hypocrites?

– Marcus Aurelius

This work is dedicated to the memory of my late Father Wojciech Zakrzewski,
who first introduced me to the “live and let live” doctrine at age six.

Contents

List of Figures

This page intentionally left blank

Acknowledgments

I would like to express my gratitude to Sharon Irving, Edward Slopek, Steven Bailey, Donald Gillies, David Tames, Carlos Teixeira, Alexander Manu, and Fiona Allison for their support during research, writing, and publishing of this work. I am also grateful to the various researchers and thinkers listed in my bibliography for offering me the ideas, which shaped my own understanding of ecological mind augmentation.

Special thanks to my Co-editor Bruno Lessard for the early support of this project, and for countless hours of editing and providing valuable feedback.

This page intentionally left blank

Introduction: The Birth of a New Domain

On March 9, 2016, *AlphaGo* the artificial intelligence (AI)-powered system developed by the team of data scientists at a Google-owned company called Deep Mind Technologies stunned the Go world by defeating the 18-time world champion Lee Sedol in game one of the best of five contests. During the second of the five games *AlphaGo* made moves that no human player ever would, prompting Lee Sedol to state his surprise that a mere machine based on probability calculations could make a move more "creative" and "beautiful" than any other opponent he has ever met. *AlphaGo* made Lee Sedol rethink what creativity meant. After losing the third and deciding game, Lee Sedol apologized to his peers for being "powerless."[1] After a five-day struggle, the final score was 4 to 1 in *AlphaGo's* favor. This result should have come as no surprise to those who know that there are whole categories of mathematical and probabilistic feats at which computers excel but which completely stump average humans. For instance, if the contest had involved a performance of a complicated arithmetical calculation, such as multiplying together two 30-digit numbers, it would have lasted mere seconds rather than days. By 2019, Deep Mind announced that they had created a newer version of *AlphaGo* that defeated the Lee Sedol's vanquisher by a score of 100 games to 0. On November 19, 2019, Lee retired from professional Go play. In his statement, he referred to AI-based systems as entities that cannot be defeated.

Only five years later, on April 8, 2021, possibly an even more consequential game took place, although it did not involve a human at all. In a video released by Elon Musk's brain–computer interface company Neuralink, Pager a nine-year-old macaque monkey with a Neuralink-implanted chip played a game of *Pong* with only his mind, no hands, and no joystick. An accomplished master like Lee Sedol might not want to make a comeback by implanting Neuralink chips to directly link his brain to an even more powerful system than *AlphaGo* but judging by the competitiveness of human nature and the pace of developments at Neuralink, very soon someone else will. Neuralink's promise according to Musk's tweet posted after the demo is to "enable someone with paralysis to use a smartphone with their mind faster than someone using thumbs" (Twitter, April 8, 2021).

In the Lee Sedol versus *AlphaGo* contest, the human lost – but who won? Was Lee Sedol defeated by a machine? From a broader societal perspective, the answer to this question is a more nuanced and far more consequential. Lee Sedol was

[1]The development of the *AlphaGo* program as well as the drama of the actual Lee Sedol's match are well captured in the *AlphaGo* movie directed by Greg Kohs.

Designing XR: A Rhetorical Design Perspective for the Ecology of Human+Computer Systems, 1–16

doi:10.1108/978-1-80262-365-920221009

not defeated by a computer; he was defeated by an entity comprised of a team of highly trained, and very human system designers armed with play data from thousands of experienced Go experts, augmented by a computer with processors capable of running relevant algorithms at speeds necessary to respond to Lee Sedol according to the rules of Go. The contest was won by neither a human nor a computer; it was won by an augmented human+computer system. As the speed and range of applications of the so-called AI grow, new questions continue to arise: How will we humans relate and connect to these advanced machines that can so powerfully augment our intelligence and behavior? What will be our relationship to them? Who will own, operate, and design these powerful systems? *AlphaGo* team defeated Lee Sedol by simply playing the game. The only input the system received was the moves Lee Sedol made on the board. The system's aim was not to play Lee Sedol, the human playing the game by tracking his increasing stress levels and his diminishing with time and effort cognitive ability. But this is exactly where the capability of the Swartz Center for Computational Neuroscience's Mobile brain/body imaging (MoBI) system is pointing. By mixing a synchronous collection of brain activity and manifested behavior in 3D environments with data-driven analysis, MoBI system can model complex interrelationships between cognitive tasks, environmental challenges, brain dynamics, and human cognition to not just perform analytics on the system data but to perform analytics on the performance of its human users (Ojeda, Bigdely-Shamlo, & Makeig, 2014). Today's H+C system designers already have a backdoor through which they can design, implement, and iterate the algorithms running systems like *AlphaGo* or MoBI, even without direct Neuralink-like brain implants. They also have at their disposal digital breadcrumbs and bio and neuro feedback data of brain user behavior backed by the explanatory findings from neuro and cognitive sciences. This asymmetrical relationship is further compounded by the fact that system users, unlike system designers, are rarely aware of patterns of their own behavior, let alone speak the same languages neuro and computer scientists and their machines do. To the majority of humans, programming languages such as C++, Python, R, or Julia are less intelligible than the sounds Pager makes while playing *Pong*. If we are to design empowering, just, and socially desirable H+C systems, translation will definitely be needed to bridge the two distinctively different worlds of computational speed and logic and the co-evolved, embodied, social and conscious human cognition. So far, the translation necessary for simple interactive programs of personal and mobile computers has been fairly easily handled by experts in human–computer interaction (HCI) and user experience (UX) design. The emerging world of media environments predicated on synthetically designed intelligence capable of neurofeedback, machine learning, predictive analytics, natural language processing, and even trained "rationality" exceeding that of master Go players will make this task a lot more complicated. This immersive future of media is not science fiction; it is the new order of things emerging from the present around us today. Computational neuroscience and direct brain–computer interfaces add even more consequential building blocks to the immersive domain moving us toward the ever-increasing symbiosis between humans and computers. The horseless carriage era of the Metaverse has already begun.

The Birth of a New Domain

As of early 2020s, virtual reality (VR) headsets were still being sold mostly to early adopters, and gamers. There has been a gradual but narrow industrial adoption of augmented reality (AR) in the areas of product design and equipment maintenance. Likewise, we can see a slow but consistent growth in the application of VR in training and skills development. Increasingly, broadcasters, film studios, and cultural institutions are beginning to explore the use of VR, AR, and mixed reality (MR) experiences as ancillary to their core offerings. In the context of the early 2020s, immersion in all of its forms and applications is still something novel, something experimental, and still lacking formal standardization like the one offered by the W3C to define application development of interactive experiences on the Open Web Platform. But even though immersive media constitutes only a small part of mainstream media consumption, there is consensus among the HCI community, entrepreneurs, and investors that this time we are truly on the cusp of a dramatically ramped up symbiosis between humans and computers, commonly referred to as extended reality (XR), immersive media, or bio-augmentation. The next emerging digital medium is a yet unsettled mix of VR, MR, AR, haptics, holograms, and other constantly expanding immersive tools that augment, enhance, and extend the human nervous system. The immersive, embodied, and intellect-augmenting allure of XR promises a more intuitive relationship between the real and virtual worlds unlike anything previously experienced in any new medium. VR goggles already allow surgeons to step inside 3D models of a patients' brains, in order to perform remote brain surgery and insert microelectrode brain implants thinner than a human hair with maximum precision (Accenture, 2018). Immersive tools enable healthcare professionals to place their patients into customized digital worlds – simulated environments in which they learn to deal with some of the most impenetrable psychic conditions, such as anxiety disorders, psychoses, attention deficit hyperactivity disorder (ADHD), pain, and post-traumatic stress disorder (PTSD) (Accenture, 2018).

Economist, and complexity theorist W. Brian Arthur, suggests that while we might think of a single technology as doing a specific job and achieving a particular human goal, a domain is a broader concept that exists as a set of engineering practices as well as an entire toolbox of useful components engineers can draw on. A single technology might define a single type of product, or a process, but a domain contains an entire constellation of mutually supporting technologies which can define an entire industry. Domains are not invented overnight. They emerge piece by piece from their individual parts. Individual computers might empower their owners and make them more efficient. A domain, such as the digital technologies as a whole, on the other hand, can give impetus to a whole new, disruptive economy that can in time be transmuted into new economic, social, and even political power. The appearance of a new domain constitutes the technologically enabled action potential described by Arthur's Santa Fe Institute colleague Stuart Kauffman as the adjacent possible. The size and impact of what transformations can be enabled by the domain's world constitutes that domain's power. Arthur suggests that the most significant innovations in history are not

improvements in a given technology but entirely new "domainings." Disruptive innovation process is not a parade of random inventions followed by subsequent adoptions by the users. Seen from a wider perspective, innovation is a constant re-expressing or re-domaining of core human needs, such as the desire to communicate, ship goods, be transported to exotic locations, or to solve health-related problems, all accomplished within the new worlds of the possible. The birth of a new domain is a process marked by the gradual arrival of emergent signals from the field, which are often missed or ignored by those who depend on the old paradigms for their worldview, wealth and power. Those who wait for a single momentous "big bang" event are usually late to the party. Pokémon *Go*, which back in 2016 sent people of all ages out in the streets, parks, and back alleys looking for virtual characters, was one emergent signal to indicate that something new was furiously being worked on in the academic and corporate labs. Tech giants such as Google, Microsoft, and Apple are busy conducting original research, filing patents, and purchasing XR-focused companies in search of new product categories which will immerse users within advanced computing systems. Ever the strategic player, Mark Zuckerberg who spent billions to acquire Oculus Rift is a firm believer in the inevitability of immersive augmentation. Companies like Caterpillar and Ford are already using AR to train their workers and design their products. Retailers like Sephora offer virtual mirrors to customers who can try make up on their faces using mobile phones. Conversational AI has become a regular feature of both the consumer and enterprise applications. Strategic harnessing of the hidden and ever-increasing power and complexity of algorithmic computation behind these systems is one part of the challenge of designing immersive H+C media environments. Together with advanced computation and 5G networks, immersive media are a critical piece of a massive shift, which is already reshaping humanity's social, cultural, and economic structures, widely seen as the fourth industrial revolution.

New domains bring with them massive transformations not only in how they let us address our core needs but how they restructure our societies. Each transformation propels new companies to greatness and discards the formerly great market leaders into the dustbin of history, as graphical user interface (GUI) obliterated the top software companies of the DOS era. The first symbiotic human–computer transformation occurred when scientists started using strings of characters to send commands to mainframe computers. The licensed MS-DOS operating system allowed the computer industry's giant IBM to bring personal computing to a wider, however, specialized audience of knowledge workers. The new users no longer needed engineers in lab coats working in clean rooms to carry on their daily HCI. GUI created by XEROX's PARC lab and popularized by Apple's Macintosh followed by Microsoft's Windows allowed even more general users to interact with personal computers via windows, icons, menus, and pointing devices (WIMP) such as a mouse or a trackpad. GUI was an essential gateway to the world wide web and later cloud computing hosted on systems that allowed everyone to connect to everyone else digitally. Apple spurred the next symbiotic human–computer transformation in 2007 by elegantly packaging of all of the necessary ingredients afforded by the just waiting to emerge smartphone domain.

The iPhone and Android smartphones added mobility to networked personal computing and a sensory dimension of touch to the primary interface.

The XR transformation will move computing technology from what we carry to what we wear, to what we implant, to the environments we immerse ourselves in, effectively bringing us ever closer to symbiotically linking the human nervous system with advanced computer systems. While the previous HCI paradigm was all about the interface that allowed interaction between computer technology and people, the immersion paradigm will be focused on a creation of embodied, multisensory, immersive experiences. Our user interfaces are already moving from screens we touch to virtual environments, which offer feedback we can sense with up to eight sensory channels. The even more significant change is being precipitated by the growing field of neurotechnology, whose expressed goal is to directly "wire up" human nervous systems to machines with brain–machine interfaces. The technical components such as electrodes, sensors, intelligent prostheses will allow immersive systems closed-loop interactions of readout and stimulation that captures and feeds back signals from the brain "translating" them into machine language control commands, and back. Such brain–machine interfaces will serve as gateways for not just single users but user collectives to access advanced computation to problem-solve and make decisions faster and more accurately than any human brain can on its own (Müller & Rotter, 2017).

Enabling technological domains is only one part of the story of transformational change. Fully manifested transformations are always social in nature. The cultural imperative of XR is borne out of AR conferences that mix industry and research experts, HoloLens hackathons crowded by hungry young hackers, and consumer electronics shows such as CES, where excited gamers wait in lines to try on the newest VR headsets such as Oculus Rift or HTC Vive. These emergent signals suggest that the immersive media imperative is a real dinosaur egg waiting to expand into a fundamental transformation, which will blur the lines between what is real and what is a computer-generated, immersively mediated artificial projection.

The Birth of a New Realm

The emergence of XR does not just signal the birth of a new domain; it much more softly announces the arrival of a new realm. By the middle of the nineteenth century, our scientific evolution of knowledge brought us to the understanding that if the new data do not fit our accepted model of reality, then we must reorganize and reorder our model so the new data can lawfully fit within it. We have learned that old ways of thinking must bow to new facts. Lawrence LeShan and Henry Margenau argue that in the light of insights gleaned from the phenomena in the probabilistic micro and relativistic macrocosmic realms of science, we can now no longer assume that a single model, a single theory, or one single realm can explain all of reality. Instead, they suggest, we should consider the parallel existence of multiple realities representing multiple states of consciousness. These separate realms can deal with the same phenomena but with entirely different conceptions, observables, laws, languages, goals, and definition of how reality works. The perfectly reasonable schema from one realm can become a powerful prejudicial force in another.

What makes human+computer augmentation a new realm in addition to being a new domain is the fact that H+C systems require coordination of knowledge from vastly different knowledge paradigms, which currently do not agree on a single definition of such core concepts as mind, intelligence, and consciousness.

With the demonstrated potential desirability for both industrial and consumer applications, investments will continue to be made which will result in both the gradual improvements and the breakthroughs in technology to make XR both feasible and viable as the next medium. This book is not about the technological or economic challenges of immersion. It is a strategic design argument about the emergence of not just a new domain but a new realm, and the easy to miss issues of purpose and consequences of creating an unprecedented, massively rhetorical medium, which will symbiotically link humans to advanced computation. Entering the age of advanced AI capable of absorbing human actors as objects in vast sociotechnical networks forces us to switch the discussion from creating individual HCI to the conversation about designing purposeful human+computer networks whose ecology and purpose are far more critical and consequential than any other single dimension, such as the individual interactions within them. A quick scan of the research and investment landscape shows us that immersive human+computer systems are coming. What XR shares with any new technological domain or new scientific realm is the need for a vantage point to give us a clear perspective on what this new socioeconomic force will do to us, or how we can design it to increase rather than downgrade our well-being. We need to fully understand all the critical premises requisite for building immersive H+C systems to strategically leverage their power for economic, social, cultural, political, or even existential human purposes.

Designing XR: A Cautious Prometheus

A prominent media and augmentation researcher standing on the stage of an XR-themed conference taking place at the top of the MIT Media Lab passionately argues why mobile digital tools are hurting us. She cites research, which suggests that smartphone use may lead to depression and anxiety in university students. Mobile phones have been found to have detrimental effects on human cognitive abilities, motivation, emotional regulation, self-confidence, and creativity. What is the proposed solution to all of these problems offered by the digital inventors? The community argues for moving further into the immersive world of digital media, this time with the category known as Wearable Cognitive Enhancements. As a long-time admirer of this particular researcher and the research work done at the Media Lab in general, I reflect on this proposal with a sense of puzzlement. How can the most brilliant inventors, despite their best intentions, promise us transcendence but end up serving us anxiety, depression, and distraction? This is not a new question but an echo of Einstein's challenge to Caltech engineering students in his 1931 address, when he asked: Why does applied science, whose focus on efficiency can save us effort, and which should make life easier, end up bringing us "so little happiness?" (Gray, 1975, p. 8).

Bruno Latour refers to the role designers play in society as that of a cautious Prometheus. He argues that the recent expansion of the concept and the

application of design can be thought of as a post-Promethean theory of action (Latour, 2012). Latour attaches five connotations to the concept of design as this new approach to taking action. The first one is humility. The second one involves attentiveness to details. The third suggests that the task of design always concerns meaning. Latour's fourth connotation proposes that design is remedial, which means that it involves an iterative process of improving something that might already exist – an act of re-definition and re-design. In the last connotation, Latour argues that design involves an ethical dimension of judgment. To Latour, a designer is a Prometheus who still steals fire from heaven but does so in a much more deliberate and purposeful manner. Making decisions under conditions of uncertainty is not only the essence of innovation but also the core of design problem-solving. What we know for certain is that all human interventions are followed by unintended consequences. Perhaps because of the years of hype surrounding VR and AI we have become desensitized to the accelerated progress that is being made in the research labs all over the world. Strategic consultancy Accenture asserts that along with XR's incredible promise of blurring of physical and virtual boundaries, the medium also presents new and severely underexplored risks, which urgently demand new questions around the issues of evidence-based reality, trust, power, and mental health. Researchers at Accenture argue that the systems-level, power, and immersive intimacy underlying XR tools can usher in a new and potentially catastrophic level of risk and danger predicated on three factors: (1) manipulation of data that is profoundly connected with personal identity, intimate behaviors, and thoughts; (2) not yet fully understood, direct connections to human mental faculties and their perceptions of reality; and (3) the distributed power and speed of advanced digital tools, making the proliferation of mistakes easy and their reversal incredibly hard (Accenture, 2018).

Like the framers of the American constitution – the ongoing experiment in participatory democracy – Einstein urged all aspiring change makers to create systems that address the core needs and capabilities of real, not imaginary humans. The creators of sociotechnical networks need to keep in mind that humans are much more fragile and less durable than the technologies surrounding them. We know that many media technology users will experience some form of mental suffering in their lifetime, which will involve either difficulties in regulating their own mental states and emotions, trouble in creating harmonious relationships with others, or a combination of both. In a powerfully insightful book titled *The Body Keeps the Score*, Bessel van der Kolk a psychiatrist focused on post-traumatic stress research (PTSD) reports that millions of ordinary people are crippled emotionally by experiencing trauma of a violent crime, sexual assault, and serving or living in war zones. Such traumatic stresses inhibit body's natural interoceptive awareness (IA) process to disconnect individuals from both their own bodies and healthy social interactions.[2] In an average year millions of average drivers commit

[2]IA refers to a sensory awareness that originates from within the body's physiological state. I will cover in detail the critical to experience design phenomenon of interoception in Chapter 2.

potentially life-threatening DUI, texting, and Pokémon-chasing offenses. About 20 percent of Americans who experience depression, or anxiety disorders also deal with substance abuse (Addiction Center, 2020). Emotional imbalance is not the only challenge facing humanity. For reasons that we are only beginning to understand, humans do not only struggle with addiction, but also with the ability to think critically, or engage in long-term thinking and decision-making. Van der Kolk argues that our minds are often run by "inner managers" who "carry huge burdens of responsibility" and "who are usually in over their heads" in performing such tasks (van der Kolk, 2014, p. 287). A sizeable and yet unmeasured percentage of humans use particular mental models and cognitive, decision-making strategies based not on the hypothetico-deductive logic of science but on a narrative meaning-making mode of stories, gossip, and conspiracy theories to guide their decisions. A survey conducted in 2016 found that 41 percent of all Americans believed that global warming was a falsehood concocted by untrustworthy scientific elites (Uscinski & Olivella, 2017). Recent findings from neuroscience suggest that psychologically traumatized people, regardless of the nature of their trauma, exhibit impaired day-to-day information processing. When presented with new information, their brain-wave patterns are characterized by a shallow depth and lack of coordination consistent with the behavioral patterns of those whose brains are not organized to pay attention or focus. As a consequence, such individuals have trouble fully engaging in the present moment and learning from experience (van der Kolk, 2014).

I do not bring up these sobering facts for shock value. Strategic design thinkers are the kind of people who would rather light up a candle than curse the darkness even though they are perfectly aware of how dark the darkness might be. A reminder that human+computer systems are not going to be developed for universally happy, emotionally balanced, strictly rational, idealized people we imagine ourselves to be, is a necessary prelude to the real job of building a desirable XR medium. These powerfully rhetorical systems will become immersive environments, which will shape the lives of average humans, many of whom are already struggling with psychological issues, are dependent on alcohol, opioids, social validation, and other shortcuts to oblivion such as gambling, to help them to cope with the challenges of everyday life. The real people who will soon be immersed in the human+computer systems are the real flesh, blood, and emotion humans we know from our daily interactions in traffic, from news reports and from sobering research on social media consumption. In the face of the reality of human fragility, the law of unintended consequences compels us to ask: What can go wrong? Will XR systems heal their users and our society as a whole, or will they cause further strife, suffering, and division?

Ushering the rhetorical power of XR is a trans-disciplinary task requiring concerted efforts between researchers from very diverse fields. Our ability to tap advanced computation needs to be balanced and informed by the emerging knowledge of the human mind, brain, and the nervous system we gain from modern cognitive sciences, by the intuitive wisdom we glean from the masters of trauma and psychotherapy, and by the empathic insights we gain from our evolutionary ability to step into the lives of other human beings. Purposeful