Evolutionary Wearables

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Abstract. Early development of Wearables emerged through professional silos of computer science and fashion design and resulted in two distinct branches typified by an aesthetic approach from fashion and by a function and ocular-centric approach from science. Attempts at collaboration between these silos tended to bring the two methodologies into conflict and often produced awkward results. Computer science is a field traditionally dominated by men and fashion design by women, so what is the future for wearable's evolution as professions are becoming less gendered? In 2009 the author established the Wearables Lab in Hong Kong. In 2012 and 2014 the Wearables Lab hosted research initiatives specifically focused on haptic interfaces where wearables are viewed as an interface between the body and the world. This article maps key themes of this research leading to speculative designs for evolutionary wearables.

Keywords: Wearables · Haptic interface Sunaptic sculpture Cyborganic Cybernetics Systems thinking Neganthropocene Gender equality

1 Introduction

The early development in Wearables emerged through professional silos of both computer science and fashion design and resulted in two distinct branches typified by an aesthetic approach from fashion often using light in garments, and by a function-led approach from science with most research spent on ocular centric devises – the wearable head mounted computers by Steve Mann for example. The methodology of the scientist is based on truth, finding the most eloquent solutions and proving their validity, where as the designer/artist finds a solution successful if it opens questions, or dialogue rather than definitive answers. Hence attempts at collaboration between these silos tended to bring the two methodologies into conflict and often produced awkward results. Computer science is a field traditionally dominated by men and fashion design by women, so what is the future for Wearable's evolution as professions are becoming less gendered?

Influencing Wearable's evolution has been its miniaturization and lower costs for higher performance widgets, effectively moving design from corporate and university research into the hands of makers. The rise in a community commons approach to knowledge has led to incredible innovation in wearable design. Since 2009 the Wearables Lab at the Academy of Visual Arts in Hong Kong has been dedicated to exploring and developing Wearables. The success of the Wearables Lab is in part due to the fact that it has not grown from a fashion or computer science department but the

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creative space of an art school resulting in critical rather than affirmative design solutions [1]. In 2012 and 2014 the Wearables Lab hosted research initiatives focused on haptic interfaces [2]. This article maps key themes of the author's research into Wearables leading to a speculative design future of evolutionary Wearables.

2 Women in Design, User Experience and Usability

An invitation to contribute to a session on Women in Design, User Experience and Usability at HCI 2015 is a privileged opportunity to share research, at the same time it was with some trepidation that the author approached the gendered title, preferring not to illuminate gender and focus on research. Having said this, it is within research itself, embedded in the language of our recorded history, that gender inequality is firmly entrenched. The pay gap between men and women is still evident although it has been lessening for decades. A recent study from Harvard University [3] looked at the gap and found that it gets larger for women toward the middle of their careers. Women are more likely to take time off to raise a family than men, and the gap shrinks again after the child-rearing years. Different industries are less flexible than others. In corporate, law and financial sectors the gap is much greater in mid-career than in the information technology (IT) industry, health and science where more flexibility has been embraced and therefore it is easier to work part-time or from home to accommodate raising a family. "Information and communication technology (ICT) and the science, engineering and technology (SET) sectors remain dominated by men in almost all European states" [4]. In the game industry "Women are underrepresented in core creation and development roles, such as coders, designers and artists. []…It would appear that occupational segregation still persists in this relatively new, male dominated industry" [5].

In the UK the Equal Opportunities Commission (EOC) found that occupational segregation was one of the strongest influences on youth when choosing their career path and that they focused on areas where their gender is represented [6]. Stereotypes prevail – considering that the visual arts and fashion industries are areas that are predominantly populated by women in tertiary education, there is a clear disparity in the fact that the big names in these industries are still predominantly male. On a more positive note many countries have seen an increase in woman participating in the workforce. One of the best examples is in the Netherlands where women's participation in the workforce grew from 31 % in 1975 to 69 % in 2006 [7]. Women are becoming more integrated in the workforce but are still behind in terms of full time employment and wage levels. Every culture and country has different attitudes and laws, and although ICT may offer greater flexibility that can help accommodate the schedules of parenting, we can not claim the issue of gender inequality does not still exist. In India where the IT service industry is enormous the wage discrepancy between men and women is 60 %. Women are viewed as second-class citizens. Men still hold the balance of power.

Karl Marx's belief was that only if the family unit was made redundant, so that women and families were not dependent on men as care givers, could there be equality between the sexes where men and women come together truly of free will without need.

Childcare should be a community concern. The individualization fostered under the prevailing globally dominant neo-liberal capitalism makes equality impossible in this sense. Kant's view is that we are in a state of constant oscillation between our desire for self-sufficiency and the need for others. Social groups form from the tension between competition for self-gain and the solidarity of the group advantage [7]. The current generation is one of the first in history who can survive individually and afford to live independently. This is a product of wealthy societies and the technological age we live in [8]. Many people choose to live alone, but perhaps rather than blind individualism, we would gain more by imagining societies that value reciprocity and empathy as it is through community that the body politic speaks. We need to embrace equality between the sexes but also find equality between all living beings; humanities egocentrism has led to the current environmental crisis. Communism and capitalism are presented as the only two variables and yet neither seems to be working. We need to search for an alternative – a third space – and this is where critical thinking, imagination and creativity are vital. Human Computer Interaction (HCI) is part of our natural techno-genesis and it opens new ways to perceive one's self and the world around us that can help us in this endeavor.

Creativity requires diversity and imagination; equality does not imply androgyny and it follows that we should embrace our differences as it provides greater diversity. In 1973 Schein outlined feminine traits including kindness, warmth, sympathy and selflessness, and masculine ones such as rationality, aggression, competitiveness, forcefulness, decisiveness, strength, independence and self-confidence. Are these traits socially constructed, stereotypes or genetic? Physiologically the left and right hemispheres of the brain compliment each other as thoughts move back and forth between them. The left hemisphere is analytical and logical and the right is more holistic and artistic [9]. The left is more dominant, but they work together keeping each other in check to help us make the right decisions. The corpus callosum is a shaft of nerves connecting the two halves. The female callosum is frequently larger than in men [10]. Specifically the posterior portion of the corpus callosum, called the splenium is larger than in males. "This finding could be related to possible gender differences in the degree of lateralization for visuospatial functions." [11]. This could explain the widely held belief that women are better at multi-tasking than men. Do women view the world differently? The neuroscientist David Eagleman [12] found that 15 % of women possess a fourth type of color photoreceptor that enables them to discriminate between colors that look identical to the rest of us who have only three.

The historical development of (HCI) has focused on ocular-centric, screen-based interaction. This is in line with the Cartesian approach across western theory, which since the enlightenment has attempted to separate fact from mysticism and led to the belief that the mind is equated with knowledge and intelligence and the body with nature. The result is that current wearable technology design practices represent a reductionist view of human capacity. The democratization of technology in recent years has opened the field of HCI to other methodologies and knowledge fields such as the arts and humanities, for example social science, anthropology and ethnography. HCI is an inherently interdisciplinary field. Discourse around design is changing, away from purely functional attributes and technical capacities toward a multisensory materiality [13] to develop a connoisseurship of somasethetic qualities [14].

3 Systems Thinking

Systems-thinking is the logic that defines the information age. We live in the era of cybernetics and the systemic organization of information enable collective forms of intelligence, these cybernetic methods of collective intelligence are transforming the way we think and will be key in defining our future. The interface itself is an aesthetic form to be crafted, not just used as a tool for production. The interface as an aesthetic form provides us with a way to redefine and view our contemporary reality [15]. Technology, conditions the way we think as individuals and as collectives.

For Marx value is expressed as labor power, for Joseph Beuys value comes from 'creativity'. The focus of "Joseph Beuys aesthetic is embedded in the idea of alignment, perpetuation, and addition. Rather than advocating intervention, he believed it was the artist's task to discover connections and expand upon them" [16]. Beuys promulgated the term 'social sculpture' which identifies his belief in the social value of creativity. Future Wearables will engage creativity to combine aesthetic and kinesthetic with interface and experience design, as Wearables evolve into more than worn objects of desire but extensions of the body and tools of interactivity. Wearables will embody technical systems that will undeniably condition individual and collective thinking, as have technologies of the past [17]. Beuys work signified a turn in attitude away from objects as the locus of meaning of an artwork, to thinking about what operates between them. Bourriaud's notion of relational aesthetics grew in popularity in the 2000's using metaphors of 'post-production' and 'the artist as Deejay' to further define the role of the artist as a modeler of activity, directing and distributing flows of information [18]. Susan Elizabeth Ryan's definition of Wearables is useful here. She describes, "dress acts" as "hybrid acts of communication in which the behavior of wearing is bound up with the materiality of garments and devices—and focuses on the use of digital technology as part of such systems of meaning" [19].

3.1 Sunaptic Sculpture

The term Sunaptic Sculpture [20] emerged in the authors work in 2003, a neologism to distinguish it from its predecessors predominantly though not exclusively 'social sculpture' and 'relational aesthetics'. At this time her research concerned arts status as an object and established arts practice based in communication and relationships. In line with Søren Pold's appeal to consider the interface as an aesthetic form, Sunaptic sculpture describes artwork that is inclusive of social systems in the Beuysian sense but may equally operate at the level of micro or macro systems (inside or outside the body). The term acknowledges interconnectedness, it accommodates both digital and analogue and promulgates the affordances of haptic interfaces as spaces for creativity. Sunaptic sculpture describes a contemporary interface where "Aesthetics can offer a critical reflection on the issue of representation: on how the representation is related to the material through which it is carried out, and to how it is related to the cultural context in which it functions" [21]. This is design that encourages creativity, inspires intelligence and promotes curiosity and enquiry.

A trans-disciplinary approach in an interconnected world is the natural form for interaction design. To further investigate the future possibilities for Wearables the author has led two intensive trans-disciplinary, intercultural research workshops. Haptic InterFace (HIF) 2012 and 2014 exploring the themes of 'praxis' (2012) and 'designing experience' (2014). Twenty professionals and creative thinkers from many backgrounds and cultures come together for ten-days of hands-on experimentation. HIF participants 2014 were Sara Adhitya urban design, Meiyi Cheung fashion design, Emma Cooper architecture, Beck Davis product design, Jared Donovan interaction design, Raune Frankjaer inter-media design, Daniel Gilgen spatial communication and physical computing, Rafael Gomez industrial design, Dave Hrymkiw robotics, Erina Kashihara light Wearables, Tobias Klein architecture and art, Zoe Mahony fashion design, Kit Messham-Muir art theory, Ann Morrison interaction design and installation art, Roger Ng mathematics, patternmaking and philosophy, Jake Oliver-Fishman art, Elizabeth Shaw jewelry. Participants collaborated on prototypes such as a gauntlet to analyze the tremor of Parkinson's disease and a tremor inspired series of jewelry; biodress; contiguous living systems; a gesture recognition aid for interactive teaching; version two of the sensate vest; self lighting umbrellas that leverage small network communication fields to generate visual sequencing patterns across crowd environments; and a theatrical collar that communicates by fanning out in reaction to movement. HIF participants collaborate on prototypes and the results are exhibited internationally. The 2014 prototypes were exhibited in Hong Kong and the final projects are destined for exhibition in Brisbane in 2015.

4 Evolutionary Wearables

4.1 Cyborganic

The first generation cyberneticists Norbert Wiener, Julian Bigelow, Arturo Rosenblueth, Gregory Bateson, Margaret Mead and Warren McCulloch described their core theme of interest as – circular, causal and feedback mechanisms in biological and social systems. Javier Livas describes Cybernetics as a prodigious super-science of interconnectedness that will save the planet from reductionist, authoritarian, corrupt, anti-democratic, or just plain stupid governance. More than a decade after Wiener published his book *Cybernetics: Or Control and Communication in the Animal and the Machine* (1950) [22] Manfred Clynes and Nathan S. Kline started using the term Cyborg (1960) [23]. The dystopian images that science fiction movies have propagated about the cyborg promulgate fear of the mechanic and are bias toward it being evil. Today anything with 'cyber' in the title is treated as synonymous with 'computer'. Although cybernetics is the science of the information age (and the tools of that age are computers), cybernetics itself is a much broader topic. To distinguish a more positive approach and regain an equal focus on the organic aspect of cybernetic research in this area, the author and her collaborators at the Wearables Lab use another variation: cyborganic.

Bio-dress (Fig. 1) seeks to foster empathetic relationships between plants and humans by mirroring state changes in a specific plant on the body through a wearable

Fig. 1. Biodress, Sara Adhitya, Beck Davis, Raune Frankjaer, Zoe Mahony and Tricia Flanagan. Photo: Beck Davis.

tech garment. Thermo-chromic paints combined with memory wire, create movement and color-change in the leaf inspired textile surface of the garment in reaction to EEG output from the plant. Steam pleated organza on the shoulder areas appear to breathe in reaction to the air quality reading.

4.2 Egocentric to Eco-Centric

We live in the anthropocene, a term yet to be sanctified by the Statigraphy Commission of the Geological Society, but none-the-less a powerful recognition of an epoch where human activity (as pervasive as natural forces) has driven global ecological change. The typical worldview of the anthropocene is that it is an ecological issue. Its main opposition is from the perspective of an economic worldview that predicts financial crisis hinged on the impact of most of the suggestions made by ecologists. What is called for is a shift in our perception from egocentric (where we see ourselves as something other than nature), to an eco-centric perception where we are intrinsically interconnected. Trans-disciplinary approaches must be adopted. "…trans-disciplinary is impelled by external conditions but also by the conviction that disciplines do not have proprietary rights over their domains. […] Ecological thought is changing the ways in which our practices might operate in the future" [24]. Acknowledging the anthropocene shifts our thinking about Wearables away from standalone products to ones that are intrinsically connected to the processes and actions that surround them, to imagine objects in terms of ecologies and lifecycles. To think about interconnectedness in this way makes matter a dynamic, transformative proposition and this is where approaches like Synaptic Sculpture are useful as they aim to sculpt matter in connection with thought and data.

Post-colonial theory, has long been discussing the Other taken to mean any minority to the majority, and it acknowledges that history has been written predominantly from one perspective (white western male). Acknowledging other perspectives has involved a process of rewriting history, first from a feminist perspective and then

gradually incorporating ethnic and religious groups. This is an on-going process, with the latest iteration including non-human life. This reinterpretation of our culture is not on the grounds of a moral imperative to be inclusive, rather an acknowledgement of the networks that sustain us and the implications of maintaining a culturally limited perspective, one that was "fuelled by the accelerated use of carbon-based energy to prioritize human life at the expense of other forms of life treated as 'natural resources" [25].

4.3 Ecosystems and Evolutionary Wearables

Future cities will be configurations of intelligent ambient spaces, where physical infrastructure as well as what we wear, is embedded with sensing and computational technology as invisible as electricity is today [26].

An interesting way that we can challenge our human-centric view of the world is to subvert our methodologies and imagine the body as a floating wetland system and our cities as bodies [27]. The future of wearable technology lies at the intersection of biotechnology, nanotechnology and materials science [28]. These fields are opening up new worlds of discovery, such as dissolving technology that can be used in biomedical applications that do their job and then disappear, and electronic wetware [29] or green consumer electronics that can safely cycle through the ecosystem.

Robots are replacing jobs heralding mass unemployment, new economic climates need to be imagined that are not based on old work models but new kinds of systems of value. "In this regard the early Marx's emphasis on the radical and revolutionary function of Bildung (communities of collective self-learning) comes to define non-statist and autonomous forms of productive, intellectual and creative community" [30]. Our ability to imagine the future enables us to design for the future. "For the first few hundred million years after their initial appearance on the planet, our brains were stuck in the permanent present, and most brains still are today. But not yours and mine, because two or three million years ago our ancestors began a great escape from the here and now" [31]. Theoretical quantum physics proposes that the great escape from our liminal perception may have only just begun. Our relationship with the world is evolving from one in which historically we were hunter gatherers 'using' the products of the world; then we learnt to harness the energy in production of materials, 'controlling the natural world' around us through industrialization; and now there is a need for us to imagine the future, to 'design and craft our own world' [32]. Our task is to redefine value in terms of our economy, we have to reimagine the Internet as a generous interface rather than a space of capital colonization and hyper-marketing and at the interface between the body and the world we must create evolutionary Wearables for the Neganthropocene.

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