Cyborg unplugged: Some ecological issues of wearable computing and personal safety devices *

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Abstract

An historical context is provided for a recent unfortunate incident that has brought to light many of the important fundamental issues associated with being part human, and part machine, in an era of terrorist-induced paranioa. This paper outlines the author's experience regarding the attachment of computer systems to the body, and some of the ethnomethodological insights gained from being with the wearable computer in many aspects of daily life for more than 20 years, while traveling to many different countries around the world. The insights presented in this paper will hopefully inform the reader of fundamental issues in wearable computing that will become important when wearable computing weaves its way into the fabric of everyday living.

Keywords Security, Public safety, Personal safety, Accountability, Mediated Reality, Human Rights, Wearable Computing, Implantables, Electrocardiogram (ECG), Electrovisuogram (EVG)

1 Mediated Reality: In search of new ways of experiencing the world

Mediated Reality refers to artificial modification of human perception by way of devices for augmenting[1], deliberately diminishing, and more generally, for otherwise altering sensory input. One of the earliest and most important contributions to the field of Mediated Reality was the work of George Sratton who built and wore eyewear made from two lenses of equal focal length, spaced two focal lengths apart. His eyewear was basically an inverting telescope with unity magnification, so that he saw the world upside-down. Although his was a very simple example of a mediated reality environment, an important element of Stratton's work was its ecological validity, namely that he wore the device in his ordinary everyday life. If performed on other subjects, such work might far outstrip the ability of university ethics committees, the protocols required of "informed consent", and the tendency for many academics to work in labs, controlled spaces, and existing literature.

Unlike traditional scientific experiments that take place in a controlled lab-like setting (and therefore do not always translate well into the real world), Stratton's approach required a continuous rather than intermittent committment. For example, he would remove the eyewear only to bathe or sleep, and he even kept his eyes closed during bathing, to ensure that no unmediated light from the outside world could get into his eyes directly [2][3]. This work involved a committment on his part, to devote his very existence – his personal life – to science. Others followed in Stratton's footsteps, living day-to-day life (eating, swimming, cycling, etc.) through left-right reversing eyeglasses, prisms, and other optics [4][5].

It is well known that controlled laboratory experiments are of great value. However, one must not forget the issue of internal validity versus external validity that gives rise to, for example, various different methodologies embodied in different fields of study (e.g. the psychologists versus the sociologists and anthropologists). More recently, these artificial divisions between various fields of study have been challenged [6].

Stratton captured a certain important human element in his broad seminal work, in which he laid the foundation for others to do carefully controlled experiments to follow up on certain specific elements and hypotheses.

Moreover, his approach was one that breaks down the boundaries between work and play, as well as the boundaries between the laboratory and the real world.

The work of Stratton, Kohler, and Dolezal was focused on mediation of a single sensory input, e.g. vision in particular. Such reality mediators accept visual input, modify the visual information, and then produce

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visual output. However, another class of reality mediator is one that provides synthetic synesthesia, e.g. a Reality Mediator that accepts input of one (or more) sense(s) and translates it to an output by way of one or more other senses. Such a device deliberately induces synesthesia (synesthesia is an empairment[1]. that affects many individuals naturally). Example of such a devices are the vision substitution devices used by the visually impaired.

Such cross-sensory reality mediators may accept input from a totally new sense that is not one of our usual 5 senses (e.g. Leslie Kay's SonicVisioN product which converts sonar to sound [8]), or may simply remap one of our 5 senses to another one (e.g. Peter Meijer's "vOICe" program [9]).

1.1 Computer Mediated Reality

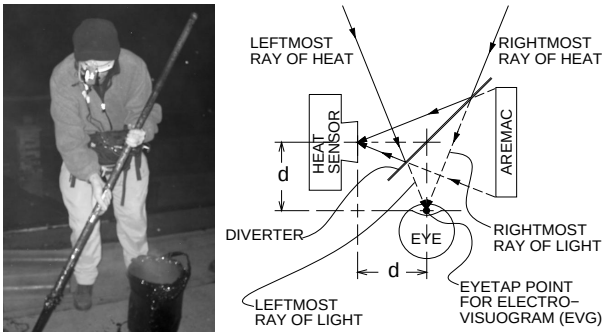
Since the 1970s the has been exploring electronically mediated environments using wearable computers. These explorations in Computer Mediated Reality were an attempt at creating a new way of experiencing the perceptual world, using a variety of different kinds of sensors, transducers, and other wearable devices controlled by a wearable computer [10].

1.2 Practical Applications

Early on, the author recognized the utility of computer mediated perception, such as the ability to see in different spectral bands (Fig. 1) and to share a computer mediated vision with remote experts in real time. (See Fig 2.) This mediation of the senses was not limited to only incoming sensory quantities, but also included wearable ambulatory biofeedback, for example, as a form of computer mediated reality, as well as the shared perception (perceptual collectives) described above. The ambulatory biosensor capture of the author's wearable computer system was not, in itself, new. For example, the late Norman Jeff Holter, a Montana physician, had invented, in 1949, a 75-pound backpack that could record a single channel of electrocardiographic signal, for transmission by radio [11]. What was new about the Computer Mediated Reality was, however, the combination of different sensors in the modification of human perception.

There emerged three broad classes of sensory input for mediated reality:

- internal personal data: that which is sensed from within the body, for example, electrocardiographic



(a) (b)

Figure 1: There was no doubt that Mediated Reality had practical uses. (a) Author (looking down at the mop he is holding) wearing a thermal EyeTap wearable computer system for seeing heat. A bucket of 500 degree asphalt is present in the foreground. (b) Thermal EyeTap principle of operation: Rays of thermal energy that would otherwise pass through the center of projection of the eye (EYE) are diverted by a specially made 45 degree "hot mirror" (DIVERTER) that reflects heat, into a heat sensor. This effectively locates the heat sensor at the center of projection of the eye (EYETAP POINT) to capture an electrovisuogram (EVG). A computer controlled light synthesizer (AREMAC) is controlled by a wearable computer supplied by the EVG to reconstruct these rays of heat as rays of visible light that are each collinear with the corresponding ray of heat. The principal point on the diverter is equidistant to the center of the iris of the eye and the center of projection of the sensor (HEAT SENSOR). (This distance, denoted "d", is called the eyetap distance.) The light synthesizer (AREMAC) is also used to draw on the wearer's retina, under computer program control, to facilitate communication with (including annotation by) a remote roofing expert.

[1]The word "empairment" is used because it is not agreed upon whether synesthesia is an impairment or an empowerment. There are mixed feelings in the community as to whether naturally occuring synesthesia is an asset or a detriment. Cytowic [7] provides a detailed account of synesthesia, building upon his earlier book entitled "The Man Who Tasted Shapes".

(a) (b) (c) (d) (e)

Figure 2: Practical application of collaborative Computer Mediated Reality: (a) First person perspective as captured by the EyeTap device. Author's hands are visible grasping the mop. (b) Mop and hot asphalt as viewed through wearer's right eye. (c) After mopping hot asphalt onto the roof surface, a base sheet is rolled down (bucket of hot asphalt shows as white in the upper right area of the frame). (d) The thermal EyeTap is useful for "seeing through" the top layers of felt or fiberglass, to determine heat flow underneath. (e) The kettle (upper right of frame) shows up as white (approx. 500 degrees) whereas the propane cylinder (bottom of frame) and the propane hose supplying it show up as black, because the cylinder and hose are cold due to the expansion of the propane gas (Joule Thomson effect). The thermal EyeTap was also useful when the kettle caught on fire because of its ability to see through smoke. Kettle fires are easy to extinguish (simply by slamming the lid shut) if the kettle can be seen through the thick black smoke given off by the burning ashphalt.

(ECG) data, electroencephalographic (EEG) data, etc.;

- external personal data: that which is sensed from elsewhere, for example, by tapping into the senses of another member of a sensory collective;

- incoming personal data: that which would have been perceived by the wearer's own senses, in the absence of device, and is instead sensed through the device.

Incoming data and internal data are inextricably intertwined. For example, that which we witness with our eyes may in fact affect our heart, respiration, skin conductivity, and associated physiologically measurable quantities. An eyewitness to a violent murder is likely to show certain electrocardiographic anomalities that can be sensed by a wearable computer [10] to trigger capture of incoming sensory data.

Of the three classes of sensory input, this incoming sensory data exists at the borderline between internal data and external data, and could, in principle, be measured either outside or inside the body. In comparing an external wearable video capture device with a retinal implant, either one may capture a picture of the perpetrator of such a crime. Indeed, it may someday be possible to tap directly into the optic nerve and record an image. At the exact boundary between incoming visual data, and internal visual data, exists the EyeTap device, because it is situated, in its effect, at the exact boundary of the eye. The EyeTap point is neither inside nor outside the eye, but exists exactly at the center of the iris, at the boundary between inside and outside [10]. It is for this reason that a recording from an EyeTap device is known as an electrovisuogram (EVG), and is conceptually related to other signals measured in or on the body, such as the electrooculogram (EOG), ECG, EEG, etc..

There is an interesting historical perspective on the eye as a recording device. The admissibility of photographs as evidence in a court of law was not initially accepted until it was argued that a camera captures a picture much like the retina of a murder victim retains an image of the last scene observed [12].

1.3 Personal Safety Device

The mediated reality device suggests also the possibility of lifelong capture and transmission of personal data, especially the internal and incoming classes of personal data. Capture of the data can allow the wearable computer to function much like the "black box" flight recorder in an aircraft that provides evidence as to why the system failed. For example, video from an electrovisuogram (EVG) can show exactly what was happening during a heart attack, and also what incidents led up to (and might have contributed to) the heart attack. Because the EVG and ECG are time-synchronized, they contribute jointly to an evidence file. Thus the wearable computer functions as a life recorder.

To protect the data of the "black box" life recorder from accidental or malicous damage, the data has generally been transmitted and recorded at remote locations. Early embodiments of the device were equipped with separate data transmitting and receiving antennas [13]. Additionally, for example, transmission of synchronized timestamped ECG and EVG data allows a remote physician to observe not only the electrical heart activity, but also the visual environment, which

may afford clues as to irregularities such as ECG arrhythmia, so that a heart attack could be prevented. Such preventative health care is an important element of a recent 15 million dollar grant jointly held by the author and nine other investigators, and forms the basis for the recently created Global eHealth Center (4th floor of the Toronto General Hospital).

2 Mediated Reality as visual art

Stepping beyond the obvious practical uses of Computer Mediated Reality, there is a more existential motivation regarding how we, as humans, are able to choose the manner in which we define ourselves [13]. It is, through this ability to choose certain elements of our own destiny, that give rise to self-determination.

2.1 Memory versus actual experience

A common criticism of simple recording and capture devices is perhaps best captured by Don Norman:

> The technologies for recording events lead to a curious result... Vicarious experience, even for those who were there. In this context "vicarious" means to experience an event through the eyes (or the recording device) of another. Yet here we have the real experiencer and the vicarious experiencer being the same person, except that the real experiencer didn't have the original experience because of all the activity involved in recording it for the latter, vicarious experience... we are so busy manipulating, pointing, adjusting, framing, balancing, and preparing that the event disappears... But there is a positive side to the use of recording devices: situations where the device intensifies the experience. Most of the time this takes place only with less sophisticated artifacts: the sketch pad, the painter's canvas... Those who benefit from these intensifying artifacts are usually artists... with these artifacts, the act of recording forces us to look and experience with more intensity and enjoyment than might otherwise be the case.[14]

Indeed, Sontag questioned the reality of photographs by asserting that all photographs are surreal [15] whereas Mitchell questioned the truth in photography [16].

The author's original goal of Computer Mediated Reality was to create a portable wireless sensory environment which, although technically sophisticated, would function more in the spirit of the less sophisticated artifacts such as the artist's sketch pad or painter's canvas to which Norman (a leading HCI researcher and defender of humanstic concerns in the machine–age) refers. This goal of Computer Mediated Reality was to create tools that would intensify and augment sensory experiences, such as the experience of seeing, through the embodiment of a photographically mediated visual experience used in conjunction with tools similar in many ways to the artist's paintbrush and canvas.

In the early 1980s the author was asked to exhibit these computer mediated visual experiences in various art galleries, resulting in a genre of photographic memory characterized by experience intensification. See Fig. 3

3 Cyborg discrimination

By the summer of 1985 the author had built a wearable computer mediated reality system into a jacket, which he wore in much of his day-to-day life. This resulted in what is now (now that "cyborg" is a more common class) thought of by many to have been a form of discrimination.

Discrimination is defined as "treatment or consideration based on class or category rather than individual merit." (www.dictionary.com). There were two elements to this discrimination:

- diffuse discrimination from individuals, either to the outward appearance while wearing the entire system, or the discrimination that remained when the outwardly visible portions were removed, leaving only the permanently attached electrodes, subdermal and dermaplant[2] portions of the apparatus (e.g. with regards to the portions of the apparatus that are permanently attached to the body being seen by others during communal change of clothes for high school gym class, the need to wear a full-body bathing suit to cover dermaplants during swims, or the like);

- official discrimination by representatives of large organizations, allegedly acting on the wishes of the organization. This discrimination pertains the unusual outward appearance of the apparatus, the functionality of the apparatus (evidence capture, live transmission of visual images of the official and the officials establishment, etc.), as well as the inward appearance of the body even when the main portion is removed (permanently attached electrodes, subdermal and dermaplant portions of

[2]Dermaplants refer to devices such as subdermal electrodes, transdermal wound closure, connections on deliberately self-inflicted wounds for purpose of making same, and other devices permanently attached to, on, or below the surface of the skin. The author finds that Dermabond (TM) wound closure material manufactured by Closure Medical is often useful for making, growing, or maintaining dermaplants.

(a) (b) (c)

Figure 3: Living in a computer mediated environment as a new way of seeing the world as visual art (a) A mid 1980s view of a corridor at McMaster University, and (b) of the Mann residence. (c) Computer mediated view of a television placed on an easel at the base of a commonly photographed space, Niagara Falls. Reality once mediated through television, is again mediated through the wearable computer, as a form of social commentary on what is reality.

the apparatus that might become visible in an airport stripsearch room).

The author discovered these various elements of discrimination by accident, simply through the process of living the wearable computing lifestyle. Of the various forms of discrimination, the author could forsee the day when the apparatus would no longer have an unusual appearance, because miniaturization would some day allow all of the apparatus to be implanted (and concealed) within the body. Ten or twenty years later, this vision was to have been realized simply by the miniaturization of the apparatus into what appear like ordinary clothing and eyewear (Fig 4(a)). Moreover, Starner has suggested that wearable computers can be human-powered, so the prospect of widely used fully functional implantables that are also human powered is quite likely [17], rendering discrimination based on outward appearance completely non-existent.

The diffuse discrimination by the masses was also simply seen as a matter of education and acceptance. Thus the fundamentally most important element of discrimination appeared to be the official discrimination based on functionality of the cyborg.

The author began to understand this discrimination throughout the 1970s and early 1980s, as being correlated to the degree of surveillance present in an establishment. It appeared, for example, that the establishments where official discrimination was greatest, where the very same establishments where their use of video surveillance was the greatest.

Therefore the author, through simply a personal desire to live in a computer mediated world, encountered hostilities from paranoid security guards, seemingly afraid of being held accountable. It seemed that

(a) (b)

Figure 4: Evolution from schema to ecological exploration. (a) Over more than 20 years the author's wearable sensory computer mediated reality environment evolved into devices having the appearance of ordinary clothing that can interface to various dermaplanted biosensors, as well as the EyeTap devices [10]. (Pictured here, taken from the roof of the CBC building in Toronto, 35mm feature length motion picture film, Cyberman, http://wearcam.org/cyberman.htm) Thus the remaining discrimination is primarily associated with the function rather than the appearance of the apparatus. (b) An ethnomethodological approach to understanding the discrimination involved placement of the most-feared element of the Reality Mediator, namely the evidence-gathering capabilities, into a completely different context. Although this device offers little or no important features of Reality Mediator, it served to illustrate how the objectionable (discriminated-against) features of the device could be made acceptable to authority.

the very people who pointed cameras at citizens were the ones who were most afraid of cameras pointed at them by a citizen.

The harsh and hostile discrimination against the author, by officials, security guards, and representatives of large organizations led the author to begin thinking mainly about official discrimination against cyborg functionality. In order to learn from these hostilities, the author wished to understand this discrimination by applying the scientific method, within an ethnomethodological sense. For example, of the various places that the author was most strongly prohibited from entering, the worst establishments were places like maffia run gambling casinos, money laundering pawnshops, jewellery stores believed to be involved in jewellery smuggling, and the like. Such organizations were ironically the places where surveillance cameras (in those days many of the cameras used photographic film rather than videotape) were abundant.

A cowardly cyborg might simply stay away from jewellery stores and pawnshops, but a courageous ethnomethodologist would want to try and understand the reasoning behind such organizational discrimination. Therefore, in the spirit of ecological science, the author constructed various forms of cyborg jewellery, in order to test an hypothesis, namely that jewellery store owners would welcome and appreciate innovative jewellery. Thus the author built Personal Safety Devices (PSDs) into jewellery (Fig. 4(b)). The reaction was quite surprising. Even when blatantly told that the devices contained a camera, jewellery store and pawnshop owners did not object to the device in any way. Although the device does not allow the wearer to live in a computer mediated world, it captures all the elements of paranoia that the officials most feared, e.g. primarily a video captured record of their establishment and activities. Yet they accepted this alternative form of the device without complaint, largely because it so nicely landed within **their** genre. Indeed, many of the jewellery store owners wanted to commercialize and sell the product pictured in Fig. 4(b).

3.1 The cyborg as a witness for global justice in a hostile world

There are numerous world events in which witnessing had a significant effect: the 1992 'Rodney King' video in Los Angeles; the Taliban regime in Afghanistan and it's downfall in 2001; the 1990 Persian Gulf War; the 2002 Catholic Church's sexual abuse scandal; the 2001 WTO meeting in Genoa Italy; the 2001 Enron collapse; and the 2001 World Trade Center/Pentagon attacks.

A central fundamental issue, therefore, appears to be that of traditional digital video capture, or the new electrovisuogram capture, for evidence gathering. Rather than avoid this issue, the author prefers to focus directly on the issue, and even suggest the cyborg as a global witness, able to provide a service to the community. This is not quite to simply suggest that we have more surveillance, as in the "Transparent Society" [18], but instead to suggest that the existing surveillance be counterbalanced with sousveillance (inverse surveillance, as described in http://wearcam.org/sousveillance.htm) where the imbalance of the surveillance-only society is replaced with a more traditional and balanced "commons notion" of mutual observablity.

When considering such a complex matrix of issues as the different rights of this new class of witnesses for global justice, we must face the possibility that claims of public safety and national security may be used to deny those rights. Private property owners, for example, may try to deny access to persons with special needs, regardless of whether those special needs arose from accident (as in the case of a wheelchair user) or from self-inflicted sensory modification (as in the case of the voluntary cyborg).

No rational being doubts the basic humanity of a person of the opposite gender, whereas racism, for example, sometimes persists without the racist having ever had contact with the oppressed class of persons toward whom s/he holds prejudice. Often, prejudice is held because of obvious physical differences such as skin color or body deformities or differences, whether the differences were due to accident or deliberate self enhancement. At a nearby university there is a student who has a grid of facial scars that were made by a ceremonial dagger: should he not have the same basic human rights as anyone else, even though the alteration was deliberate and part of his personal cultural beliefs and practices?

Initially, those who found him fascinating, scary, sad, amusing, or pity-able, later find that, instead, he was simply another human being with a different background, after working with him or getting to know him. However, in cases of terrorism and social unrest, xenophobia is amplified as our willingness to get to know those from different backgrounds is decreased through the threats we might feel against cultural or national identity that can get in the way of our differences.

One might draw the conclusion that the difference between valid and invalid discrimination is determined by the permanence of the voluntary body alteration. If the student had drawn the same grid on his face, with chalk or makeup, daily, instead of having it inscribed there permanently, would he have suffered a greater discrimination, since it would be apparent that

he continues to wish to have these markings?

Society doesn't generally discriminate between people based on whether or not they have things attached to their ear lobes. Indeed, women in many societies are allowed, if not encouraged (or even required), to wear earrings. Now, what if these 'ear enhancements' actually measured heartbeat, to provide health monitoring of the wearer, or even captured images (like the jewellery of Fig. 4(b)) and collected evidence of human rights abuses that could be transferred to distant locations and broadcast for all to witness? What if the wearer decided to attach the earrings permanently (like many earings that are welded loops) so that they could not be removed without destruction.

Several different factors affect public discrimination. What differs the valid from nonvalid discrimination?

There is also the issue of collective versus individual discrimination, as in following customs of one's tribe versus following one's own ideas and inventions, and sometimes the difference between the rules of the "tribe" or collective and the rules for the individual to survive in differ. Ethical individuals separated from one moral environment may therefore be become outcasts in a new moral environment, until their thoughts and ideas (and morals) are adopted by the members of the new environment.

Within the discrimination equation, we must therefore also consider those who make a permanent change to their minds and bodies, for the sake of science, exploration, and the benefit of humankind.

Such consideration must go beyond the accidental occurrences that make modification necessary, like a pacemaker to regulate a faulty heart. The cyborg consideration must therefore include space for deliberate changes like the author's dermaplants (wound closure on some electrocardiographic sensory apparatus, etc.) that facilitate lifelong health monitoring. And going beyond today's notions of wearable or dermaplanted computers (sensory modification) the author has also explored brain modification, like the deliberate growing of new neural pathways in the brain to self-modify toward a closer synergy with various cybernetic elements.

Such self created changes suggest the possibility of a new sense of self, much as we select our own clothing for more than just to keep warm. And just as we are free to select our own clothing as a form of self expression (unlike prisoners who wear uniforms dictated by prison authorities), we now have the possibility of selecting our senses. As Stratton, and many others (including the author) have shown, such new discoveries can go beyond lab-like settings, and enter the ecological nature of external validity that can only be be answered when applied to ordinary daily life. The author, like Stratton, Dolezal, and Kohler, who were always "doing their jobs" during their daily life of observing the world through experimental eyeglasses, like the artists, scientists, and researchers of ordinary life, this does not, and cannot stop when the principal investigator leaves the university. Being such a researcher is to adopt the lifestyle of always doing research, and always making observations. The cyborg is at once a cyborg and always a cyborg, whether at work, traveling to and from work, or boarding an aircraft to go on vacation. And this class of cyborg individual need not be limited to only scientists. It could also include, in addition to artists and scientists: medical rights workers; bonded couriers; diplomats; human rights ombudspersons; and election monitors such as Jimmy Carter. The sanctity of the body, as a space for research and of the brain as a place for personal thoughts (whether part of the body or brain are computerized) is an important element of a free and democratic society.

4 Recent events and the need for a new protected class

Until recently, the author's research was enabled by personal interaction with many talented collaborators, which involved frequent travel to share these research results and produce the best work possible for public's benefit.

However, due to recent events, the author is unable unable to travel by airline. See for example, http://wearcam.org/unplugged.htm which describes how the author's wearable computer vision system (designed and built using the author's own time and money, over many years) was damaged while traveling within Canada. The cost of repairs to the eyeglasses alone has been estimated, in a 15 page formal quotation from a company specializing in such systems, at $435,000 and would take approximately 200 days.

Given the current paranoia and "security" climate following the 2001 September 11th attacks, air travel is unlikely, anytime in the near future, if ever. Such restrictions effectively make the author a prisoner in a world defined by terrorists, but the implications of this situation are far-reaching in a world where many of us will eventually become literaly attached to computers in the near future.

For millennia, humans have developed a increasing dependencies on technological innovations that extend our abilities and mediate our experience of the world in positive ways. Shoes and clothing, so familiar now that many of us do not give them much thought anymore, protect us from the concrete we walk on and the cold wind. No one questions their value to

society because we have generally agreed that these items are beneficial and we've developed conventions for their use. Beyond such basic items as shoes and clothing, many of us also add more advanced adaptive technology to our bodies – prosthetic legs, pacemakers, and eyeglasses (including the visual memory prosthetic, http://wearcam.org/vmp.htm) – to achieve better physical and interactive capabilities. When those artificial adaptations are removed abruptly from our persons, not only do we suffer the loss of the capabilities they provide to our lives (and to our work), but there can be a physical shock to our bodies that, in for certain kinds of systems, may even result in death.

Those who have experienced virtual reality technology are familiar with the dizziness one feels when removing the special eyewear. Even simple optical eyeglasses, if the optics modify our vision to a great enough degree (Stratton's upside-down eyeglasses and more modern left-right reversing eyeglasses, prismatic eyeglasses, and severe corrective eyewear), cause our eyes to adapt over time until we require them to see properly. Once the body has adapted to using and needing them, if they are striped away, one will generally see even more poorly than if one had never worn the eyeglasses to begin with, at least in the degree of dizziness and disorientation. The ungraceful or unexpected removal of biofeedback devices that interact with bodily functions is even known to put the wearer's life in immediate danger (e.g. getting stuck in a state of hyperhidrosis).

4.1 Existing protected classes

We don't often hear airline announcements requiring passengers to "turn off all pacemakers during takeoff and landing." Persons living with diabetes often travel – generally without incident – while wearing small, pocket-sized insulin pumps attached to catheters on their bodies. Such devices protect one's life on a minute-to-minute or hour-to-hour basis, especially during travel, which can be stressful, or during mealtimes when additional insulin is required. Pacemakers and pocket insulin pumps, both of which are small electronic devices attached to, or embedded in, one's body, are technological devices commonly allowed onto aircraft by airline personnel.

Unlike cellular phones, personal prosthetics (pacemakers, heart monitors, computer vision systems, etc.) are generally very well shielded and do not produce significant emissions. Such devices hardly pose a real risk to modern aircraft navigational equipment.

Established social norm allows people who were injured or suffered an accident to wear devices out of need.

Why do these rights to body modification not extend to scientists, journalists and humanitarians who are just doing their jobs, or decide to become cyborgs by choice?

4.2 Elective cyborgs as a new protected class

It is useful to define the elective cyborg e.g. one who has inflicted upon one's self, whether considered an empowerment or an impairment, a need for being part computer, part human.

Airline staff do not dare deny the right of a person to wear a pacemaker. In fact, regardless of why the need arose for one's pacemaker, whether the ill health causing the need for wearing the pacemaker arose from negligence of the wearer, or from external forces (e.g. genetic disposition), the wearer insists on, and receives, the right to continue wearing the device. Likewise, society accords accessibility rights to persons in wheelchairs, regardless of whether their spinal injuries occurred through their own negligence or in an accident that was no fault of their own. So, it is a well-established fact that some classes of technology users are protected: what is needed is the widespread acceptance of new classes of protected users, namely self-made cyborgs. The author's permanently installed heart monitor, for example, serves as a form of preventative medicine, to alert of any problems that might be in their early stages.

A new category of allowances is needed, both for travel and other purposes, for those of us who will redefine ourselves and deliberately adjust our beings. Critics may claim that, because our 'differences' are created by choice when we decide to modify ourselves, we should be subject to worse treatment than those whose differences are not by choice.

But is this fair to technologically modified users who are now, and will continue, redefining the boundaries of the current norms for the greater good? Will the protections of the US Constitution's First Amendment protect travelling journalists from the forced removal of secure body borne devices that depend by design on the physical connection to the wearer not being severed? Can we not establish policies and procedures that will protect these new digital witnesses? Decades from now, will journalists and humanitarians be able to wander the earth, reporting on hotspots and restoring human rights before abuses turn into holy wars and conflagrations involving weapons of mass destruction that threaten all life on the planet?

4.3 Cyborg journalists as witnesses

Wearable computing technology, specifically for enhancing the work of, and protecting the persons of, people who operate in remote, challenging regions of the world may be useful to journalists and human rights

workers, since they operate on the front lines, trying to bring the news of the world to the developing nations and raise the consciousness of the privileged few about the real issues that affect the majority of the world's population.

These people risk their lives to bring the truth to us, yet they are attack victims, and even injured and killed in alarming numbers.

According to the Society for Professional Journalists, gathering news internationally is a very dangerous job:

> sadly, the death of a journalist isn't unusual. Last year, at least three dozen reporters were killed for doing their jobs. They asked questions, looked at records and reported what they found. They didn't put on a uniform or carry a weapon, but they, too, were fighting for freedom

–Society of Professional Journalists, Eugene S. Pulliam National Journalism Center, 3909 N. Meridian St., Indianapolis, IN 46208, http://www.SPJ.org/spj_missions_intjourn.asp

4.4 The need for witnessential networks

Indeed, the story of Daniel Pearl, kidnapped and murdered in Pakistan in early 2002 while working on stories about the post-Sept 11 situation in central Asia, or the four Red Cross aid workers killed by a US 'smart weapon' near Kabul in October 2001, are but two tragic examples of the need for better protections for these professionals. The time has come to build protective technology, and establish more secure and reliable modes of communication, for these front-line investigators: CryptoRights is working to provide informatic tools for them and for the information they collect, which is essential to the establishment and preservations of global justice.

In addition to the specific examples above, other users of protective wearable computing technology might include:

- At-risk patients where physiological monitoring provides improved health
- Human rights workers documenting human rights abuses in developing nations
- Journalists gathering news in conflict zones
- Non-violent political activists in close proximity to police [crowd-control]
- Public service workers providing flood control and emergency disaster aid
- Environmental activists intervening to protect natural resources
- Medical aid workers using telemedicine services from remote locations
- Election monitors overseeing newly-formed democratic voting precincts
- War crimes investigators uncovering evidence of crimes against humanity
- Weapons inspectors monitoring the production of weapons of mass destruction

4.5 Witnessential Cyborg

Becoming a cyborg is an asset to society, both for the scientific merit, the artistic merit, as well as the immediate value of increased security. The cyborg's improved memory may well be more than a grainy picture from maine that alleges to show the alleged terrorists. Carl Sagan often said "extraordinary claims require extraordinary evidence" and the witnessential cyborg, of all people, is one who can provide such extraordinary evidence. Had a witnessential cyborg encountered the perpetrators of the recent terrorist attacks, at least we might have had a memory of the event, and perhaps some extraordinary evidence, or at least a better sense of what the terrorists looked like.

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