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Location and Interactive services not only at your fingertips but under your skin

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Abstract

This paper explores the work of Professor Kevin Warwick, a researcher in the Department of Cybernetics at the University of Reading in the United Kingdom, who has played a major role in propelling the science of humancentric chip implantation. On the 24th of August 1998, just over a decade ago, Professor Warwick became the first man to officially implant a radio-frequency identification (RFID) transponder under his skin. This paper explores Warwick's achievements, motivations, and chipping experience, offering a unique insight into the ethical dilemmas and controversy surrounding implantable devices for identification purposes, interactive environments and the potential for location-based services. The authors employed a qualitative research strategy. A case study of Professor Kevin Warwick and his research endeavors are presented in a narrative form. The study used three approaches to collect data for the case study- (i) an email questionnaire, (ii) a primary interview, and (iii) secondary documentary sources about Warwick. The data itself is analyzed using qualitative content analysis. The outcome of the research is a contextual account of Warwick's motivations towards the scientific study of implantable computing for the sake of medical progress; one of the approaches which (at least in this instance) underpins chip implant research for human benefit.

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Location and Interactive Services Not Only At Your Fingertips but Under Your Skin

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ABSTRACT

This paper explores the work of Professor Kevin Warwick, a researcher in the Department of Cybernetics at the University of Reading in the United Kingdom, who has played a major role in propelling the science of humancentric chip implantation. On the 24th of August 1998, just over a decade ago, Professor Warwick became the first man to officially implant a radio-frequency identification (RFID) transponder under his skin. This paper explores Warwick's achievements, motivations, and chipping experience, offering a unique insight into the ethical dilemmas and controversy surrounding implantable devices for identification purposes, interactive environments and the potential for location-based services. The authors employed a qualitative research strategy. A case study of Professor Kevin Warwick and his research endeavors are presented in a narrative form. The study used three approaches to collect data for the case study- (i) an email questionnaire, (ii) a primary interview, and (iii) secondary documentary sources about Warwick. The data itself is analyzed using qualitative content analysis. The outcome of the research is a contextual account of Warwick's motivations towards the scientific study of implantable computing for the sake of medical progress; one of the approaches which (at least in this instance) underpins chip implant research for human benefit.

Keywords: Kevin Warwick, cybernetics, chip implants, interactive environment, location services, ubiquitous computing.

1 INTRODUCTION

The most common human chip implant to date is the radio-frequency identification (RFID) chip. An RFID chip is a small glass capsule, approximately the size of a grain of rice (11mm long, 1mm diameter) that encloses a microchip and antenna coil [1]. The chip does not require an internal power source; alternatively, a built-in antenna in the chip uses the magnetic field from an RFID reader to power the chip, allowing it to provide information [1]. In humans, the chip is normally injected into the forearm or hand using a hypodermic syringe or as is less common practice these days, through an incision of the skin. Depending on where the chip is purchased, it may house a plastic cap that causes the chip to bond to human tissue and prevent the implant moving around the body [2].

Chip implants in RFID transponders and tags are primarily used for identification purposes in emergency response applications [3]. However, humancentric chip implants have the potential to revolutionize the way we live and work through their application in interactive environments, ambient applications, location-based services, communication services, and uberveillance [4]. The overall potential for this technology has yet to be fully realized. This paper documents the motivations of Professor Kevin Warwick who has been one of the most active cybernetics researchers in the study of microchipping people, especially for medical applications. Kevin Warwick is a world-renowned researcher, endowed with a great number of awards and honors, indicating the recognized significance of his research [5]. He has also published over 500 papers.

2 PREVIOUS WORKS

…humancentric chip implants, cyborgs, and smartdust… In the past, these words would have been associated with futuristic visions of technology but they are now no longer science fiction. Ubiquitous computing refers to the technology that is continually available to the user while remaining transparent to the user him/herself. Weiser (1993) stated: "[t]he most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" [6]. The ubiquitous technologies that Weiser describes in his article are now prevalent in society. The mobile and invisible attributes of ubiquitous technology are shared with the current attributes of human chip implants.

So ubiquitous do Foster and Jaegar predict RFID implants for humans will become, that they state it may even become a pre-requisite for employment in the not too distant future: "[s]ound farfetched? Today, yes. A decade from now, maybe not" [1]. This is not an exclusively new prediction, as McMurchie reflected a decade ago: "As we look at wearable computers, it's not a big jump to say, OK, you have a wearable, why not just embed the device?… And no one can rule out the possibility that employees might one day be asked to sport embedded chips for ultimate access control and security" [7].

In 2005, Marburger et al. [8] conducted a market analysis on Verichip with projected growth potential models estimating that "VeriChip will sell 1 million to 1.4 million chips in 15 years." Considering that in 2004, according to Lockton and Rosenberg [9], only about 7000 Verichip implants had been sold, the forecasted adoption is expected

to follow a typical product diffusion curve. In addition, at the time [9] was written, only medical applications of the Verichip had been approved by the FDA. Had this not been the case, the estimated growth potential models may have been even larger in size. It is also stated in the report [9] that the main target for maximum adoption is outside the United States, however later adoption in the United States is expected [9]. Swartz [10], Black [11], Lockton and Rosenberg [9] and Michael and Masters [12] have documented the presence of Verichip in South American and European countries, indicating the potential for international market penetration.

Graafstra [13] believes the "number of do-it-yourself RFID [implantees] has grown to include hundreds of people worldwide." The publication of Graafstra's *RFID Toys* [14] and his article, *Hands On: How Radio-Frequency Identification and I Got Personal* [15], both contain explanations on how humans can implant themselves with RFID tags. A study of "underground implantees" has yet to be conducted offering international insights and perspectives.

Attitudes have evolved over the past 5 years towards humancentric implantation into the human body. Perakslis and Wolk [16] conducted surveys in 2002 that showed 78.3% of participants were unwilling to implant a microchip into their body mostly because it was "creepy." However, 3 years later another survey showed that those unwilling to get a chip implant into their body was reduced to less than half (48%) and one third (33%) of respondents were willing. The Perakslis and Wolk investigation showed that a "potential life saving device" and "safety and security" were the main motivations behind the respondent's decisions to receive a chip implant.

Perakslis and Wolk [16] have researched the developments in the human chip implant technology in a social context. Their research explains the effect of "9-11, the growth of globalization and the converging interests of the information age," leading to a growing acceptance of human chip implants as a method of providing security. This research provides statistical evidence of society's growing acceptance of RFID implants and the reasons behind it. It is a timely study, coinciding with the roll-out of several mass market RFID-based applications including, automated number plate recognition systems (ANPR), e-tollways, e-passports, and the proposed new face of driver's licenses potentially enforceable by the Real ID Act in United States [17].

Michael and Michael analyze the actions of current participants in automatic-identification technology and find that, "so long as individuals are gaining they generally will voluntarily part with a little more information" [18]. Michael and Michael find that when participants adopt a technology it becomes a part of their lives and the benefits that the user receives are prioritized over the associated risks. They conclude that it is important for people to understand the social implications of technology, as they may be detrimental to not only themselves, but also to society as a whole.

Masters explores the current applications of humancentric RFID technology in a landmark dissertation [19]. The findings of her research show that in 2003, applications could be categorized as convenience-related, care-related, or control-related. Masters provides a discussion on the social implications and ethics of the current applications of humancentric RFID technology with an emphasis on privacy and security.

The societal implications of humancentric chip implants used for location based services (LBS) are studied in [20]. Perusco and Michael use scenarios to predict societal implications, if widespread adoption of implantable technology eventuates in the location based services industry. Control, trust, privacy and security issues feature in this study.

Naisbitt and Philips [21] state: "once technology is embedded into society, such as into public policy, it is difficult to abandon". At this point in time, human chip implants are not regarded as "embedded into society", that is, deeply engrained into every day electronic and mobile commerce applications but the possibility remains. By informing the public of probable social implications of this emerging technology before widespread diffusion, consumers can consider the benefits and costs of adopting such a technology.

The societal implications, such as privacy and security, of chip implants are a recurring theme in the literature. Previous works focus on the current applications of the technology and what their implications might be. What is largely ignored in the preliminary exploratory studies are the motivations, experiences and likely trajectories of current implantees and their innovations [22]. The reasoning behind the people-centered methodology used in this research is illustrated by Mr Amal Graafstra who stated in an interview with Katina Michael: "My concern is not about the actual technology, I love the technology. I think that it is great; I hope it's developed and used for good. My concerns are with the people. A bomb is no worse than a flower, if no one presses the button" [2].

3 CONCEPTUAL APPROACH

The ability of modern technology to affect society is not a new phenomenon and dates back to1946 when Giedion voiced his concern on the social implications caused by technology [23]. This was a time before the computer was a prominent technology and still, as far back in 1948 Giedion could see that technology could lead to "the elimination of the complicated handicraft" [24]. Similar research followed as society became more dependent on technology, as is seen in Ellul's forecast of a technology-dominated future. In 1964 Ellul proposed that technology

would cause aesthetics and ethics to be sacrificed for efficiency giving technology the ability to change every aspect of life that it was associated with [25].

In 1999, Kling coined the term "social informatics" which he defined as, "the interdisciplinary study of the design, uses and consequences of information technologies that take into account their interaction with institutional and cultural contexts." The importance of social informatics was emphasized in Kling's (1999) article, referring to social informatics as having "important repercussions for public policy, professional practice, and the education of information technology professionals" [26].

It was not just critical observers and onlookers however, who were concerned about the social implications of technology but developers of the technology as well. Weiner, for example, believed that technology could cause "degradation of man in the use of any mechanical adjuvants," meaning technology has the ability to take away the worth and dignity of human labor [27]. Another distinguished technology specialist, former Chief Executive Officer of Sun Microsystems, Bill Joy voiced his concerns about the future social impact of technology. Joy noted how "[o]ur most powerful 21st century technologies… are threatening to make humans an endangered species" [28].

The significance of studying the social implications of technology is truly evident when opinion on technological change has gone so far as to suggest that technology has the potential to destroy the very make-up of humanity. It was in Rosenberg's work where the bold statement was made, that "technology may be the end of the world" [23]. Using categorization and scenarios, Rosenberg analyzed the nuclear bomb- a technology which he believed could "result in destruction of most of the planet." Rosenberg came to the realization that no matter what the initial intent of the technology, the control that the inventors have over the future use of the technology is quite limited.

It can be seen though, that research in the field of the implications of technology is not completely pessimistic. Rosenberg [23] states in his findings that "an informed and sufficiently aroused public can make a difference [in the control of the implications of technology]," a view that is shared by Michael and Michael [29].

The case study, as a research methodology, according to Yin is used to "contribute to our knowledge of individual, group, organizational, [and] social... phenomena" [30]. Data for the case study was collected from the official website of Professor Kevin Warwick, secondary documentary sources in the form of journal and newspaper articles written about him and his work, an email questionnaire presented to Warwick in 2003, and a follow up in-depth interview conducted over the telephone in 2007. The data is analyzed using qualitative content analysis.

4 PROFESSOR KEVIN WARWICK

Monday, 24th August, 1998, risking life and limb in the name of research, Kevin Warwick became the first man to implant an RFID transponder under his skin [31], [32]. From this moment on, Warwick embarked on a research project with a series of experiments that would eventually lead to microchip implants that allowed communication between human nervous systems and computers providing potential applications toward medical cures [33]. Warwick is dedicated to his cause, intending to be the initiator of the next step of human evolution, "Cyborg: Half man, Half machine" [34, 35]. Warwick [2] reflects about his aims: "…I am quite different to other people in the field. I know there are some other people researching in this area but they tend to look more at the therapeutic or repairing. But it's clear the technology opens up a number of possibilities for upgrading and taking ourselves to the next level. We got the technology, so let's have a look, let's see what's possible, whether we want to do it or not is a sociological question or a commercial question. But at least to find out, "can we have extra senses?"…

Professor Warwick, like many other pioneer microchip implantees, has experience working in the telecommunications industry. Leaving high school when he was 16, he worked for British Telecom for six years before commencing an academic career acquiring a doctorate from Imperial College, London, and eventually being offered the Chair at Reading University [36]. It was at Reading University that he started Project Cyborg, where microchip implants were implanted into Warwick's body to further his research in, what he puts as, "how microchip implants open the way to exciting new applications in the fields of medical science, bionics and human biometrics" [37].

5 MOTIVATION

When a technology is potentially physically harmful, it is unusual that the scientist researching and testing the technology will test it on themselves rather than using a 'guinea pig'. Despite this, Warwick felt that it was necessary: "It's one of those things, if you're trying something like this for the first time, you need to experience it yourself… Experiencing it for myself and understanding what it feels like is tremendously exciting, and I actually get to benefit from it" [32].

He also described that the burden of injury should be brought upon himself: "[H]aving one of the researchers or somebody else that didn't need to carry out the experiment involved, and something went wrong - which it could easily do - I don't know how I could live with myself. If it goes wrong and it's me involved, then OK. I made the choice" [32]. Warwick felt that being an actual implantee would enable him to test all the possibilities and to experience the sensation first hand.

Warwick's background also had a profound influence on the reason why he implanted a microchip into his body for his experiments: "I am historically a communications driver… For me, it was the possibility of opening up a new communication channel" [2]. Warwick has set out to achieve a similar breakthrough in the communications industry as Alexander Graham Bell and he believes that microchip implants are the tool that will enable him to do this [2].

Similarly, Warwick's background from working in the Robotics field at Reading University [36] influenced the motivation for implanting microchips into his arm. Warwick predicts that before the 22nd century, machines will have become more intelligent than the human being and the consequence of this: "intelligent machines [that] are going to outstrip humans in many ways and take over from us effectively" [38]. Warwick predicts that "[u]nless progress is halted now, which is extremely unlikely, then before long it will be intelligent machines running the show and not humans" [2]. He believes the only way to compete with the imminent robot domination, is by upgrading the human body with microchip implants, essentially making humans more intelligent than the machines: "[a]s robots become free thinkers, the only way humans can compete is to use computers to enhance the human brain" [33].

Not only is Warwick's inspiration for chip implant research derived from self-accomplishment, but also from the achievement of helping patients diagnosed with certain diseases. "The number of people benefiting from [my research] is now increasing," says Warwick. There are a number of neural microchip implants developed by Warwick providing benefits for spinal injury [39], epilepsy and Parkinson's disease sufferers, as well as a wide range of other terminal disease sufferers [32].

There is also monetary incentive in Warwick's work. Warwick has received over £2 million in funding from different organizations in order to conduct his research and more in support of research endeavors since. Donor organizations see it as a long-term investment. This is demonstrated in Warwick's words: "So if it's a UK company that launches a thought communication device that takes off, they will make enormous sums of money, which will be good for the country, which is what we hope would happen" [32].

6 THE CHIP EXPERIENCE

In 1998, a fifteen-minute surgical operation was all it took to project Warwick into the fame of being the first recorded person to be implanted with a functional microchip transponder [40]. Warwick's account of the experience was as follows: "It's well inside my body, in my left arm, just above my elbow. [It's] held in place by three stitches - partly so that the wound is held together, but also so that the capsule doesn't float around anywhere" [41]. Dr. George Boulos, who was in charge of the operation, described the process as "a routine silicon-chip implant" [41]. Warwick was given a local anesthetic and was not in any physical pain at all during or after the operation [40].

The first microchip implanted into Warwick was a commercial RFID transponder implanted into his upper arm; the brand name of this tag was withheld [37]. The particular tag was inserted into Warwick to test if an RFID transponder could be inserted into a human body and still function with outside sensors to perform a variety of applications. During the experiment, which lasted 10 days, when Warwick walked through his building at Reading University, doors would automatically open, pre-programmed websites would appear on his computer and speakers would welcome him to the building [40].

Although Warwick did not feel any physical pain during or after the experiment, the implant did have an impact on his body, mentally: "In my building I feel much more powerful… But certainly when I'm out of the building, I feel as though part of me is missing" [41]. Warwick described feeling "much closer" with the technology fitted around the building when he had the implant. This essentially had an effect on him when the experiment was over: "[i]n my [own] house, I have to open doors and turn on lights. I don't feel lonely, but I don't feel complete" [40]. The implant in Warwick's arm was taken out after only ten days due to concerns that his body would begin to accept it, making it much harder to remove later.

The second chip he had implanted was a silicon chip consisting of a battery, radio transmitter, receiver and processing unit and was connected to the nerve fibers of his left arm [42]. Cyborg 2.0 was a pioneering experiment that involved a neuro-surgical implantation into the median nerve of Warwick's left arm to link his nervous system directly to a computer to assess the latest technology for use with the disabled. He was successful with the first extra-sensory (ultrasonic) input for a human and with the first purely electronic telegraphic communication experiment between the nervous systems of two humans. The experience of this experiment was described by Warwick: "[a]ll neuro-signals between my brain and body were transmitted, recorded and analyzed by the computer… Using motor neural signals detected by the array, we were able to use the neural interface to move an intelligent artificial hand" [37].

Warwick's wife Irena, also received the same implant and they actually "connected" via a network: "[h]er brain signals traveled electrically to stimulate my nervous system and brain, and when she moved her hand three times, I felt in my brain three pulses, and my brain recognized that my wife was communicating with me" [32]. When asked by M.G. Michael how it felt to be communicating with wife Irena, nervous system to nervous system, Warwick explained in detail. "When my brain received neural signals that had come electronically from my wife's brain… that

was so exciting that we had achieved that… I mean instead of having to move through pressure waves as we do with the telephone, we went directly from neural signals into the electronics and stayed purely electronic. To me, this is enormous! But, I think the problem is, at the moment, that people don't understand exactly what we did there. To me there is no question the most important breakthrough, the first direct nervous system electronic communication" [2].

Another interviewer asked how the neural implant felt and if there were any unrecognized sensations, Warwick replied: "[e]very day I'd get the odd sort of zing down fingers or thumb. That might be just simply the thing settling down, the pin settling down in the nerves or it might be picking up static and things like that… The signals are loud and clear, but it's difficult to work out what the hell the signals mean" [39]. Warwick carried an implant for three months during the Cyborg 2.0 experiment, the world's first successfully documented electronic communication from brain-to-brain.

6.1 Community Reactions

Similar to other pioneers of breakthrough research, Warwick is one that has undergone fire from experts and public critics that believe that Warwick's views are irrational and his technology is negative for society. A technology journalist, Dave Green is one such critic who has disapproved of Warwick's research, "He's one of the most publicly recognized robotocists but his work doesn't really back it up… The man is a total media junkie" [43]. An expert at Sussex University, Blay Whiteby, has publicly stated that, "most people in the field feel he's providing false expectations and false fears," and believes the drastic view is a publicity stunt in order to get funds for his research. Whiteby's colleague, Dr Inman Harvey has even gone so far as to referring to Professor Warwick as a "buffoon" [34].

Warwick's answer to this criticism is that nothing can stop the momentum of his research as was conveyed in an interview with a journalist from *The Guardian*: "I want to try to change things, to have a go at completely altering what it means to be human. And if that upsets you somewhat, that is your problem. I am not going to stay awake at night worrying about it" [44]. Furthermore, Warwick has reflected about what his research means and how people should interpret it: "I think it is important for society to consider the different options rather than in 10 years time be faced with all these people being remote controlled and then saying "Oh what a shock. We didn't know anything about that." | "Well, you were told about it 10 years ago and you should have spoken up about it then". I think any progress of this new type of technology is going to have potential positives and potential negatives, it just changes the way humans and technology interact in a very broad range of modes" [2].

6.2 The Question of Ethics Surrounding Implants for Humans

Warwick's recent research is trying to achieve enhancement of the human brain- in Warwick's words "stretch[ing] humankind" [32]. There is an enormous amount of speculation of the social implications that could accompany this type of technology. Although these implications do not influence the progress of Warwick's research, he is certainly aware of it and in several interviews discusses it intimately. With respect to humancentric implants and their applications he told M.G. Michael: "And therefore, I think we have to be open, where are we going with it, what are we doing with artificial intelligence? We got to be very, very careful otherwise we're opening up Pandora's Box and once we've opened it, once we've switched on machines that are more intelligent than we are, they are not going to let us... they are making the decisions" [2].

Warwick has predicted that his research could potentially evolve mankind into an artificially intelligent phase: "[s]o then I would believe that, yes, we can technologically evolve and future offspring, their bodies will be more in tune and more biologically aligned with the technological possibilities" [2]. In turn, he has been questioned as to the possibility of an elitist society of people who can afford, as Warwick puts it, the "upgrade" in intelligence [2]. Warwick puts it down to his elastic band theory: "I think any technology like this can stretch society, much like an elastic band… It doesn't necessarily pull the bottom end down; in fact, it may actually help the whole way through. But it does stretch society, in terms of people who have more and can influence more. It's a case here though, of whether there is so much of an enhancement that the elastic band breaks, and we end up with two groups or maybe more" [2]. Furthermore, he believes: "[w]e are looking at an intellectual upgrade, your intelligence is improved by having an implant that simply improves how your brain operates."

Earls [32] has documented critics of Warwick's research that believe the implementation of artificial intelligence in humans will make the poor people of society, poorer. Maybury [45] believes that, "[t]he advent of machine intelligence raises social and ethical issues that may ultimately challenge human existence on earth." The high price tags associated with this technology could potentially build barriers to entry for those that cannot afford it and those that can.

The intervention of the government as to the prohibition of chip implantation in Wisconsin and numerous other states has made Warwick question political motivations. Warwick responds to these newly enacted laws as a political media stunt. "Politicians are often after the short fix. They say 'this technology is terrible' to give someone a nice political agent," he says. According to Warwick, the

outcome of laws like these is "problematic" and prevents a lot of people from getting the benefits that a technology can provide, without really preventing any of the negatives [2].

Similar to other chip implantees, Warwick receives a lot of questions based around privacy and human chip implants being the enabler of a national identification system. However, Warwick believes that it is not chip implants that are the concern here, but rather the attitudes toward national identification and the degree of acceptance for such schemes: "I am giving [a perspective] that is not anti-implant but is anti-freedom of the individual to impose some sort of identification device on everybody" [2].

When asked about the importance of ethics in his implant research, and on the topic at large, Warwick responded: "I see it as a natural thing, it is a technological development. Like technological evolution it is a very much a natural thing. It is something with positives and something with negatives so we definitely need to technically look at what's possible. And also, from an ethical and moral point of view, and how we deal with that. I think realistically it needs to be looked at seriously. I think some White House commission or committee and various ethics is needed because while therapy is usually okay, enhancement we are really not sure about…. but I think it is quite a naive view to separate them like that."

A huge application of the technology being developed and tested in Warwick's research is for the medical industry. Warwick believes carers and loved ones of Alzheimer's and dementia sufferers should be able to authorize for these sufferers to get chip implants, because "it could save the person's life." However, he believes this is only the case when safeguards are in place to ensure the power is not abused [2]. One of Warwick's main concerns is that the technology will become readily available, but will not be regulated and accepted for patients who could possibly take full advantage of the new techniques and tools.

7 FUTURE

Cyborg 3.0 is the project that Warwick is currently working on and is based around connecting computers to brain signals. The advantages of the applications of this technology allow terminally diseased or paralyzed sufferers to control mechanical objects simply by using brain signals. In the medical literature this is known as the study of the brain-computer interface (BCI). An example of one of Warwick's goals connected to this project is, as Warwick himself puts it, "[what] we would like the spinally injured patient to do is drive around a car just by thinking about it, directly by brain signals" [2].

Warwick is also working on rewiring the nervous systems of those who have lesions blocking the mobility of their body parts. The following is his description of the process: "What the surgeon wants to do is attempt to bridge over lesions so to literally put implants, as I would put it to, rewire the nervous system where there has been a break… a person over a period of time can learn or relearn how to use parts of their body which have become not functional because of the lesion" [2].

Besides medical applications Warwick has also been working on other cybernetics projects. However, Professor Warwick has not lost sight of his predicted future where "intelligent machines [are] running the show, and not humans" [2]. It is clear that the applications of his current research can also work to enhance the intelligence and extra senses of human beings. After all, Warwick envisions a world in which humans evolve into "the cybernetic organism[s]; part human, part machine" [34].

*

What we do know for certain, is that *Pandora's Box* has, indeed, been opened. And those who know of the myth will tell us, that it has never been clear what it was *precisely* that she was supposed to have let escape.

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