Cyborg Rights

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Recent decades have seen increased incidence of interventions with the bodies of human beings. These interventions raise a variety of questions about rights. Some relate to the right to have the intervention performed, or not performed. Others involve the rights of people who have already been the subject of an intervention.

The author addressed the question of 'human-artifact hybridization' several years ago. The purpose of the research reported on in this paper is to build on brief comments made in [10, sect. 5.2], and somewhat extended in brief companion papers [11], [12], by conducting a deeper analysis of the rights aspects of human-artifact hybridization.

The paper's scope is intentionally limited. First, the motivation is instrumentalist not philosophical. Second, the focus is on interventions of a physical, rather than of a biological or cognitive nature. Further, the analysis is concerned with the functionality of the body, to the exclusion of merely cosmetic or ornamental interventions. Finally, it considers legal rights, not fundamental rights or moral rights.

The paper commences by defining the scope, investigating the concepts involved, and proposing a set of definitions to support the subsequent analysis. The notion of rights is briefly surveyed. The issues that arise are investigated by means of number of case studies. This enables the identification of 20 candidate rights. A discussion of alternative ways in which change may come about leads to conclusions about the responsibilities of the engineering profession.

Cyborgization

Origins

The term "cybernetics" was coined by Norbert Wiener in 1948. It referred to the then-new notion of controlling human-designed processes through feedback and response, in ways similar to those evident in natural organisms [30], [31]. He contrived the word from the Greek word for "steersman."

The term "cyborg" is a contraction of "cybernetic organism," and entered the language in the early 1960s. Its origins are commonly attributed to two U.S. research scientists, who used it to refer to an enhanced human being who could survive in extraterrestrial environments or, in their own words, "the exogenously extended organizational complex functioning as an integrated homeostatic system unconsciously" [13].

More generally, a cyborg is a human with whom mechanical and/or electronic parts have been integrated. Driven by feature films that depict imaginings of sci-fi authors, popular culture envisages a cyborg as necessarily having functionality that has been extended beyond that of a normal human being. One of the Oxford English Dictionary's (OED's) two definitions is steady and unambitious: "an integrated man-machine system," whereas the other is "a person whose physical tolerances or capabilities are *extended beyond normal human limitations* by a machine or other external agency that modifies the body's functioning" (emphasis added). For the purposes of this analysis, it will be necessary to distinguish enhancements from more mundane interventions.

A related notion is "bionic implants." The concept of bionic implants, however, is largely confined to the entertainment arena, having originated in a 1973 novel called "Cyborg ," which gave rise to two television series, "The Six Million Dollar Man" and "The Bionic Woman." The main characters on these television shows each had "bionic" eyes, legs, and arms. The OED's definition refers to "an artificial, esp. electromechanical, device that replaces part of the body; having ordinary human capabilities increased (as if) by the aid of such devices." The OED dates the word's use in this manner to the early-to-mid 1970s.

In popular culture, a cyborg's enhancements are physically inserted into the person. However, it is important to also encompass circumstances in which this condition is not satisfied. One important consideration is the need to include the notion of "wearable computing." This term has been in use since at least 1980, when Steve Mann applied it in particular to wearable cameras and head-mounted displays. More generally, see Rhodes [26], and the product catalogue at Wearables Central. Reflecting this line of technological development, Mann proposed a broad definition of a cyborg as "a person whose physiological functioning is *aided by or dependent upon* a mechanical or electronic device" [23, emphasis added].

The formulation of an appropriate definition for "cyborg" is deferred until after consideration of two different kinds of devices.

Prostheses

The OED defines a prosthesis or prosthetic as "[a] replacement [for] defective or absent parts of the body [in the form of] artificial substitutes." It traces the word's use in this manner to 1706. Drawing on the OED, as well as [23] and [10], this article adopts the following definition:

- *Prosthesis or Prosthetic* – an artifact that provides the human body with previously missing functionality or overcomes defective functionality

In one sense, this definition is narrower than the OED, in that, reflecting the instrumentalist purpose, it excludes merely cosmetic or ornamental artifacts such as glass eyes and breast implants, and requires the artifact to enable the performance of a function.

On the other hand, this approach extends beyond the OED's "new

body part" limitation to encompass the recovery of bodily function by means other than the installation of a substitute body part. For example, a new and equivalent part could be added without removing the old one (as in renal dialysis); or a quite different part could be introduced (such as a heart pacemaker); or an existing body part could be adapted by means of an artifact (such as a stent), without directly replacing the missing or defective one.

Further, by avoiding any requirement that the artifact be installed inside the body, the definition opens up three sub-categories, reflecting different relationships between the prosthesis and the human body:

- *Endo-Prosthesis.* This is a prosthesis internal to the human body and interfaced with it. Examples include artificial hips and knees, stents, pacemakers, cochlear implants, and implanted lenses
- *Exo-Prosthesis.* This is a prosthesis on an outer extremity of the human body and interfaced with it. Examples include contact lenses, and artificial hands, arms, and legs
- *External Prosthesis.* This is a prosthesis separate from the human body, but interfaced with it. Examples include spectacles, walking sticks, and crutches, but also renal dialysis and heart-lung machines

Common usages of the term "prosthesis" focus on endo-prostheses and to some extent exo-prostheses, but largely exclude external alternatives. The broader scope is necessary here, however, partly to reflect its "spacesuit" origins, but primarily because the purpose is to examine the direction in which legal rights may need to be developed.

The OED defines prosthetics as "The design, manufacture, and fitting of artificial substitutes for missing or defective parts of the body; a branch of dentistry, surgery, or medical technology dealing with this," and traces its emergence to 1897. This article uses the term more broadly, to refer to the technology of prostheses as a whole, whether they are substitutes or complements, and whether they are endo-, exo,- or external.

Orthoses

The OED defines an orthosis or orthotic as "An external orthopaedic appliance or apparatus, such as a brace or splint, that serves to support, assist the function of, or prevent movement in a body part such as a limb or the spine." It traces its emergence to 1857, but the usage is primarily from the mid-twentieth century. Used in that manner, its meaning overlaps with either or both of "external prosthesis" and "exo-prosthesis." as those terms were defined in the previous sub-section.

This paper adopts a rather different approach. Again following [23] and [10], the following, more expansive definition is proposed:

- *Orthosis or Orthotic* – an artifact that supplements or extends a human's capabilities

Whereas an artifact that assists in the recovery of normal sight is a prosthesis, one that provides "sight" beyond the normal human-visible spectrum (e.g., infrared detection) is an orthosis. Similarly, a replacement hand or leg may be a prosthesis if it recovers or replicates normal functions, or an orthosis if it extends them in some way. This approach therefore provides a term for a category of artifact that has significantly different implications from the notion of prostheses as it is proposed in this paper. The FIDIS project drew the same distinction in relation to "ICT implants," distinguishing those that "*restore* or *repair* human capabilities" – endo-prostheses, as the term is used in this article, and those that "*enhance* … human capabilities" – endo-orthoses [16, pp. 9–10, emphases in original].

The definition of orthosis enables a parallel set of terms to be applied, in order to distinguish the following sub-categories:

- *Endo-Orthosis.* This is an orthosis internal to the human body and interfaced with it. Examples include chip implants such as those that disclose an identifier or other data, whether to assist the person's location to be found or tracked, or to, for example, automatically open a door.
- *Exo-Orthosis*. This is an orthosis on an outer extremity of the human body and interfaced with it. Examples include artificial limbs that do something more than the natural limb would have done, such as extra fingers, highly-articulated joints, and spring-steel legs.
- *External Orthosis.* This is an orthosis separate from the human body, but interfaced with it. Examples include telescopes and microscopes; skis, golf-clubs, and snorkels; body-suits such as those for knights, deep-sea divers, astronauts, and competitive swimmers; and anklets and wristlets used to monitor the location of people such as prisoners, remandees, parolees, and institutionalized patients.

Orthotics is defined by the OED as "The branch of physiotherapy that deals with the use of orthoses; the design and fitting of orthoses," and is traced to 1957. It is used here more broadly, to refer to the technology of supplementary artifacts as a whole, and whether they are endo-, exo-, or external.

Prosthetes, Orthots, and Cyborgs

Terms are needed for the various categories of person arising from prosthetic and orthotic processes. The definitions adopted are as follows:

- *Prosthete* – a human with a prosthesis.

> In practical terms, the protection of a person's rights depends on laws, on the rule of law, and on the means whereby the relevant laws are actually enforced.

- *Orthot* – a human enhanced by means of an orthosis.

The definition adopted for cyborg reflects the preceding discussion, and draws particularly on the line of reasoning in [23], which defined a cyborg as "a person whose physiological functioning is aided by **or** dependent upon a mechanical or electronic device" (emphases added) [10], [16]:

- *Cyborg* – a human with either a prosthesis or an orthosis or both.

This approach differs from the OED's second definition of cyborg, which requires the person's capabilities to be "extended beyond normal human limitations," and hence is limited to people enhanced by what is called in this paper an orthosis. For the purpose of analyzing cyborg rights, it is important to encompass both prosthetes and orthots.

The Clynes and Kline [13] notion of a cyborg also excluded prostheses, because it extended from an external orthosis (a spacesuit) to exo- and endo-orthoses. In addition, their context of use was highly specific (extraterrestrial environments). Further, the orthosis needed to be substantially integrated with the human, so that it could be used unconsciously. This may be a desirable attribute, but it is unnecessary to impose it as a definitional feature.

The following further terms are proposed, building on the above definitions:

- *Prosthetization, Orthotization, and Cyborgization* – The process of installing in a human respectively a prosthesis, an orthosis, and either or both of them.

Additional distinctions need to be drawn, to reflect the extent to which the person is an informed and willing subject, or the prosthesis or orthosis has been imposed on them:

- *Voluntary Prosthetizatio/Orthotization/Cyborgization*. This arises where a person requests, or consents to, the prosthetic or orthotic process. The key characteristics of a valid consent are that it be informed and that it be freely-given [9], [14], [16, p. 37].
- *Involuntary Prosthetization/Orthotization/Cyborgization.* This arises where the person does not consent to the prosthetic or orthotic process, but it is imposed upon them. Two further sub-categories need to be distinguished:
  - *Overt, Involuntary Prosthetization/Orthotization/Cyborgization.* In this case, the person is aware of the involuntary imposition. An example is chip-enabled anklets for people in institutions (although not for those, such as the comatose and patients with sufficiently advanced dementia, who are incapable of knowing or understanding the implications and hence cannot provide informed consent).
  - *Covert, Involuntary Prosthetization/Orthotization/Cyborgization.* In this case, the person not only did not consent, but also is not aware that the process has occurred. An example is the close association of a tracking device to a person without it being brought to their attention, or otherwise coming to their attention.

Rights

Human rights may be abstract claims or interests, or they may be grounded in religion or philosophy and asserted to be fundamental, axiomatic, and inalienable. This article, however, is not considering philosophical notions or the justifications for laws, but rather laws themselves as they relate to prosthetes and orthots. The review undertaken here is of necessity brief and superficial. All aspects of the topic are well known, and hence little recourse is made to the formal literature. Otherwise unattributed quotations in this section are from relevant Wikipedia articles in the first quarter of 2010.

The term "rights" is used in this paper in the sense of "legal, social, or moral freedoms to act or refrain from acting, or entitlements to be acted upon or not acted upon." In practical terms, the protection of a person's rights depends on:

- laws ("[systems] of rules, usually enforced through a set of institutions");
- the rule of law ("the law is above everyone and it applies to everyone"); and
- means whereby the relevant laws are actually enforced.

The history of legal authority for rights is long and tortuous. Commonly recognized steps along the way include the Magna Carta (1215), the English Bill of Rights (1689), the French Declaration of the Rights of Man and of the Citizen (1789), and the U.S. Bill of Rights (1789–1791). In many countries, at least some rights are entrenched in a Constitution. Some

rights, however, (and in some countries, all rights) depend on legislation that can be overturned by a mere Act of the Parliament and/or (in common law jurisdictions) interpretations of case law by courts.

International codification of rights has been achieved, in the following primary forms:

- the Universal Declaration of Human Rights [28]. UDHR is a "declaration" not a "treaty," and hence is not legally binding on countries. It is not without critics, particularly in the Muslim world. It has, however, influenced many national constitutions and treaties;
- the International Covenant on Civil and Political Rights [20]. Once acceded to, this is legally binding on countries (although enforcement is not easy). It is widely adopted, but with many reservations and declarations; and
- the International Covenant on Economic, Social and Cultural Rights [21]. This is perhaps less widely adopted, and is also subject to many reservations and declarations.

A useful distinction can be made between two categories of rights:

- "a *liberty right* [is a right that entails] a freedom or permission for the right-holder"; and
- "a *claim right* is a right which entails responsibilities, duties, or obligations on other parties regarding the right-holder."

Rights may be declared in a positive manner, but they also arise as a corollary of obligations imposed on others. A relevant example of this is the widespread obligation on organizations to ensure that buildings that they occupy are accessible by people in wheelchairs. The obligation on the organization implies a right of individuals who are dependent on wheelchairs for mobility to have convenient access to those buildings.

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Another distinction of relevance to this paper is between three generations of rights:

1) *rights to liberty and participation in political life.* Such rights are political in nature, and provide protections for the individual against excesses by the state. Examples include freedom of speech, the right to a fair trial, freedom of religion, and voting rights (addressed in [28, articles 3-21];
2) *rights to equality*, which are social, economic, and cultural in nature. Examples include rights to be employed, to housing, to health care, and to social security and unemployment benefits (addressed in [28, articles 22-27]; and
3) *further rights*, which have to date achieved less broad international acceptance. Examples of potential relevance to this analysis include rights to self-determination, to economic and social development, to a healthy environment, to natural resources, to communicate, to participate in cultural heritage, and to intergenerational equity and sustainability.

An important aspect of rights is that they have been subject to adaptation over time. For example, until the nineteenth century, many commonly accepted rights applied to only some of the population. Even in modern, western democracies, "a variety of those inequalities persisted well into the twentieth century, and some into the twenty-first. Developments during the late twentieth century have led to calls for additional rights to be recognized. For example, Internet-era rights were argued for even as the Internet was becoming widely available [2], [7].

Rights are fragile. One example from the first decade of the new century is the substantial numbers of "national security " overrides of longstanding protections in "free nations" that were justified by claiming that they are needed to thwart terrorist attacks. Another contrary trend is the resurgence of the collectivist perspective. In East Asia, this can be seen as a reaction against the western European tradition of humanism. Even within "western-style democracies," however, some critics perceive the freedoms arising from human rights to be excessive or easily abused, and have argued for charters to emphasize responsibilities as well as rights. Concerns have also been expressed about the inherent dominance of the interests of the species *homo sapiens* over other animals and the plant kingdom, or over nature as a whole. The rise of environmentalism may result in further qualifications to human rights that have significant implications for resources, such as freedom of movement.

It is reasonable to expect that rights will continue to be subject to adaptation, that new rights will emerge, and that old rights will be modified, expanded, and contracted. The purpose of this paper is to investigate adaptations that may be needed in order to deal with cyborgization.

Case Studies in Cyborgization and Rights

The literature reviews conducted during the preparation of this article uncovered only a limited number of treatments of the specific

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topic. A sci-fi literature exists, which investigates many aspects of cyborgs, but primarily as threats to humankind. A techno-utopian literature considers cyborgs as post-humans, a philosophy literature considers moral and ethical aspects (although it focuses primarily on biological and cognitive enhancements rather than electro-mechanical artifacts), and there are derivative literary criticism and media studies literatures.

Few papers have been located, however, that adopt the instrumentalist perspective used in this paper, that examine cyborgs as they exist at present and appear likely to increasingly exist in the near future, and that consider rights as they apply to augmented human beings. Important exceptions include [14] and [16]. See also the questions asked in the final paragraph of Warwick [29] and in a use case scenario in FIDIS [15]. Also relevant are the "ironic but serious proposal for a Cyborg Bill of Rights" in Gray [19, p. 31], and the counter-argument in Levy [22] to the effect that the challenges arising from cyborgization are not radical.

In the absence of an established body of theory and evidence, the approach adopted in the research reported on in this paper was to investigate dimensions of the issues through case studies of various cyborgs operating in various contexts. In order to ensure richness of material, the set intentionally included a diversity of prostheses, of orthoses, and of contexts. Space limitations preclude more than a description of a single case and very brief overviews of the remainder.

The case described here relates to the use of anklets with embedded chips to facilitate detection of non-compliance with movement restrictions. This was first officially sanctioned in 1983, in New Mexico. Their use has spread to some other jurisdictions. They have been applied not only to prisoners, but to parolees as a condition of parole, and even to remandees (who have yet to be convicted of an offence, and may well never be). This represents an extension of the prison beyond the prison walls and reduces costs to the state. Generally, an anklet is a form of overt involuntary exo-orthosis.

There is an economic incentive to extend use of such devices to further categories of people. Some may be already institutionalized, such as dementia sufferers, comatose hospital patients, and perhaps other kinds of patients as well. Other categories can be seen as "the virtually institutionalized," such as recidivist criminals and detested (ex-?)criminals such as those who have completed their sentences for child sex offences.

Chips have been implanted in livestock and pets since about 1990. Chips have been offered for implantation in humans since about 1998, first in tooth-enamel and then in soft tissue. There have been a number of reported instances of chips being implanted in humans [24], although to date, no reliable reference has been located for them being imposed involuntarily. A chip implant is a form of endo-orthosis, and may be voluntary, overt involuntary, or even covert involuntary [26].

Like other endo-prostheses and endo-orthoses, the chip-implantation process may give rise to infection, it may be rejected by the body, and it may interfere with tissue, organs, or bodily functions [4], [18]. In 2004 (some years after it had first been implanted in humans), the U.S. Food and Drug Administration (FDA) cleared the Verichip for implantation without breaching health laws. The decision was widely but misleadingly reported as being legal and even moral approval by the U.S. government for the conduct of chip-implantation in humans.

The other cases investigate real-life and near-future scenarios. Some relate to quality-of-life and to matter-of-life-and-death prostheses; others extract lessons from handicapped and professional sports; and yet others consider the arguments of proponents and opponents, including in military contexts. The descriptions are in the Supplementary Materials (see Tables I and II; also see "On-Line Resources").

The following section summarizes the evidence arising from the complete set of cases, in order to infer possible new forms of rights.

Implications

This section draws on the cases outlined above in order to identify the kinds of rights that may be emergent, or may be at least asserted, claimed, or desired, by various categories of people and organizations. It then examines ways in which such rights may come into existence.

Candidate Rights

The mini-cases described in the previous section identified in more or less precise form a set of 20 claims or interests that represent candidate rights. They are shown in Table I.

Processes to Facilitate Change

If new balances are to be established in response to cyborgization, then political triggers and processes are needed to bring about change. This sub-section considers some possibilities.

In common law jurisdictions, it is feasible for successive judgments by superior courts to accumulate a body of law that establishes new rights. The process is slow and haphazard, however, and it offends politicians. Given the progress that has already been made with cyborgization and the rapid rate at which it is developing, it would appear to be far more preferable to achieve change through parliamentary processes.

Ethics and morality seldom have volitional or political force [8]. On the other hand, claims for new rights can be usefully analyzed from the perspective of applied ethics. An example of a field in which some progress has been made is bio-ethics, which has been active since at least the 1920s. Spurred on by Aldous Huxley's anti-utopian

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Table I
Candidate Rights

Rights of the Non-Cyborg (or Pre-Cyborg)
• A claim right on the state, to receive quality-of-life prostheses – case (1) – spectacles and hearing-aids
• A claim right on the state, to receive matter-of-life-and-death prostheses – case (2) – renal dialysis, stents and pacemakers
• A liberty right to decline a prosthesis or orthosis – case (4) – RFID-anklets and chip-implants, and case (7) – RFID chips as the norm
• A claim right on service-providers, to take due care in the design and testing of prostheses and orthoses and procedures for installing them – case (4) – chip-implantation
• A claim right on the organizers of sporting events, to enable participation in events with cyborg athletes – case (5) – wheelchair sports
• A claim right on the organizers of sporting events, to enable participation in events separately from orthots – case (5) – double-amputees
• A claim right on service-providers, preventing the denial of access to services by non-cyborgs – case (7) – RFID chips as the norm
• A claim right on employers, for orthoses of a protective nature – case (9) – IEDs
Rights of the Prosthete
• A liberty right to disconnect from a prosthesis – case (2) – life support systems
• A claim right on treatment professionals, to require disconnection from a prosthesis – case (2) – life support systems
• A claim right on operators of facilities, to be able to use external, exo- and endo-prostheses in facilities used by the public – case (3) – wheelchairs on aircraft
• A claim right on operators of security controls, to not be unduly discriminated against or subjected to demeaning procedures – case (3) – artificial hips
• A claim right on the organizers of sporting events, to enable participation in events separately from able-bodied athletes – case (5) – double-amputees
• A claim right on the organizers of sporting events, to enable participation in events with able-bodied athletes – case (5) – double-amputees
Rights of the Orthot
• A claim right on operators of security controls, to not be unduly discriminated against or subjected to demeaning procedures – case (3) – artificial hands
• A claim right on the organizers of sporting events, to enable participation in events with able-bodied athletes – case (5) – double-amputees
• A claim right against others, to be able to utilize their enhanced functional capability, perhaps only within a particular context, but perhaps generally, and at least in some circumstances free from retributive justice – case (9) – military and security personnel
• A liberty right, to be able to observe, transmit and record behavior of others – case (9) – sousveillance
Rights of the Supplier and Installer
• A liberty right to develop, experiment with and install prostheses and orthoses – case (8) – constraints on cyborgization
• A liberty right to be free from imposed legal liabilities except where negligence is demonstrated – case (8) – constraints on cyborgization

Table II
Responsibilities of the Engineering Profession

- The raising of public awareness, at national and international levels, about prosthetes, orthots, and cyborgs generally, and the challenges that they give rise to.
- The stimulation of discussion, at national and international levels, about prosthetes, orthots, and cyborgs generally.
- The informing of discussion about public policy issues arising from prosthetes, orthots, and cyborgs generally.
- Upgrades to professional Codes of Practice for those working on or with prosthetics and orthotics, initially expressed in abstract manner, but quickly moving to operational statements.
- The expression of Conditions applying to the installation and use of particular kinds of artifacts.
- Upgrades to professional Codes of Practice and Membership Rules, in order to enable enforcement of the Codes and Conditions. In particular, it is necessary to:
  - preclude membership by individuals who breach the Codes or Conditions, or are employed or contracted by corporations that do so;
  - preclude membership by, and stigmatize, corporations that work in breach of the Conditions, or that require or encourage their employees or contractors to breach the Codes or Conditions

novel *Brave New World*, published in 1931, and the adoption of eugenics by the Nazi Party, the perception arose that biological sciences and bio-engineering are meddling with human-ness, and that adjustments are needed to the framework within which relevant political, social, and economic institutions operate. There has been significant feed-forward from the bio-ethics arena to law reform agencies and parliaments.

Like biologists, engineers have ethical obligations in relation to the impacts and implications of the new capabilities that they create. The basic tenet proposed in Clarke [5] was that "all researchers and professionals must regard the implications of their work as part and parcel of their research in and application of IT. Consideration of implications needs to be integrated, not segregated."

Over two decades later, however, the IEEE Code of Ethics (version of 2006) still states merely that "[a member of IEEE commits] to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment." This is completely vague about the implications for individuals, and nowhere is even this limited commitment translated into enforceable operational undertakings.

A fledgling robot ethics movement was initiated by Asimov [1] as the Laws of Robotics, and examined in Clarke [6] and FIDIS [17]. An IEEE Technical Committee on Roboethics has existed since 2004. But, 70 years after the problem was defined, the movement appears to have generated no concrete outcomes.

Robotics has matured far more slowly than the imaginations of sci-fi authors and academic and commercial salesmen; so perhaps a 70-year delay in that particular endeavor represents no great problem for mankind. Cyborgs, on the other hand, are here and now. Indeed, over 40 years ago, an outline of prosthetization called "The Cyborgs Among Us" had already been identified as one of many "future shocks " [27, pp. 193-199]. Despite that, virtually no progress has been made in professional self-regulation, and still less in developing a formal regulatory regime. A contribution was located in the medical profession, but in the form of an internal Committee report with no direct impact [4]. Contributions in the engineering profession are merely at the level of discursive articles such as Foster & Jaeger [18].

How are the questions of cyborg rights identified in this paper to be addressed in the absence of any regulatory framework? Of the most serious concern are involuntary orthosization (perhaps under the pretense of choice, but without genuine consent) and covert orthosization. Also of considerable concern are the right to disconnect, unfair discrimination, and the avoidance of unreasonable liability for harm arising from the installation and use of prosthetics and orthotics.

Table II outlines, in concrete terms, functions that it is contended IEEE has a moral obligation to perform.

On Line Resources

At http://www.rogerclarke.com/SOS/CyRts-1102-SM.html

see:

- Scope Limitations of the Paper
- Case Studies
- Glossary

Great Promise, and Significant Threats

The process of cyborgization harbors great promise, but also significant threats. The scope for

inequitable access to potentially beneficial prostheses is enormous, and so is the risk of a backlash against orthoses that are perceived to be "unnatural" or potentially harmful. Political, social, and economic institutions must grapple with the fruits of the labors of information and communications technologies, and they must be informed by the professional bodies that represent researchers and engineers. At present, those professional bodies are unacceptably inactive.

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