# Ethical, Legal and Social Concerns Relating to Exoskeletons

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## ABSTRACT

Exoskeletons, i.e., wearable robotics, are designed and built to amplify human strength and agility. In many cases, their purpose is to replace diminished or lost limb functionality, helping people regain some ambulatory freedom. As such, exoskeletons are particularly suited to help those with restricted mobility due to paralysis or weakened limbs. For all their promise, exoskeletons and other wearable robotics raise a number of ethical and social concerns that will need to be confronted by ethicists, the industry, and society as a whole. General social concerns relate to the personal and psychological impact on disabled individuals and their families. And as a society, we may need to reconsider able-ness, in light of these and other technological opportunities for overcoming our limitations. But that's only for those who can afford these machines: with exoskeletons costing as much as a luxury car, there are social justice concerns relating to access to this cost-prohibitive technology, as well as the eventual dependencies on such an expensive device. Ought insurers be required to purchase these for paralyzed individuals to significantly improve their quality of life; or are there competing interests and ideals that might support an insurer's refusal to invest in this technology? Some exoskeleton manufacturers, in conjunction with defense contractors, are reportedly pursuing military grade as well as industrial grade exoskeleton solutions. These solution enable soldiers and workers to perform longer and harder. In upgrading humans into quasi-machines, however, we run the risk of treating them more like machines than humans. In the workplace this may result in the overworking of an employee, in the military this could further dehumanize warfare and its very human actors. The prospect of augmenting otherwise healthy individuals (as distinct from treatment focused on achieving, sustaining or restoring health) raises further ethical concerns relating to human enhancement, an area fraught with slippery slopes. These issues are not only limited to our regular daily interactions, but also arise in sports, as the disabled (and now disgraced) Olympian, Oscar Pistorius, has shown us. There are no simple solutions for any of these issues, although many solutions may arise organically; for example, costs and access issues may be lessened as the technology becomes more widespread and cheaper. Other issues can be dealt with through well thought out regulatory solutions. But, for society at large, exoskeletons and other future human enhancements technologies raise much more longstanding and complex questions that will force us to redefine how we perceive humanity and self.



## Categories and Subject Descriptors

K.4.1 [**Computers and Society**]: Public Policy Issues, Social Issues, *ethics, privacy and regulation.*

K.5 **[Legal Aspects of Computing]** General and Government Issues.

I.2.9 **[Artificial Intelligence]** Robotics *Commercial robots and applications*

## General Terms

Human Factors, Legal Aspects,

## Keywords

Robotics, Exoskeletons, Ethics, Law, Social Issues, Disability Sports, autonomous

## 1. INTRODUCTION

Exoskeletons are an exciting emerging technology that promises, among other things, to provide re-gainable mobility to paraplegics. In this context, exoskeletons are, at their most basic, human-machine interfaces comprising robotics and computers, or more specifically, motors and sensors and software and novel algorithms that combine the former. While the concept of exoskeletons has been around for some time —see only the wide range of devices devised by our imaginations as represented in film ranging from Aliens (1986) to Avatar (2009)— the miniaturization of sensors, advancements in computing power and algorithms, innovation in battery technology and strong but light materials have all made what was once science fiction, a reality.

Given the potential of these technologies, exoskeletons are not only of interest to the disabled community where they provide the promise of walking, climbing and greater mobility, but they also present an exciting technology for the military, as well as for able bodied workers in industries requiring stamina, repetitive motion and hard labor.

This growing use of and interest in exoskeletons notwithstanding, there is a dearth of academic research on the ethical, social and legal aspects of this impressive technology. This is particularly

important in light of the general growing lag between the rate of technological innovation and the corresponding ethical, legal and social oversight of those technologies. Many of the ethical legal and social concerns raised herein will likely emerge sooner or later. As such, they ought to be dealt with, or at minimum, at least acknowledged and discussed before the technology becomes more integrated and enmeshed in society, and these concerns become more difficult or even impossible to overcome.

## 1.1 Goals of the Paper

This paper will be an attempt to reverse this research gap by moving the policy engagement upstream; instead of regulating as a reaction to technology, this paper aims to provide anticipatory expert opinion that can provide regulatory and legal support for this technology, and perhaps even course-correction if necessary, before the technology becomes ingrained in society.

As such, this paper intends to highlight many of these non-trivial issues. The paper will look to ethical, legal and social issues separately, although in some instances, many of these issues may overlap, and have repercussions in other areas. However, while this paper intends to provide a broad overview of the issues, the concerns raised represent only some of the pertinent issues and are not intended to be an exhaustive list.

## 1.2 Human Enhancement

What is and what is not human enhancement is a central concept to many of the legal, social and ethical issues associated with exoskeletons. Unfortunately, the definition of this term remains ambiguous and is non-trivial. Currently there is no consensus as to what ought to be considered human enhancement per se and what is not.

Thus whereas researchers can generally agree that human enhancement comprises the extraneous, non-natural providing of skills or abilities beyond those typical to the species, it's not clear, for example, at what point an added-on tool becomes more than just an extraneous tool and becomes an incorporated enhancement. More specifically, at what point does an exoskeleton become sufficiently integrated (either internally, or even externally both physically and/or through a brain interface[1]) such that it is an actual extension of the individual, and an enhancement thereof, and not simply just an external tool.

Some have argued that perhaps an "always on" feature of a tool, changes it from an extraneous tool to an integral and integrated component of the individual.[[2]] However, in the example of exoskeletons, battery life limitations make the fulfillment of this criteria unlikely. Moreover, under an "always on" theory of human enhancement corrective lenses might also be considered an enhancement.

An additional/alternative criteria in defining enhancement may relate to the distinction between therapeutic and non-therapeutic manipulations. Under this criteria, non-therapeutic changes or alterations could be considered enhancements, (or are more likely than therapeutic changes to be considered enhancements), whereas most if not all purely therapeutic changes would fall out of the ethically problematic realm of human enhancement. However, this criteria is also problematic as it is not clear whether therapeutic changes ought to be limited to regaining the individual's status quo (e.g., on par with the average of the species), or whether they should include therapeutic changes that exceed the status quo.

Following the corrective lenses analogy, LASIK or similarly eye altering surgery which raises the individual's eyesight back to the status quo would not be considered enhancement. But, under this definition, the commonly performed and widely accepted Tommy John Surgery, e.g., ulnar collateral ligament (UCL) reconstruction wherein ligaments from other parts of the body are used to reconstruct parts of the elbow, might be considered human enhancement ;[3] evidence indicates that baseball pitchers with declining skills prior to surgery see an improvement in their skills post surgery,[4] with some even calling it surgical doping.[5]

This last criteria in defining what is and what is not enhancement is further problematic as it is arguably biased against those who were born with a disability relative to those who's disability came later in life. For those born with a disability changes to body would arguably be an enhancement as they raise the individual above her status quo, whereas the same changes for an individual who became disabled may simply return that individual to the status quo.

While there are no easy answers in defining human enhancement, a definition is eventually necessary for a legal analysis; whether something like an exoskeleton falls under the rubric of human enhancement remains a paramount issue in devising regulation of exoskeletons.

In particular, scholars tend to fall into three camps in assessing the level and nature of necessary regulation. [6] Some argue that more than a base minimum would only serve to disincentivize future technological developments and would clash with the natural right to control ones' own body.[7] These transhumanists argue that human aspects of freedom and autonomy demand that we be able to enhance at will.[8] Others argue that the potential side effects and social upheavals that could result from human enhancement technology requires strong regulations, if not even a moratorium on research in this area until we can work through all the problems. [9] In between these two poles are those who argue for regulation developed in light of the inalienable rights to control our own bodies.[10] Andy Miah has described the sometimes bizarre and illogical position of these last two groups: "We embrace all those enhancements that we have deemed a reasonable extension of natural ability and we carefully regulate those that we haven't."[11]

## 1.3 Are Exoskeletons human enhancements

The lack of definition as to what is or what is not human enhancement notwithstanding, it would be hard to state that exoskeletons are per se human enhancement: Exoskeletons have varied purposes and integrate with the body differently depending on the manufacturer and/or goals, For example, an exoskeleton that allows a paraplegic to regain some motor skills, arguably ought to be viewed as very different than an exoskeleton that is used by a soldier to obtain extra fighting skills in the eyes of the law.

Whether or not Exoskeletons are considered enhancements, exoskeletons however, are likely, in all their forms, robots, i.e., a physical machine that obtains data from the environment, processes that information and then interacts with the environment based on that data: In Caro's formulation, one that "senses thinks and acts."[12]

And, like being defined as a human enhancement, being defined as a robot brings its own baggage of robotics exceptionalism, as it has introduced a systemic change to the law in dealing with this technology with dozens of US states having robot-specific laws.[12]

## 1.4 Exoskeletons Currently in Development

Currently there a number of companies working on developing exoskeletons for both the military and consumer use, both therapeutic and non-therapeutic. Key stakeholders in this area are Cyberdyne's Hal, Ekso Bionics, Argo Medical's ReWalk Robotics, Parker Hannifin's Indego and Rex Bionics.

ReWalk, the result of an Israeli company, was the first exoskeleton to obtain FDA approval for the use of their technology for paraplegics, is relatively expensive at around 70,000 dollars per device. This high cost notwithstanding, there are a number of institutions worldwide that provide access to these exoskeletons for therapeutic usage. A number of clinical trials are also underway to examine the usage of this technology.

Ekso Bionics, in conjunction with Lockhead Martin, developed a number of non-therapeutic exoskeletons including, HULC (Human Universal Load Carrier) with military usages, ExoHiker, which helps hikers carry large loads, Exoclimber, specifically designed for stairs and slopes and eLEGS, (Exoskeleton Lower Extremity Gait System) which is a hydraulically powered system that could allow paraplegics to stand and walk with additional support.

Cyberdyne, a Japanese company with an ominous name has a line of exoskeleton robots that provide both therapeutic and non-therapeutic usages. The therapeutic uses of these devices include uses for individuals with brain and mobility disabilities and the non-therapeutic uses including eldercare and worker assistance devices.

Rex Bionics, part of Edison Investment Research Limited. Rex is focused on rehabilitating patients with spinal injuries and disabilities relating to stroke or Multiple Sclerosis with a focus on both home use and rehabilitation institutions.

## 1.5 Exoskeletons in Popular Culture

The ethical legal and social concerns relating to exoskeletons are arguably exacerbated by the use of exoskeletons in popular culture, particularly in film where more often than not, they provide the user with extraordinary abilities. Lists of exoskeletons in film abound online and include films dating back to the 1950's. Most of these suits grant their wearers strength, agility and other powers. [13] most are associated with aggressiveness and warfare, few, like the Caterpillar Power Loader in the 1986 movie Aliens is designed for picking up heavy objects. This public perception of exoksleons as fighting machines potentially confounds the man other positive uses of such technologies.

# 2. ETHICAL CONCERNS

As described above, augmenting humans is rife with concern. And while it can be easily justified in some situations, e.g., for therapeutic purposes, in others their use is typically ethically more problematic.

However, in addition to just strapping on an exoskeleton for no particular reason, there are a number of defined opportunities for non-therapeutic, dual-use-like enhancement that might be particularly problematic; for example in in sports, heavy industry and military applications. Here the ethical dilemmas are even more pressing.

## 2.1: Dual Use

With a number of exoskeleton manufacturers focusing on the industrial and military uses of the technology, we run the risk of dehumanizing our workers and our soldiers that are strapped into exoskeletons. For example, in the case of industry, the use of exoskeletons in areas requiring heavy repetitive lifting, managers and others overseeing the workers may overlook the human components and needs of their workers, seeing them only for their enhanced mechanical abilities that the exoskeletons provide them. As will be discussed later this may also have legal implications.

### *2.1.1 Industrial Use*

At minimum when exoskeletons are incorporated into industry, from construction to manufacturing, to even geriatric care providers, rules and regulations ought to be promulgated that protect the workers from being dehumanized and overworked.

### *2.1.2 Military Use*

With the prospect that soldiers might be upgraded uparmored and otherwise enhanced by exoskeleton technology comes the risk that not only will the enemy fail to see the soldiers as humans, a particular problem for our soldiers and a propaganda coup for the other side, but so will the soldiers commanding officers.

One voiced concern is that commanding officers might expect their enhanced soldiers to be able to work harder and longer, with more consideration for their robotic side and perhaps with lesser concern for their mental wellbeing as a result of this harder work. Additionally, commanding officers, in seeing even a little less humanity in their soldiers, might be more likely to send their charges into dangerous or difficult situations, situations that they would have avoided had the soldiers not been mechanically enhanced. Soldiers in armies tend to also have fewer rights than civilians; regulations may be necessary to limit the ability of the military to test exoskeletons on soldiers without the use of informed consent and other legal safety nets.

Moreover, according to those theories that war is supposed to be as horrible as possible to disincentivize combat between parties, the mechanization of the soldier plays into that mindset, making war worse. Additionally, the enhancing of soldiers makes the political cost of war less, as its assumed that mechanized soldiers will be less likely to become politically costly casualties. In any event, its likely that the eventual use of exoskeletons in battle will necessitate a rewriting of some rules of engagement.

Finally, in general taxpaying citizens supporting scientific innovation may be concerned with the dual use nature of the technology wherein the funded research may have initially been intended to create life enhancing technologies and only later being coopted into military and non-therapeutic uses.

### *2.1.3 Use in Sports*

In addition to the obvious problematic areas of dual use, there are additional ethical concerns raised with the eventual incorporation of this and related technologies into amateur and professional sports and the social disruption resulting from the incorporation of this technology. (Some have already argued for multiple leagues in sports including separate leagues for the enhanced and not-yet enhanced.[14])

Eventually, lines will need to be drawn to determine what amounts to illegal or unfair augmentation and what remains fair enhancement by exoskeleton, if any. Here fairness might take into account any harms that might be caused to the athlete as a result of the technology, the dehumanizing or superhumanizing of said athlete, the virtuousness of the enhancement, and whether or not the resulting enhancement is against the practically undefinable concept of the spirt of the sport. [15]

The issue of enhancement in sports is not necessarily a novel issue, as every time a new technology arises, the sports authorities

need to determine whether that technology will be allowable. For example, whereas hyperbaric chambers and tents remain allowable, some bathing suits that aim to mimic shark skin are not.

In some instances, precedents may have already been set, for example with regard to exoskeletons and their use in marathons. A number of marathons have already allowed disabled athletes to run using these technologies. While currently, the use of the technology doesn't threaten the standings of the top athletes, but will the marathons reconsider their adoption of these technologies when records are threatened? Or will we see separate categories of runners, in addition to gender, enhanced and non-enhanced.

In examining this question it is important to recognize that whereas conventional wisdom sees our top athletes as the product of blood sweat and toil, in reality, most if not all are born naturally genetically enhanced to compete, including for example, longer limb length for some top swimmers, or greater oxygen carrying capacity for certain bikers.

# 3. SOCIAL CONCERNS:

## 3.1 Access

In addition to these ethical concerns, there are a number of social concerns. For example, currently the technology for enhancement of the disabled is somewhat costly, limiting access to those few who can either afford to purchase access to the technology or those lucky enough to have health insurance plans that will pay for the costs associated with using this technology.

This goes to the much more difficult question regarding whether the disabled have a right to technology that returns them to an equal playing field with their peers. Does human dignity demand that we do all that we can for those less fortunate than ourselves? Can the disabled argue that they have a right, under their governments to access this technology at a reasonable and affordable price?

This discrimination of access, based solely on ability to pay without recognition for the type of injury or the health benefits raises non-trivial social justice concerns in addition to ethical concerns relating to the role that expensive exoskeletons play in actively further relatively disadvantaging those who are disabled but cannot afford this technology. While we are mindful that with regard to all areas of human enhancement, fair distribution of the technology is not necessary equitable distribution of technology. Moreover, non-equitable distribution of the technology, as described above with the dual use nature of the technology can create a market wherein eventually economies of scale will result in the technology being more affordable for everyone.

In discussing the social aspects of access, ought health care providers to pay for everyone to have access? How should insurers decide who does or does not get access to this technology.

Moreover, as a society, perhaps we be promoting more dual use of this technology, if for no other reason than that economies of scale might reduce the cost to use and/or obtain an exoskeleton for disabled individuals.

## 3.2 Dependency and Withdrawal

There may be concerns that the availability of exoskeletons will create a dependency on the technology, and a limited availability will lead to withdrawal like symptoms, wherein disabled individuals who may have relied on the technology, may exhibit psychosocial withdrawal-like symptoms when they lose access, either because of scarcity or because they can no longer afford access.

## 3.3 Defining Ableness and Disability

In addition to the social justice concerns regarding access and dual use of the technology, they are additional concerns relating to the definition and reassessment of the definitions of ableness and disabilities. With the prospect that humans can be augmented with integrated exoskeletons and other prosthetics, we may need to reassess what defines ableness and disability and in particular, whether an individual augmented with an exoskeleton such that they regain the ability to walk and/or otherwise be mobile to an some degree, an equal degree, or perhaps in the near future, to a greater degree than those without the exoskeleton, is still disabled.

A simple minded comparison might be a comparison between individuals with 20/20 vision, individuals with glasses, individuals who have undergone LASIK surgery to regain or even further enhance their vision and individuals who have incorporated contact lenses that provide telescopic vision and/or ight vision.[16] Are the individuals with glasses impaired in comparison to those with natural 20/20 vision? What about those who wear contact lenses? What about the individuals who have undergone lasik surgery to regain 20/20 eyesight, are they similar to or different than individuals with glasses in comparison to those without.

This comparison is not without precedent. Under the American's with Disabilities Act (ADA, 1990), perhaps the preeminent civil rights statute for the disabled in the United States, and described by James Brady in a New York Times Editorial as necessary statue for people with disabilities - the largest minority in the U.S. [who] were left out of the historic Civil Rights Act of 1964,[17] the need for corrective lenses is not per se, a disability under the ADA: "In enacting the Americans with Disabilities Act of 1990 (ADA), Congress intended that the Act "provide a clear and comprehensive national mandate for the elimination of discrimination against individuals with disabilities" and provide broad coverage;"[18]

As per the U.S. Equal Employment Opportunity Commission (EEOC) website, "Ordinary eyeglasses or contact lenses" – defined in the ADAAA and the final regulations as lenses that are "intended to fully correct visual acuity or to eliminate refractive error" – must be considered when determining whether someone has a disability. For example, a person who wears ordinary eyeglasses for a routine vision impairment is not, for that reason, a person with a disability under the ADA. The regulations do not establish a specific level of visual acuity for determining whether eyeglasses or contact lenses should be considered "ordinary." This determination should be made on a case-by-case basis in light of current and objective medical evidence."[19]

In Sutton v. United Airlines wherein the US Supreme Court determined that a definition of disability ought not be adjudicated "in their hypothetical uncorrected state—is an impermissible interpretation of the ADA. Looking at the Act as a whole, it is apparent that if a person is taking measures to correct for, or mitigate, a physical or mental impairment, the effects of those measures—both positive and negative— must be taken into account when judging whether that person is "substantially limited" in a major life activity and thus "disabled" under the Act"[20]

Later, under the 2008 amendments to the ADA (ADAAA), signed into law by George W. Bush, 18 years after his father George H. Bush signed the ADA into law, Congress made a conscious effort

to broaden the term disability, heretofore narrowed by Sutton and its progeny. [21] The ADAAA is designed to "reject the requirement enunciated by the Supreme Court in Sutton v. United Air Lines, Inc., 527 U.S. 471 (1999) and its companion cases that whether an impairment substantially limits a major life activity is to be determined with reference to the ameliorative effects of mitigating measures;"[22]

Under the above mentioned 2008 amendments to the Act, regulatory agency guidelines to the contrary[23] were codified such that: mitigating measures, i.e., those that "eliminate or reduce the symptoms or impact of an impairment [including] medication, medical equipment and devices, prosthetic limbs, low vision devices ( e.g., devices that magnify a visual image), hearing aids, mobility devices, oxygen therapy equipment, use of assistive technology, reasonable accommodations, and learned behavioral or adaptive neurological modifications [,may not] be considered when determining whether someone has a disability … In other words, if a mitigating measure eliminates or reduces the symptoms or impact of an impairment, that fact cannot be used in determining if a person meets the definition of disability. Instead, the determination of disability must focus on whether the individual would be substantially limited in performing a major life activity without the mitigating measure. "[24]

Notably, however, " the positive or negative effects of mitigating measures [may] be considered when assessing whether someone is entitled to reasonable accommodation or poses a direct threat." [24] As such, employers "can take into account both the positive and negative effects of a mitigating measure. The negative effects of mitigating measures may include side effects or burdens that using a mitigating measure might impose" [24] As such, "if an individual with a disability uses a mitigating measure that results in no negative effects and eliminates the need for a reasonable accommodation, a covered entity will have no obligation to provide one." [24]

And while an employer cannot require "an individual to use a mitigating measure. However, failure to use a mitigating measure may affect whether an individual is qualified for a particular job or poses a direct threat." [24]

Considering these regulations in the context of an exoskeleton, while an employer cannot ignore the fact that a person is disabled simply because they employ an exoskeleton, and while an employer cannot force an employee to use an exoskeleton, the use of an exoskeleton by an employee may act as a mitigating measure sufficient to find that the employee is not in need of any reasonable accommodations by the employer. Further, as the cost of exoskeletons go down, one could conceive of a time in the near future wherein an employee could demand the use of an exoskeleton as a reasonable accommodation by the employer.

In light of the mixed response of the ADA to mitigating technologies, the use of an exoskeleton further confounds the self-identification of individuals as disabled or not disabled. Like hitech prosthetic limbs that nearly mimic true function of a lost limb, exoskeletons may soon unobtrusively mimic the true function of a limited-function limb leading some people to self-identify as disabled, and others to perhaps self-identify as not disabled. In all likelihood this will create substantial confusion in the general public and particularly in the service industries that given this scenario, might struggle to assess what level of service is necessary for these individuals.

# 4. LEGAL ISSUES

Social issues of ableness and disability reach into legal issues, as described above. In addition to issues relating to disability, there are a number of other issues relating to the law.

*4.1 Exoskeletons in Court*

As with all new technologies, in the US jury system, lawyers in the early cases will have the opportunity to establish the necessary metaphors to properly frame the technology to suit their case. In these early cases, unfavorable precedent could be set —bad facts make bad law— to shoehorn all exoskeletons into one metaphor or another. [25]

## 4.1 Exoskeletons in Criminal Law

Criminal law requires that the actors have bad motivations for their actions. With exoskeletons, the motivation analysis may be confounded by the autonomous or semiautonomous nature of the devices and the nature of the human-machine interface.

## 4.2 Exoskeletons in Tort Law

In tort law, courts look to, among other factors, the foreseeability of the tortious result of an action in assessing the negligence of the actor. With regard to exoskeletons, the interaction between human, motors, sensors and software may not always result in forseeable results. This is all the more complicated by autonomous and semi-autonomous exoskeletons that may interact with the environment irrespective of the intentions of the user. Further confounding these issues, concerns may arise when the machine-human interface includes direct neural connections between the user and the device, wherein unconscious or subconscious intentions may be translated into actions by the exoskeletons, those actions may result in a tort.

Additionally, the use of the common law theory of res ipsa loquitor wherein the courts acknowledge the imbalance of information between the tortfeeser and the victim, may become unmanageable in cases of exoskeletons wherein the multiple stakeholders associated with the exoskeleton, including the manufacturer, the programmer, the user, among others, makes it unlikely that anyone has a good handle on the information.[25] This is particularly the case under the Restatement (Second) of Torts, wherein § 328D outlines a process for finding negligence by the tortfeeser: determining whether the accident is one typically the result of a negligent action, and more problematic in the case of exokseletons, that the defendant had exclusive control over the instruments that were the proximate causes of the tort. In the case of exoskeletons, it may be difficult to infer that a user of an exoskeleton had exclusive control over the autonomous or semiautonomous robot. Notably, though The Restatement (Third) of Torts, § 17, leaves out the exclusive control element.

## 4.3 Exoskeletons in Product Liability Law

In general, in product liability law we often look to strict liability, finding the producer of a device liable irrespective of their negligence. Moreover, in some instances there are different criteria for liability depending on whether the faulty device is a medical device or a non-medical consumer device. At this point, FDA approval for the device notwithstanding, its not clear how tort law will treat faulty exoskeletons.

In some areas of product liability the law has imposed strict liability on faulty products. However, strict liability falls away in some areas of technology, including software, were society has come to acknowledge and expect glitches and software bugs.[ 26]

In the case of exoskeletons, it is unclear whether courts will enforce strict liability, as is common in other machine-software devices, such as cars, or whether a different standard will be set.

### 4.4 Exoskeletons and Privacy

Exoskeletons by design may collect data on the user. This data collection may be necessary for product feedback and/or medical necessity. For example, exoskeletons may collect location information, usage information, neural input information, vitals data and other private information relating to the user. Regulations would need to be developed, not only to standardize this data collection so that it can be useful cross platforms, but all to enforce encryption and/or other levels of protection when the data is at rest, data in use and data in motion.

### 4.5 Exoskeletons and Workers Compensation

Under standard Workers Compensation theories, employers pay workers compensation to injured employees in exchange for legal leniency if an employee becomes injured in their place of employment, potentially due to a fault of the employer. If and when workers begin to use exoskeletons in the workforce, workers compensation for employees injured while wearing an exoskeleton may be limited, but the employee may have recourse in going after the producer of the exoskeleton.

### 4.6 Exoskeletons and workers' rights

Currently many workers have sets of rights that limit their work hours and that sets wages, among other worker related rights. It is unclear how exoskeletons may change the amount of time the law is willing to let employers work their employees, and whether compensation may be different for employees that use exoskeletons and those that do not use exoskeletons.

## 5. CONCLUSIONS

Although the exoskeleton industry is in its infancy, it is obvious that there are a number of ethical, legal and social concerns that must be acknowledged and maybe even dealt with before the technology becomes entrenched and bad precedent creates legal, social and/or ethical realities that might hinder future development of the technology and/or harm the users of the technology.

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