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Published in:
International Journal of Technoethics

Publication date:
2013

Document Version
Peer reviewed version

Citation for published version (APA):
Koops, E. J., Di Carlo, A., Nocco, L., Cassamassima, V., & Stradella, E. (2013). Robotic technologies and fundamental rights: Robotics challenging the European constitutional framework. *International Journal of Technoethics*, *4*(2), 15-35.

Published as: Koops, B.J., A. Di Carlo, L. Nocco, V. Casamassima & E. Stradella (2013), 'Robotic Technologies and Fundamental Rights: Robotics challenging the European Constitutional Framework', 4 *International Journal of Technoethics* (2), p. 15-35

Robotic Technologies and Fundamental Rights: Robotics challenging the European Constitutional Framework

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ABSTRACT

Robotic technologies—constructed systems that interact with their environment in a way that displays some level of agency—are increasingly intertwined with human life and human bodies. This raises many regulatory questions, since current legal frameworks have few robotics-specific provisions and robotics pose new challenges to legal notions and underlying assumptions. To help guide the regulation of robotics, fundamental rights should provide a basic touchstone. However, the constitutional framework of fundamental rights is itself not immune to being influenced by robotics. This paper discusses how the protection of fundamental rights is affected by robotics technologies, taking into account the mutual-shaping process of fundamental rights, regulation, and technology. After a general overview of how fundamental rights are challenged by robotics technologies, we zoom in on three specific application domains: industrial robotics and the issue of workers' rights and liability, assistive technology with a focus on autonomy and privacy of elderly and disabled people, and biomedical robotics (including brain-machine interfaces) in relation to informed consent and self-determination. The analysis highlights diverse implications of robotics in light of fundamental rights and values, suggesting that regulators will have to deal with rights and value conflicts arising from robotics developments. To help address these conflicts, a set of shared norms, standards and guidelines could be developed that may, in the form of soft-law, serve as a bridge between abstract fundamental rights and concrete robotics practice.

Keywords: fundamental rights, robotic technologies, robotics, European Charter of Fundamental Rights, vulnerable subjects, industrial robotics, assistive technologies, brain-machine interfaces (BMI), deep-brain stimulation (DBS)

ROBOTIC TECHNOLOGIES AND FUNDAMENTAL RIGHTS: A EUROPEAN UNION PERSPECTIVE

The role played by new technologies in contemporary society has significantly increased over the last decades. Technology is now an essential part of everyday life; it even increasingly is becoming an integrated part of the human body, as people not only use clothes and glasses but also implants and bionic devices. Since technology is neither good nor bad, nor is it neutral (Kranzberg, 1986), technology must be subjected to moral and social controls (Bunge, 1977, p. 106). This makes, technoethics is an important field of scholarship, which is defined as "the branch of ethics that investigates the moral issues encountered by technologists and by the public at large in connection with the social impact of large-scale technological projects" (Bunge, 1979, p. 70). Technoethics is concerned with "critical debates on the responsible use of technology for advancing human interests in society" and thereby "help guide ethical problem-solving and decision making in areas of activity that rely on technology" (Luppicini, 2009, p. 4).

Ethical questions of morality and ethical problem-solving closely relate to other fields of decision-making, not the least to legislative decisions. A key element in ensuring the responsible use of technology for advancing human interests are human rights, which perform a crucial task in "preventing the wrong" that is one of the concerns of ethics (Griffin, 2008, p. 19). Ever since Locke's *Two Treatises of Civil Government*, human rights have functioned as "moral constraints on the arbitrary acts of rulers" (Griffin, 2008, p. 11).

Although naturalistic accounts of how human rights come into existence have largely given way to procedural, contract-theory accounts (e.g., Dworkin, 1977), recent attempts try to re-introduce a more substantive account of what constitute 'human' rights, by conceiving of them as protecting the normative agency of humans (Griffin, 2008).

Interestingly, it is precisely the notion of (normative) agency that is also being affected by technology, through the rise of technologies that display some level of agency themselves: robotics. Thus, from a technoethical perspective focusing on responsible use of technology, robotics raise questions not only about how the protective function of human rights plays out in a robotics-pervaded world, but also how robotics affect the interpretation of human rights itself. In that light, it makes sense not to speak of 'human' rights but rather of 'fundamental' rights, i.e., basic rights pertaining to entities with (moral) agency to protect their functioning in society—which may apply not only to humans but also to legal persons and, perhaps in some future, to machines or man-machine combinations that are capable of moral reasoning. Using the term 'fundamental rights' is also in line with the way in which these basic rights are currently being shaped in law. Against this background, this paper aims at discussing the protection of fundamental rights in contemporary technology-pervaded society. We will adopt a European Union perspective, because the EU's dual aim of fostering an innovation-friendly internal market as well as an area of freedom, security, and justice makes the regulation of robotics particularly salient in this jurisdiction.

After an introduction into EU fundamental rights and robotics, we discuss how fundamental rights are challenged by robotic technologies. We then take into consideration three particular fields of robotic applications to highlight some relevant legal issues. As the analysis highlights that conflicts may arise in the protection of fundamental rights, we end with identifying some ways to handle conflicts in the European constitutional framework.

The protection of fundamental rights in the EU: the role of the European Charter of Fundamental Rights

Since a catalogue of rights was not included in the European Treaties, for a long time fundamental rights have been protected in the EU as "general principles", deduced by interpretation from the constitutional traditions common to the Member States and relevant international treaties. Aside from the disadvantages of such indirect protection, citizens could directly obtain protection before the Court only against decisions which were specifically addressed to them (art. 230 TEC). This contrasts with the Council of Europe's system of the European Convention for the Protection of Human Rights and Fundamental Freedoms (ECHR), which fully guarantees individuals' right to directly appeal against violation of their rights (art. 34 ECHR).

By stating that the EU Charter of Fundamental Rights of 7 December 2000, as adapted at Strasbourg in 2007, "shall have the same legal value as the Treaties" (article 6, para. 1, Treaty on European Union (TEU)), the Treaty of Lisbon has transformed the Charter into a legally binding document. The Charter[2] codifies rights at the EU level, gathering together civil, political, economic and social rights, including some "new" fundamental rights such as an explicit right to data protection and provisions regarding bioethics. Article 6, para. 1, TEU states that "the provisions of the Charter shall not extend in any way the competences of the Union as defined in the Treaties", while article 51, para. 1, states that the primary addressees of the Charter are the EU institutions and that "the provisions of this Charter are addressed […] to the Member States only when they are implementing Union law". These provisions prevent any federalising effect of the Charter (Grussot, Pech, & Petursson, 2011; otherwise: Cardone, 2012; Strozzi, 2011).

Since the Charter has the same value as the Treaties, national judges have the power not to apply national laws which are incompatible with the Charter's rights. This means recognising the Charter's precise, clear, unconditional provisions (Van Gend en Loos judgement of 1963) having direct effect on national laws (Case

C-144/04, Mangold [2005], I-9981, Case C-555/07 Kücükdeveci [2010]; Besselink, 2012). Procedurally, national judges may raise before the Court of Justice questions of compatibility of EU legislative acts with the Charter's provisions, by means of references for preliminary rulings (art. 267 Treaty on Functioning of the European Union (TFEU)). An improved form of access to EU justice is the possibility for individuals to institute proceedings, in case of alleged fundamental rights violations, not only against "decisions" but also against general regulatory acts (see article 263 TFEU). Article 6, para. 2, TEU provides a basis for the EU to accede to the ECHR, entailing that all the EU acts will be subject to judicial scrutiny by the European Court of Human Rights to verify their compatibility with the ECHR provisions. Since the EU Charter practically covers the entire scope of the ECHR, cases of violations of the ECHR which would not also violate the EU Charter will be unlikely. According to the principle of prior exhaustion of domestic remedies (art. 35, para. 1, ECHR), individuals should presumably first refer to the Court of Justice of the EU to allege a violation of their fundamental rights.

Furthermore, the duty for national judges not to apply national legislation that violates EU law might also be extended to national rules violating ECHR provisions, which, after the accession of the EU to the ECHR, should be considered part of the European law. At present, however, such a perspective is not followed by the Court of Justice (Case 571/10, Kamberaj [2012]; Martinico, 2012). Finally, it also should be stressed that the EU Charter might be used as a parameter for the constitutionality of national laws (Austrian Constitutional Court U 466/11-18, U 1836/11.13, 14 March 2012).

In short, the Charter provides the European Union with an instrument for protecting citizens' fundamental rights, which will be an important touchstone when EU institutions regulate emerging robotic technologies.

Robotic Technologies

Robots are often associated with simple mechanical devices that perform dirty, dull or dangerous tasks. The International Organization for Standardization (2012, p. 38) defines a robot as an "actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks". The Oxford English Dictionary (OED) describes a robot first as "a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer".[3] At the same time, robots are also associated with humanoid machines that take over all kinds of functions from humans. The OED continues its description with "(especially in science fiction) a machine resembling a human being and able to replicate certain human movements and functions automatically".[4] Between simple mechanical tools and fully-functioning humanoids, robots comprise a spectrum of more or less autonomous devices that can perform a wide variety of tasks.

Robotic technologies, however, are not restricted to mechatronic devices. Robotics can also comprise remotely operated devices, such as telesurgery, drones or remotely operated vehicles, which may not function autonomously, but involve a certain degree of freedom in their functioning. Robotic software—'bots' or 'softbots'—also performs tasks with a certain level of autonomy. In fact, the OED includes certain softbots in a second definition of robot, namely "another term for crawler", i.e., "a program that searches the Internet in order to create an index of data".[5] Moreover, robotic technologies can also involve a combination of biological and artificial matter such as a robotic prosthetic hand connected to a human being's nervous system.

What these technologies have in common is that they display some level of agency through the way in which they interact with the environment. This notion of agency is particularly important for our purposes in this paper, as the rise of technologies with some level of agency challenges a basic understanding within the fundamental-rights framework, namely that rights and duties attach to humans and human actions. For the purposes of this paper, we therefore consider 'robotic technologies' to mean constructed systems—be they embodied in hardware, software, or hybrid bionic systems—that interact with their environment in a way that displays some level of agency.

European Law and Technology between hard and soft law

In spite of a widespread availability of new technologies, a specific legal framework for robotics does not currently exist in Europe. Issues arising from new technologies are generally dealt with by referring to existing national and European regulation and to general legal principles and instruments. To this end, regulation on for instance consumer protection, tort law, privacy and data protection or health and safety of products is normally taken into consideration. Although such rules represent a helpful basis to address legal questions, a need for more precise regulation may arise with respect to specific robotic applications.

A study carried out in the framework of the European RoboLaw project[6] shows that, generally speaking, regulation of new technologies is presently the result of an intersection between technical norms, ethical (or social) norms, hard law and soft law. Given the fact that technical norms provide a condition—and not a legal duty as hard norms do—in which one can achieve a given result, technical norms do not have intrinsic normative value, but they may acquire a legal status (e.g. standards established by standardization bodies, like ISO or CEN, that are referred to in case-law). In contrast, ethical and social norms stem from a given social context to determine what is "good" or "acceptable" (e.g. Codes of conduct). Consequently, they are not legally binding, but they may function as instruments of soft law which have a "comparative function". This function of soft law—particularly evident in the field of regulation of robotics—means that the respect of non-binding rules by the producers and sellers, is enforced by the market and social forms of regulation. These rules indeed serve as a parameter of reliability and quality assessment of stakeholders.

Crossroads between different types of norms in robotics regulation seem to reflect a more general trend in regulation. A hybrid model of rule-making, lying between general policy statements and legislation, may represent a more effective approach when dealing with complex and diverse problems characterised by uncertainty, which prevail in emerging technologies like robotics. This perspective acquires a particular significance in the EU framework, where a new regulatory policy has been developing over the past decades, characterised by an increasing emphasis on the use of alternative or complementary instruments to traditional command-and-control legislation, inspired by the aim to enhance the effectiveness, legitimacy and transparency of EU action.

This implies that if we consider how robotics affect fundamental rights protection, we need to take into account how existing norms, including technical and social norms and soft law, afford or inhibit the development of particular robotics application in a way that might impinge on individuals' fundamental rights.

HOW FUNDAMENTAL RIGHTS ARE CHALLENGED BY ROBOTIC TECHNOLOGIES

As with all new or emerging technologies, robotics raises various legal questions, not the least in relation to fundamental rights. We can distinguish between two levels of how fundamental rights are challenged by robotic technologies. First, and most obviously, the question how the current fundamental rights can be applied to robotics. Second, there are more fundamental challenges to the fundamental-rights framework such as the question whether new fundamental rights are needed to address gaps in legal protection that may arise through robotics. We will start with the first question.

Applying fundamental rights to robotics technologies

The above-mentioned Charter of Fundamental Rights of the European Union ('Charter') provides one of the most extensive and up-to-date enumerations of fundamental rights. We will briefly discuss which rights in the Charter might be affected by robotic technologies.

Title I of the Charter, 'Dignity', articulates that human dignity is inviolable (art. 1). Although robotics does not pose a challenge to human dignity as biotechnology, it is conceivable that further-reaching robotic applications, such as replacing well-functioning human limbs with super-functioning bionic limbs, could be perceived by some to violate human dignity. Perhaps it could also be argued that systematically outsourcing human care tasks to robots on a large scale, such as providing care to the elderly through carebots and companion robots with only a brief human visit each fortnight to see whether the robots are functioning well, undermines the dignity of human beings.

More important in title I is the right to integrity of the person: "[e]veryone has the right to respect for his or her physical and mental integrity" (art. 3). Primarily, this is a negative right that protects people from undue interference with their body or mind. Particularly for man-machine applications, such as prostheses connected to the nervous system or deep-brain stimulation, this implies that robotics affecting a person's integrity can only be applied with the individuals' free and informed consent. A challenge for legal practice will be to determine what constitutes informed consent in a field where the effects of technology are to some extent unpredictable and long-term health effects are yet unknown. At the same time, the right to a person's integrity is also a positive, self-determination type of right, implying that persons can develop their physical and mental functioning as they want (at least to the point where this might affect rights of others). People may therefore in principle be free to embed prostheses, chip implants and neural implants into their bodies. Since built-in technology soon tends to be perceived by individuals to be a part of themselves, the right to integrity of a person may also have to apply to human implants. This provides strong legal protection, but it raises questions when the implants are connected to external devices (Koops & Prinsen, 2007, p. 196; Roosendaal, 2012, p. 83).

Other self-determination rights are found in title III on equality. Particularly important for robotics are "the rights of the elderly to lead a life of dignity and independence and to participate in social and cultural life" (art. 25) and "the right of persons with disabilities to benefit from measures designed to ensure their independence, social and occupational integration and participation in the life of the community" (art. 26). Care and companion robots can significantly improve the possibilities of the elderly to lead a relatively independent life and to participate in social life, while hybrid-bionic applications such as exoskeletons and prostheses can help people with disabilities to lead independent lives and to participate in community life. Elderly and disabled people might therefore have strong claims to use robotic applications, possibly with some positive duty for governments to foster the development of such applications and to provide financial assistance.

In the same vein, the right to health care (art. 35) in title IV ('Solidarity') implies a duty of governments to provide access to robotics applications in the medical sphere. The fact that the Charter stipulates that a "high level of human health protection shall be ensured" could be interpreted as a positive duty for the European Union to stimulate the development of robotics in preventative and curative medicine.

Moving back to classic negative fundamental rights, the rights to privacy (art. 7) and data protection (art. 8) imply that people are protected against intrusion into personal or sensitive information that is generated or stored in robotic applications. Surveillance drones,[7] for example, should only be used if they comply with the conditions of article 52 Charter, implying that the surveillance must have a basis in law, be proportional and necessary, and meet an objective of general interest. The right to data protection also limits what robots can do in terms of registering information about individuals, which is relevant for, for example, household and street robots. Since body-related information can be sensitive (often constituting health-related information), human implants generating or storing information should be very well protected against external intrusions (Kosta & Bowman, 2012). And for man-machine combinations involving the nervous system, such as prostheses that are controlled by brain signals, it may also be relevant to take freedom of thought (art. 10) into account.

Since softbots process data almost by definition, data protection will be crucial in setting limits to what these bots can do. At the same time, however, fundamental rights, such as the freedom of expression (art. 11) and the right to cultural, religious and linguistic diversity, (art. 22) also involve the benefits of information-gathering, suggesting that individuals have the right to use softbots to facilitate their forming of opinions or expressing their cultural or religious identities. As it often occurs with information technology, the rights to privacy and to freedom of expression may require careful trade-offs (cf. Szekely, 2009). If governments deploy softbots for large-scale data processing and profiling, the right to good administration (art. 41) and the right to an effective remedy (art. 47) come into play. Due process is particularly relevant when decisions are taken about individuals based on computer software in which the logic underlying the decision may be particularly opaque; not only to data subjects, but also to institutions in whose name (semi-) automated decisions are taken (Hildebrandt, 2008). And should functioning of softbots or mechatronic robots cause harm and lead to a criminal prosecution (presumably of the person responsible for the robot behaviour), the fundamental right that criminal sanctions must be proportional (art. 49) will be relevant in determining to what extent the robot's behaviour can be attributed to the charged person.

When robotics is connected to human bodies, ethical and legal implications arise within the broader debate about human enhancement (see Benford & Malartre, 2007; Savulescu & Bostrom, 2009). One of the most important fundamental rights in light of human enhancement is the right to non-discrimination (art. 21). Is discrimination on the basis of someone being enhanced through robotics allowed? Since the prohibition of discrimination involves "any ground", enhancement is included, so people with a bionic arm or a brain implant should not be discriminated, for example, when applying for jobs. This will be especially important for the medical and insurance industries, because there may be substantial differences between the assessment of health risks of non-enhanced and enhanced humans. Nevertheless, it should be possible to make some differentiation in these areas since it is not by definition unreasonable to demand higher liability insurance premiums from someone with a bionic arm, if that person runs a higher risk of causing damage. Thus, in some respects robotics-enhanced humans could be treated differently, as long as this is done on the basis of a difference that is relevant for the purposes involved.

However, the opposite kind of differentiation may be more likely and potentially more dangerous. When enhanced humans function better or have increased or new capabilities through robotics applications, non-enhanced humans could be discriminated and the right to non-discrimination should be invoked to prevent 'normal' humans from becoming an underclass to enhanced humans. At the same time, differentiations could be justified. If an employer can choose between a human of average strength and resilience and an enhanced human with a bionic arm and exoskeleton that allows her to carry out super-human tasks, should the employer then not be allowed to choose the stronger candidate? However, should robotics-enhanced people systematically perform better at certain tasks, then the right to engage in work (art. 15) of non-enhanced people could get into a predicament.

The fine line between justified distinctions and unjustified discrimination may be particularly challenging to pinpoint for robotics technologies that allow not only the restoration of disabled capacities, but at the same time also afford new or enhanced capabilities, such as touching hot objects with bionic hands or seeing infrared waves with visual implants. The case of Oscar Pistorius—the 'blade runner' athlete—illustrates the importance of assessing whether robotic technologies provide restoration to 'normal' functioning or an additional advantage; it also illustrates the difficulty of making this assessment since one cannot usually divide a hybrid bionic system into 'the technology' and 'the human' to ascertain what is the added value of the technology to the functioning of the human body.[8] Moreover, such an assessment has to be made on a case-specific, individual basis since decisions involving fairness cannot be likely made on classes of disabilities or classes of prosthetic devices. This may well create a substantial burden on institutions and courts, but it "must be viewed as just one of the challenges of 21st Century life".[9]

The Charter also contains fundamental rights that may not at first sight be associated with robotics, but these nevertheless are relevant to take into account in the life-cycle of robotics technologies. People involved in research and development of robotics technologies can claim freedom of the arts and sciences (art. 13), implying that restrictions on the development of robotics technologies can only be imposed if they comply with the conditions for restricting rights or freedoms stipulated in article 52 of the Charter. In the same vein, industry producing and selling robotic technologies have the freedom to conduct a business (art. 16), and hence should not be curtailed in their business without good reasons serving a public interest or without an adequate basis in law. Employees involved in developing or producing robotic technologies have a right to fair and just working conditions (art. 31). In the case of factories employing industrial robots, the employees must be able to claim social security in case they suffer an industrial accident caused by a robot (art. 34). Similarly, buyers of robotics products have a right to consumer protection (art. 38) implying that product liability may apply, if robots do unexpected things the buyers were not informed about. They also have a right to property so that they cannot be deprived of their robots except in the public interest and under conditions provided for by law (art. 17). And in case robots are at the end of their life cycle, they should be disposed of in a responsible manner; given the "high level of environmental protection and the improvement of the quality of the environment" that article 37 of the Charter commits the European Union to ensure.

This brief overview of fundamental rights that may be affected by robotic technologies is not exhaustive. One could also go into questions such as whether article 9—the right to marry and the right to establish a family—should include the right to marry a robot (Levy 2008, pp. 151−159, 304−305). However, we leave the discussion here as the overview sufficiently demonstrates that a wide variety of fundamental rights is at issue in robotic technologies, including both negative ('freedom from') and positive ('freedom to') rights, which do not always lead towards the same direction. One important challenge therefore is to deal with conflicting rights, which we will take up in section 4. First, however, we want to point out a few other fundamental challenges to the human-rights framework.

Challenges to the framework of fundamental rights

Besides applying existing fundamental rights to developments in robotics, one should also consider whether robotic technologies could trigger, in the longer term, a need for the establishment of new fundamental rights. As the scope of this paper does not allow for an elaborate discussion, we have to limit ourselves to mentioning some hypothetical candidates (see, more extensively, Koops, 2013, from which the following examples are taken). If hybrid-bionic applications allow expanding brain functions, including memory enhancement, a need to forget (for example, for coping with traumatic experiences) may arise, or—more likely—a need for a right to be forgotten, for example, a ban against cyborgs accessing other persons' life history without consent. In light of the potential social pressure involved, if certain robotics applications provide huge benefits, individuals' right to integrity and self-determination might need to be extended with a right to imperfection, to emphasise that individuals should be allowed, if they so choose not to improve certain capabilities, for example, to resist the pressure to replace an amputated arm by a realistic looking bionic arm. Also, at the collective level, a discussion may be envisioned whether—following a 'Proactionary Principle' (More, 2005)—a social-economic right to technological advancement or innovation could be in order, given the undeniable advantages of robotics for society, which may not reach their full potential when hindered by excessive precaution. At the same time, a positive obligation on governments to stimulate the pluralism of humankind could be helpful, in order to prevent a possible tendency of human-enhancement technologies to evolve humankind into a boring uniformity of quasi-perfect people. In line with Fukuyama's concern about the biotechnological revolution erasing all negative qualities of humans and also erasing those positive qualities that only flourish in contrast with negative experiences (Fukuyama, 2002, pp. 172−173), pluralism of human qualities and the cherishing of imperfections could become important duties of care to preserve the depth and richness of human experience (Koops, 2013, pp. 177−178).

A second fundamental challenge to the fundamental-rights framework is the question who can claim fundamental rights (for seminal discussions, see Matthias, 2007; Solum, 1992). At some point, if robots become sufficiently autonomous and sufficiently perform independent and important tasks in society then a need will arise to also provide them with fundamental legal protection. Such a point likely lies in a remote future, if it will come at all, to the extent that fundamental rights are associated not only with functional agency, but also with self-reflection and moral agency. Nevertheless, it is not inconceivable that self-consciousness will emerge in, for example, complex multi-agent robotic systems, although at that point humans may also have evolved into hybrid amalgams that fundamentally challenge our current understanding of humans as unified identities that are transparent to themselves (Koops, Hildebrandt, & Jaquet-Chiffelle, 2010, pp. 558−559). In the more foreseeable future, however, one can envision robots as candidates for a minimum level of fundamental-rights protection even though they are not in all purposes similar to human beings, just as legal bodies, such as companies or international organisations, have legal subjectivity and can to some extent claim protection of fundamental rights such as the right to a fair trial. Particularly softbots could in the short to medium term perform important socio-economic functions in a relatively autonomous way, which legislators could back up by providing them with a limited form of legal subjectivity (Wettig & Zehendner, 2004), which in turn might establish a reason for applying certain fundamental rights, such as the right to privacy or to 'bytily' integrity, to softbots.

A third challenge is to determine to what extent the fundamental-rights framework should be considered to be leading in terms of steering the development of robotics, rather than be affected by these developments itself. Although fundamental rights are—as the term implies—fundamental, they are not untouchable. The fundamental-rights framework is continuously developing, partly in response to changes in the social, economic, and cultural landscape. Technologies have a significant impact on society, the economy, and culture, and therefore also influence normative assumptions and the way in which legal norms are interpreted over time. The mutual shaping of law, technology, and society implies that we cannot take the existing fundamental-rights framework for granted, but must always also consider to what extent socio-technical changes should lead to a re-interpretation or re-evaluation of legal norms, including fundamental rights. There may be a certain chronological order in the mutual shaping, in that at first, fundamental rights will primarily affect the way in which robotic technologies are developed and employed, whereas over time, the impact of robotics on fundamental rights will increase in importance (Koops, 2013, pp. 166−167). Nevertheless, the process of mutual shaping challenges the legal system to apply fundamental rights to technologies while at the same time it acknowledges that the interpretation or evaluation of the fundamental rights at issue also depends on the technology itself.

ISSUES FOR FUNDAMENTAL RIGHTS RAISED BY SPECIFIC ROBOTIC TECHNOLOGIES

To provide some depth to the above bird's-eye view, we will now zoom in on the implications of some specific robotics applications in different domains.

Industrial robots: workers' rights and liability

The massive and continuously growing use of robotic technologies in the industrial field has produced a growing debate over the alleged "dark side" of industrial robotics (Atkinson, 1989). One of the critical aspects which have been stressed several times is the possible negative impact on the occupational levels. Actually, "the two-edged nature of technical change: that it both destroys old jobs and creates new ones"

(Freeman, Soete, & Efendioglu, 1995; Puro, 1985) has been underlined for a long time. Nowadays, the impact of information and communication technology (ICT), among others things, let many think we are entering an entirely new era of a "post-industrial" society where information is the overarching commodity. In particular, we can identify three successive shifts in technology from the early 1970s: cheap processors, cheap networks, and cheap sensors (Zittrain, 2008), multiplying both the potential of robotics and informatics and their applications and their risks, including those relating to workers' health and job security.

Even though it has been early demonstrated that "historical and theoretical evidence argue against the idea that technological innovation will create permanent unemployment" (Bartlett, 1984−1985), the implementation of robots into the workplace, until relatively recently, has been regarded with suspicion. However, in the 1980s, the idea to contravene the new technologies was rapidly abandoned, and the attention of scholars focused instead on the need to give people an adequate professional training − and retraining − and to change the modalities of recruitment in order to bring supply and demand of highly-skilled jobs closer together (Bednarzik, 1985; Grossman, 1985; Rudin, 1985; Steffen, 1989). Consequently, in the U.S., Canada and many EU Member States, the application of the "work preservation doctrine" − or of similar rules aimed at the same objective − was hypothesised. According to this doctrine the modalities of introduction of industrial robots and their effects on the workforce should be part of a mandatory collective bargaining among employers and trade unions (Allan Lugo, 1986−1987; Mitchell, 1972; Moon, 1987; Story Parks, 1984; Zidich, 1984). The aims would be to reduce the counterproductive tension between labour and management, to avoid, whenever possible, the expulsion (as well as to facilitate the retraining) of a large number of unskilled or semi-skilled workers, and to engage unions in the gradual replacement of the current systems of job classification, making high flexibility in tasks assignments possible (Rosenberg, 1984; Solomon & Hyman, 1989).

On the other hand, we also need to consider that there may be workers who, for various reasons, are unable to retrain or do not have an interest in taking higher and possibly better remunerated tasks. For those people the imposition of a task change might be, to some extent, unethical, above all if the use of robots only aims at reducing firms' costs. At the same time, the necessity for industries to adapt quickly to innovation and the fact that dangerous jobs can be completed by robots, saving workers from exposure to health-threatening situations or substances, push for the extensive use of robotics in industrial contexts. However, this does not mean that using robots will necessarily reduce the employer's liability for workers' health and safety, since industrial robots themselves may constitute a hazard (Ebel, 1986). Therefore, it is essential to ensure that industrial robots are made safer through appropriate devices and workers receive adequate instruction in the proper handling of robots (Linsenmayer, 1985).

In case of damage or even death of workers caused by industrial robots, as already happened in the 1980s (August, 1988), it will be necessary to ascertain whether the accident was due, at least partly, to human errors (including of the victim herself). However, since every "worker has the right to working conditions which respect his or her health, safety and dignity" (art. 31, para. 1 Charter), even comparative negligence on the employee's side would not suffice to avoid liability of the employer, except in case of damage caused by a grossly negligent behaviour of the worker. Workers' fundamental rights imply that the need to foster innovation in industrial robotics cannot lead, as has been proposed by scholars in personal robotics field (Calo, 2011), to a limited immunity of manufacturers or employers. Anyway, the application of common workers compensation schemes, allowing employers to escape liability whenever current safety measures are applied, should theoretically lead to a similar outcome, at the same time balancing the need to guarantee a (partial) restoration for injured workers. However, as in the case of nanotechnologies, lack of scientific knowledge about risks may lead to a limited ability to prevent damages in the industrial environment (Mandel, 2008). It should also be kept in mind that, as in the case of unmanned vehicles, accidents involving (or caused by) industrial robots may be a new testing ground for the use of such technologies on a large scale and outside the industrial environment.

Furthermore, it might be envisaged that an employee using robots might also cause damage to colleagues or property, potentially leading to civil or criminal liability and to negative employment consequences (e.g., he/she might be fired). Therefore, as has been suggested in relation to nanotechnologies (Brenner, 2010; Lin, 2007), workers may demand greater safety precautions in exchange for these uncertainties. We could imagine workers also demanding wage premiums to offset uncertain risks, but it is debatable whether collective action determining such an "exchange" (i.e. "more wages vs. less protection") is compatible with individual workers' rights to a safe working environment. In the same vein, working-conditions bargaining should not be detrimental to employees' right to privacy on the workplace (which can be affected by surveillance robots), given the fundamental nature of the right of privacy (art. 7 Charter). This applies a fortiori to countries, such as Italy, that prohibit the use of equipment for remote-surveillance of workers (see Italian Laws of May 20th, 1970 n. 300 and of June 30th, 2003 n. 196). In these countries, industrial robots should not have the specific aim to monitor workers, as it would affect the workers' right to dignity (Casillo, 2008).

Assistive Technology: autonomy and privacy of elderly and disabled people

Robotics has great potential for helping elderly and disabled people to improve their functioning in the form of assistive technologies. Care robots can assist the elderly or disabled people, or their carers, in daily tasks, help protect them through monitoring their behaviour and health, and provide companionship in the form of companion robots (Sharkey & Sharkey, 2010, p. 27). There are many ways in which robots can be of assistance, for example bringing food or medication, dietary advice, feeding, lifting in bed, helping people to bathe or go to the toilet, serving as a memory aid and keeping watch to prevent elderly from falling. These robots raise various legal and ethical issues. Two primary, interrelated concerns discussed in the literature, are how assistive technologies affect autonomy and privacy.

Care robots may help elderly or disabled people to live at home rather than in an institution. At home, autonomy in the form of human dignity "is often achieved through cultivating skills and empowering the independence of the patient/care-receiver" (Van Wynsberghe, 2012a, p. 177). Since robots can improve people's capabilities, they can enhance their autonomy, for example, through an exoskeleton giving elderly an increased sense of control, which can, for example, empower them to increase social relationships by going to meeting places (Borenstein & Pearson, 2010, p. 281; Sharkey & Sharkey, 2010, p. 31). Some elderly people will also prefer being assisted by robots rather than human beings in certain intimate tasks such as bathing or going to the toilet (Sharkey & Sharkey, 2010, p. 31). However, robots could also decrease people's autonomy because they take over tasks and possibly, responsibilities from the patient. For example, a dietary assistant robot that tracks all caloric intakes may inhibit people in developing their own internal motivation to watch their diet (Van Wynsberghe, 2012a, p. 176). Moreover, while robots can empower people to do more, they may also bring risks to people's health or safety. Particularly with elderly people who might have slowly diminishing mental capabilities, it will be a challenge to design robots in such a way that they balance supporting people in their wishes and guarding their safety. "If a senior were to request that a robot throws them off the balcony, should the robot carry out that command?" (Sharkey & Sharkey, 2010, p. 31). Robots can be programmed to carefully restrain people when they start doing potentially dangerous activities, such as climbing on a chair, but this comes at the risk of introducing "authoritarian robots" (Sharkey & Sharkey, 2010, p. 33).

A particular concern is that if robots replace humans in certain care tasks, the care-receivers will suffer from a lack of relationships with human beings. As Sparrow and Sparrow (2006, p. 152) point out, people experience their autonomy partly by making decisions, however small they may be, that are being respected and recognised and "granted moral weight by another human being". If people's requests are carried out by robots, their choices might be experienced as less reflecting of their autonomy than if they were carried out by human care-givers. Moreover, relationships between elderly and disabled persons and the persons who are ultimately responsible for their care are affected, if robots replace relationships of trust and concern with relationships of efficiency or remote monitoring (Sparrow & Sparrow, 2006, p. 153). Companionship robots might lead to family and friends thinking "Don't worry about Granny, she's got the robot to talk to" (Sharkey & Sharkey, 2010, p. 35).

However, the flipside is that robot assistants could equally and validly be perceived as helping people to gain a certain level of independence from other people (Borenstein & Pearson, 2010, p. 286). Indeed, companionship robots do not lead people to neglecting Granny, but also attract people to visit her to see and play with her fun robot (Sharkey & Sharkey, 2010, p. 35). The point is that we should not look at care robots simply as substitutes for human beings in an otherwise unaltered setting; rather, we must consider the whole context of how care for the elderly or disabled people is organised socially and institutionally (Borenstein & Pearson, 2010, p. 283). An important aspect of this is that care robots not only affect care-receivers, but also care-givers. While they may enhance the autonomy of a family and other care-givers by changing a burden of care into a choice of care (Borenstein & Pearson, 2010, pp. 283‒4), it could also negatively impact on care-givers if they feel they are no longer needed or desired and lose human contact with the care-receiver. Large-scale deployment of care robots will also affect the human capabilities of people caring for elderly or disabled people (Vallor, 2011, pp. 266‒267).

As with autonomy, the right to privacy for the elderly or disabled people can also be positively or negatively affected. Care robots can help people to retain more privacy and keep control over their personal data (Borenstein & Pearson, 2010, p. 282). They can affect the importance attached to privacy: a care robot brings affordances, such as lifting people, so that they do not need their spouse to see them in possibly embarrassing situations, which can lead to people prioritising privacy over other values such as efficiency or human contact (Van Wynsberghe, 2012b, p. 22). However, care robots can also lead to behaviour being increasingly monitored. Since care robots need to have a good understanding of their surroundings, they will often be equipped with sensors and cameras that record the environment. These monitoring capacities raise significant privacy and data protection issues and hence should be taken into account in the design of assistive technologies (Cardinaux, Bhowmik, Abhayaratne, & Hawley, 2011, pp. 255, 262‒263; Sharkey & Sharkey, 2010, p. 33). For example, it will be more acceptable for elderly or disabled people if care robots do not apply constant video surveillance, but merely records and assesses movements without transmitting the images (Broadbent et al., 2011, p. 116). It might also be helpful if robots do not walk around and monitor autonomously, but do the equivalent of knocking on a door and wait to be invited in (Sharkey & Sharkey, 2010, p. 32).

More generally, such privacy-by-design features would fit in developing care robots in such a way that they comply with data-protection regulation, such as the European Union Directive 95/46/EC, which requires a legitimate basis for processing personal data (e.g., user consent, or protecting a vital interest of a patient), purpose specification and use limitation when data are collected. If consent is used as a legitimating ground, a concern in the case of elderly people who may suffer from mental incapacitation is that their family could give consent by proxy, but not necessarily in conformity with what the person would have wanted had she been able to express her will (Sharkey & Sharkey, 2010, pp. 32‒33). Since data will often be health-related and thus sensitive, they will have to be very strictly secured against leakage or unlawful access, not only to prevent abuse of personal data, but also to prevent malicious attacks such as making a robot trip an elder with limited stability or play noises that confuse people with dementia (Denning, Matuszek, Koscher, Smith, & Kohno, 2009).

To conclude, assistive technologies have a significant impact on the autonomy and privacy of elderly and disabled people, but the impact can be positive or negative (or both), depending on the context. As Sharkey and Sharkey (2010, p. 36) conclude, it "is not the use of robots in elder care per se that should concern us, but the ways in which they are used." Because the way in which various types of care robots are used varies widely, no general rules can be given for how they can comply with fundamental rights such as privacy, or fundamental values such as autonomy. The impact of care robots should be analysed in a broad context of care ethics, human capabilities, and individual differences. The best step for ensuring a responsible development and use of care robots is likely to be in the form of guidelines for various contexts and different functions and challenges of assistive technologies (Sharkey & Sharkey, 2010, pp. 37−38).

Biomedical Robots: informed consent and the right to self-determination in BMI applications

Recent advances in the area of biomedical robotics and neuroscience hold great promise in restoring motor, sensory or cognitive functions which are damaged as a result of an injury or a disease. These advances include the development of neural implants and neuronal prostheses, based on the connection of a human brain to a computer by implantable micro-electronic devices, called brain-machine interfaces (BMI). These brain-implantable devices may represent a therapeutic option for several disorders and illnesses (Friehs, Zerris, Ojakangas, Fellows, & Donoghue, 2004). Nevertheless, research on BMI and possible future applications raise questions about their impact on patients' self-determination and decision-making capacity. If one considers the effects of BMI on the right to self-determination, two opposite situations should be examined. On the one hand, there is the risk of undesired alterations of personality that could be induced by BMI's application (Klaming & Haselager, 2010). On the other hand, modern brain technology might instead contribute to enhance self-determination of patients with communication disorders by enabling them to interact with the surrounded environment (Clausen, 2008; Kübler & Birbaumer, 2008).

When considering the right to self-determination in respect to clinical interventions, aspects of informed consent have to be taken into account. From a legal and ethical point of view, informed consent represents a precondition for medical treatments (article 5 Convention on Human Rights and Biomedicine; article 3 European Charter of Fundamental Rights). According to the procedures laid down by law, patients should be in a condition to weigh personal factors along with clinical information to make the choice whether or not to undergo a given treatment or trial (Beauchamp, 2011). A number of conditions normally apply for a valid consent: these certainly include that patients shall receive adequate information from physicians and have the capacity to consent. The latter may be understood in a twofold manner, depending on whether one refers to the decision-making capacity of a given patient or to the capacity to communicate his/her will, assigning legal value to the choice the patient has made. Patients with locked-in syndrome, for instance, are not able to consent to a medical treatment since "they cannot communicate a consent or refusal at all, though having the cognitive skills necessary to understand the required information" (Clausen, 2008).

Due to the relevance of informed consent in guaranteeing personal autonomy and self-determination in the medical field, identifying and solving issues arising from BMI applications has become a challenge which needs to be addressed. Using brain-machine interfaces is likely to impact all of the several conditions mentioned above with respect to informed consent. To understand how it might happen, one has to consider that BMI technology is a wide category which includes devices performing different activities in connection with the human brain (Decker & Fleischer, 2008). These devices may be implanted to record brain signals in order to direct them to an external computer or to stimulate neural activity "by sending electrical impulses directly into neural tissue or by placing magnetic fields near to them". Recording BMI systems are clinically used to improve or substitute communication skills in patients who are completely paralysed and unable to speak or otherwise unresponsive. Decoding information recorded by such devices may also be employed to develop neuronal prostheses (Micera et al., 2010). Current applications of stimulating BMIs are cochlea implants for repairing auditory impairment in deaf patients and deep brain stimulation (DBS), which benefits people suffering from end-stage Parkinson's disease, essential tremor, or dystonia, and may play an important role in the future in treating depression and obsessive compulsive disorder (Lozano, Dostrovsky, Chen, & Ashby, 2002; Lypsman & Glannon, 2012; Mayberg, Lozano, Voon, McNeely, & Seminowicz, 2005; Perlmutter & Mink, 2006). Furthermore, research on brain-machine interfaces might offer important breakthroughs in restoring motor and sensitive functions in paralysed patients (Van den Brand et al., 2012).

Establishing a deep interaction between a human brain and a machine has raised questions on possible undesired changes in the user's personality. It has been highlighted that brain-implantable devices have a certain influence on personhood (shifting personality, fluctuation from a depressive to a euphoric state, alteration of desires and will) and may alter the patient's free will (Clausen, 2010; Klaming & Haselager, 2010; Lypsman & Glannon, 2012). In such cases, effects on the decision-making process of a BMI user have to be taken into account to assess whether the patient, when asked to consent to further medical treatments, is still aware of risks and benefits and able to determine his/her will without any influence. The assessment of personality alterations caused by BMIs applications is particularly important in the informed consent debate, since it stresses the unsolved issue concerning the gap between a substantive approach and a formal/procedural one to the notion of informed consent. In the first sense "a person gives an informed consent […] if and only the person, with substantial understanding and in substantial absence of control by others", consents to undergo a medical treatment. The second meaning refers, instead, to the compliance of a given informed consent to procedures and rules provided by the legal system (Beauchamp, 2011). In one case, a matter of autonomy and self-determination and in the other, the result of a given social and institutional context. In relation to people who are able to give valid consent, the effects produced by neural implants seem to require a careful reflection on both approaches. With regard to the substantive approach, current and future research in the field of BMI has to precisely assess the possible risks of undesired alterations of personality so that physicians may offer adequate information to patients in relation to the cost/benefit assessment. Moreover, from a legal point of view it seems necessary to establish rules and procedures which will consider, at least, the following aspects: permanent or temporary nature of the implantable device, invasive or non-invasive BMI, how consent can be freely withdrawn in case of BMI applications, and a specific procedure for obtaining informed consent when treatment through brain-implantable devices is carried out several times on a given patient (Helgesson & Eriksson, 2011).

Considering applications of BMIs for treating severely paralysed patients shows that brain-implantable devices can also have a great potential in enhancing autonomy and self-determination. Recorded and decoded electrical signals from neural tissues may be sent to a computer in order to restore some communication skills in those patients who are totally unable to communicate, although aware and conscious of their environment (Clausen, 2008). The development of these devices is bound to offer breakthroughs in protecting the right to self-determination of such vulnerable people. However, to attribute legal value to the patient's will expressed through the device—as is necessary with regard to informed consent—specific criteria and conditions have to be established. Italian case-law, for instance, attributed legal value to a will that was communicated by an electronic device of a person suffering from end-stage amyotrophic lateral sclerosis (Pizzetti, 2010). Using a device which directly expresses personal will and choices was considered more in line with the protection of the right to self-determination than appointing a guardian for the patient's interests. However, to assign legal value to such statements, three conditions have to be respected, according to the Italian case: the device has to be suitable to this purpose and periodically checked; it shall represent a reasonable and proportionate instrument in relation to physical and psychic conditions of the patient; finally, two witnesses have to be present in order to ensure that statements come indeed from the patient.

In conclusion, medical devices based on brain-machine interfaces may, in certain circumstances, have great potential for protecting and enhancing the right to self-determination. Nevertheless, undesired and unpredictable alterations of a patient's personality and autonomy could derive from BMIs applications and influence the decision-making process. Therefore, according to the opinion "Ethical aspects of ICT implants in the human body" of the European Group on Ethics in Science and New Technologies, implants of devices shall be carried out cautiously and, mainly when vulnerable people are involved, their lawfulness has to be assessed with respect to fundamental rights' protection.

FACING THE ISSUES: HOW TO HANDLE CONFLICTS IN A CONSTITUTIONAL FRAMEWORK

The increasing interaction of human beings with robotic technologies is producing more possibilities to fulfil fundamental rights, as a result of great potential of such technologies to facilitate and enhance human capabilities. However, having more ways to satisfy human rights is never straightforward, as it may mean an increased likelihood of conflicting rights. Technologies can facilitate rights of some while negatively affect rights of others, involving questions of distributional justice and equal access. And for individuals, improving certain rights can come at the cost of other rights, for example, industrial robots taking over dangerous jobs but increasing surveillance on the workfloor, or neural implants that enhance autonomy but may affect personality. To be sure, conflicts occurring between fundamental rights is by no means a new matter. Nevertheless, robotics may lead to an increase in rights conflicts because of their wide range of affordances in relation to human capabilities. However, from a legal point of view, the effects produced by new technologies on fundamental rights should not be framed as merely a question of number of conflicts. We argue that it is rather a matter of identifying the type of conflict, which provides a direction for looking for solutions.

With respect to the type or quality of a rights conflict, one has to consider that fundamental rights are basically expressed through principles, which in turn reflect the pluralism of values in a democratic society. The reason why fundamental rights clash with each other has to be properly identified in the lack of a hierarchy in values by which all conflicts could be solved. Indeed, constitutions, setting catalogues of rights and paradigms of values, generally do not define hierarchies nor presuppose an articulated system of predefined criteria to handle conflicts. In this regard, it may be argued that robotic technologies might influence value notions and value systems, by fostering those rights or values which are more fulfilled by robotic applications to the detriment of rights or values that are less compatible with certain robotic applications. Should we trust technology (and its developers) to lead the way, we would allow the constitutional framework to subtly change shape as the plural values embedded in the framework acquire different meanings, without a careful normative consideration whether we want society to change thus. Assuming that technologies are an instrument to realise rights but not a licence to have human values changed without reflection, we must decline such a perspective. And while the increasing pervasiveness and impact of robotic technologies on society increases the responsibilities of their developers (Luppicini, 2009, p. 16), in line with the paradigm of value-sensitive design (Friedman, 1997), we cannot trust all value conflicts to be solved in the design process of robotics technologies. There are no clear-cut *generic* answers to questions of what robotics applications should or should not be able to do, and therefore, not all value conflicts can be solved by making design choices in the development stage of robotics. This implies that we should not overlook the value and rights conflicts that may be involved in when robotics applications land in society, but must try to meet these conflicts head-on, through technoethical critical debates about what it means for robotics technologies to be responsibly used.

Following such critical debate, deciding on the responsible use of robotics applications in light of conflicting values and rights will be an important task for the law. With respect to solving conflicts, we know from the previous sections that the EU has no specific regulation on robotic technologies so that "technologically oriented" conflicts between rights are generally solved by identifying within existing legal frameworks a rule that may be applied on the basis of a similarity relationship between cases. When no specific rules are applicable, courts normally solve an issue by a case-by-case comparison (Alexy, 2002; Zucca, 2007). The increasing issues arising from emerging robotic technologies make this kind of approach unsatisfactory. It is more and more perceived that the need for smart regulation, including soft law approaches, could be an appropriate answer to regulating technologies in a complex and highly dynamic context. Indeed, soft law enables balancing the flexibility of non-binding and participatory rules with a sufficient level of legal certainty that would otherwise be compromised if we were to rely solely on the judge to (re)define fundamental rights in relation to robotics on a case-by-case basis. The creation of widely shared or standardised rules and guidelines applicable to robotic technologies would be a response (especially) to meet the challenge of applying existing regulation to new developments that challenge fundamental rights in various ways. Shared norms, standards, and guidelines can assist judges not as an exclusive, but as a suggestive instrument to address conflicts of rights or duties in cases involving the 'intersection' between persons and technology that challenges traditional legal categories.

CONCLUSION

As robotic technologies become more pervasive in contemporary society, we must face the challenges to fundamental rights that the increasing merging of human beings with technology brings. In this respect, this paper has focused on different issues in the various fields where robotics is applied. Industrial robotics, for example, having historically developed before assistive and biomedical robotics, is an area already extensively regulated, at least in developed countries. Conversely, the other fields, due to their relatively recent growth, probably need greater regulation. Such regulation, depending on the matters and on the interests at stake, could be introduced in the form of "hard law" or by means of "soft law" rules, whose usefulness is based on an ability to give flexible or continuously updated answers. This would also comply with the rapid changes that are characteristic of such technologies.

At the same time, a common thread in all three fields of robotics is the need to protect the most vulnerable people. In fact, in the industrial robotics area there is a need to protect non-skilled workers against risks of safety as well as job security that may be involved in the use of new technologies. In the field of assistive robotics, users' autonomy and privacy and the right to equal access to such technologies must be guaranteed. Finally, the use and experimentation of biomedical robots have to be done in compliance with the patients' and users' fundamental rights to dignity and self-determination. Each of these fields involves a complex weighing of interest, as there are no straightforward answers to how exactly robotic technologies should be developed.

In addressing these issues, we believe that the European constitutional framework, including the recent EU Charter and the long-established Constitutions of each Member State, can provide a basis of legal principles for a responsible development and use of robotic technologies that deeply impact on people's life. As we have argued, the constitutional framework will not yield unequivocal answers to regulatory questions, but it needs to serve as a touchstone for regulation, and therefore also must have a prominent place in the broader technoethical debate about robotics. To help address conflicts between rights and values that will inevitably arise, we suggest the development of a set of shared norms, standards and guidelines that can, in the form of soft-law, bridge the gap between high-level and abstractly formulated fundamental rights and the down-to-earth, daily practice of developing and deploying robotic applications.

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[5] Oxford English Dictionary online, 'robot' and 'crawler', http://oxforddictionaries.com/ (accessed 12 February 2013).

[6] www.robolaw.eu.

[7] See http://en.wikipedia.org/wiki/Unmanned_aerial_vehicle (accessed 12 February 2013).

[8] See Court of Arbitration for Sport 16 May 2008, *Pistorius v. IAAF*, CAS 2008/A/1480.

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