Suggestion for a green paper on legal issues in robotics

*Contribution to Deliverable D3.2.1 on ELS issues in robotics*

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Executive summary

This document contains a description of legal issues in robotics and a set of recommendations to overcome these issues. It also contains some elements of roadmap to overcome these obstacles. The document does not explore all legal issues in robotics. It is the result of one of the first dialog between the law community and the robotics community. It is meant to stimulate a debate on this topic. It constitutes a proposal for a green paper on legal issues in robotics.

This document can also be taken as a guide book for robotics people to know basics on legal issues in robotics as well as for lawyers as a reference to matters that concern robotics and its development in Europe.

The document contains 10 chapters.

In the introduction we describe the context of this green paper and the methodology chosen. In chapter 2 we frame the issue: we make a tour of some definitions of a robot we then describe the existing legal framework for law issues in robotics in Europe. We also provide there some basic concept about autonomy and describe the abilities of a robot. In the next chapters we present an analysis of the legal issues in robotics, following a top down approach analysing these issues in areas of private law, criminal law, intellectual property right etc. Chapter 3 dedicates to market and consumer law, chapter 4 concentrates on Intellectual Property Rights, The chapter 5 concerns labour law, the following chapter 6 is on data protection. Chapter 7 relates to criminal law. Chapter 8 is upon civil law, and presents contractual and non-contractual liability issues in robotics. In the following chapter 9 we present solutions that could help solving issues presented. Chapter 10 describes some principles proposed under common law regime. We then conclude this green paper, summarizing the suggestions made in the document. The appendices contain a glossary, the list of people involved in the elaboration of the document, the publications made, the bibliography, the meetings organized and a visual presentation of the roadmap.
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1. Introduction

1.1. What is the purpose of this document?
This document constitutes a set of suggestions for a green paper on legal issues in robotics. It describes the effort undertaken in the project euRobotics (euRobotics coordination action, 2012) on legal issues hindering the development of robotics in Europe. The document contains recommendations to overcome issues and some elements of roadmap to overcome these obstacles. The document does not explore all legal issues in robotics. It is the result of one of the first dialog between the law community and the robotics community. It is meant to stimulate a debate on this topic.

euRobotics (Bischoff, Pegmann, Leroux, Labruto, & al, 2010) is a coordination action supported by the European Commission. The general objective of this coordination action is to identify obstacles hindering the development of robotics with a specific focus on service robotics and to propose actions facilitating the developments of robotics activity in Europe in terms of research, development, innovation, market or usage. This document represents one part of the road mapping effort conducted in euRobotics on Ethical, Legal and Societal (ELS) issues deterring the development of robotics in Europe. The study focused on legal issues specific to robotics. We however try to emphasize the connections of legal issues in robotics with legal issues in other major technical sectors of the industry in order to provide additional reason to stimulate evolutions of the current jurisdiction when necessary. We limited our study to European legislation although we observed with surveyed the effort made in the domain outside Europe.

This document can also be taken as a guide book for robotics people to know basics on legal issues in robotics as well as for lawyers as a reference to matters that concern robotics and its development in Europe.

In the following, sections, we describe the concept of green paper and the methodology adopted to identify legal issues in robotics.

1.2. What is a “green paper” and a “white paper”
This document constitutes a proposal for a “green paper” on legal issues in robotics. Green paper is a term used by European Commission to define “a discussion document intended to stimulate debate and launch a process of consultation, at European level, on a particular topic” (Green paper). It may be preparatory to a “white paper”. A White paper (EC terminology) is a “document containing proposals for European Union action in a specific area” a document gathering some proposition to be presented to the political instances of the EC. A white paper can be a set of recommendations to change a legal framework for example. This document is not a green paper stricto sensu. It constitutes a proposal for a green paper since it is not an official EC document.

The purpose of euRobotics action being rather broad and concerning Ethical Legal and Societal issues at the same time, limits the spectrum of issues addresses in this proposal for green paper. This document does not pretend to provide a complete overview on legal issues in robotics and to provide an exhaustive list of actions to undertake. This document is the preamble to a further document containing proposals for a “white paper”, which will be elaborated within the research project Robolaw (www.robolaw.eu), a project also supported by the European commission under the Framework Programme 7.

1.3. Why choosing a top down approach?
The methodology followed in the document consists in a top down approach consisting in studying for each legal domain, the consequences on robotics. This chapter explains the reasons of this choice as well as the global methodology chosen.

The first steps of the effort carried on gathering a community of legists, philosophers, specialists in ethics together with experts in robotics interested in targeted topic. The list of experts and specialists is in the appendix of this document. euRobotics organized a set of meetings in order to describe the

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1 grant agreement number 248552
objectives, make the jurist and robotics communities know each other, “share” common language, vision and objective and finally organize the work on the green paper. We paid attention to choose experts from different countries to take into account the differences between different jurisdictions and practices.

To circumscribe the issue, we tried at first stage to organize the work around a set of case studies. Studying the legal issues in robotics starting from case studies had several weaknesses:

- **A bottom up approach presents the risk to forget some legal issues**

  Concentrating on case studies would lead to highlight a reduced set of legal issues. The risk is to leave aside and forget important matters and finally to show only a limited and restricted impact of legal issues on robotics development and activities. For example focusing on assistive robotics might highlight some major aspects.

- **There is a risk of fragmentation of the problem**

  Considering legal issues from specific case studies (surgical robotics, autonomous transport or co-working for example) would lead to reduce the impact of legal issues in the economy, thus limiting the interest to change the existing legislations. For example detecting non-contractual liability issues in assistive robotics have not the same impact has expressing these non-contractual liability issues in service robotics as a whole.

- **A bottom up approach may drive to miss commonalities within robotics and with other technological disciplines.**

  For example forgetting to study autonomous transport would lead to miss the commonalities for this case study with legal issues in car industry, thus missing an opportunity to take advantage of the dynamics of this important sector of the industry.

- **A bottom up approach is time demanding**

  There is a large number of case studies in robotics: co-working, autonomous transport, aerial, surgical and assistive robotics, etc. Case studies are presented in detail in the Strategic research Agenda for Robotics Source spécifiée non valide. These case studies are inhomogeneous in legal terms: the issues are quite different in surgical robotics and in assistive robotics for example. Analysing legal issues for each case study would need to understand whether current legislation is in line with each specific case, in all European countries. This appeared to be too much time consuming.

We decided therefore to choose a top down approach starting from existing legislations to analyse which the impact on case studies. The goal was to propose more impacting solutions, transverse to robotics applications possibly linking these issues to other economic sectors emphasizing this way the importance of challenges to tackle. An illustration is for example to consider legal issues in autonomous transport as the same topic as legal issues in automotive or to consider privacy issues in assistive robotics as a particular case of privacy issues in with computers.

It is interesting to see that the difference between this top down approach chosen in the green paper and the bottom up approach mirrors the different approach to legal interpretation in civil law on one hand and common law on the other hand.

1.4. **What does the green paper not deal with?**

This report deals with short or mid-term visions of robotics. We excluded the case studies related to futuristic visions of robotics like post-humans. We also excluded from our study military robotics. The analysis on ethical and societal issues is part of the report D3.2 Ethical Legal and Societal issues in robotics a deliverable from euRobotics project.

1.5. **Plan of the document**

Chapter 2 frames the issue: we make a tour of some definitions of a robot. We then describe the existing legal framework for law issues in robotics in Europe. We also provide some basic concept about autonomy and describe the abilities of a robot. In the next chapters we present an analysis of the legal issues in robotics, following a top down approach analysing these issues in areas of private law, criminal law, intellectual property right etc. Chapter 3 dedicates to market and consumer law, chapter 4 concentrates on Intellectual Property Rights, The next chapter 5 concerns labour law, the
following chapter 6 is on data privacy law. Chapter 7 relates to criminal law. Chapter 8 is upon civil law, and presents contractual and non-contractual liability issues in robotics. In the following chapter 9 we present solutions that could help solving issues presented. We then conclude this proposal for a green paper, summarizing the suggestions made in the document. The appendices contain a glossary, the list of people involved in the elaboration of the document, the publications made, the bibliography, the meetings organized and a visual presentation of the roadmap.
2. Framing the issue: critical aspects

Robotics and law is quite a huge field and any definition can be challenged for being too broad (and elusive) or too narrow (and exclusive). Whatever the level of development of their cognitive capabilities, robots can currently be considered as automatic machines. In this sense, it is crucial to understand what a European legal framework should be in order to allow

- taking advantage from currently available technology in robotics and AI;
- a proper regulation of production and commercialization of robots;
- guarantee public safety;
- protect individual freedom and rights.

2.1. A matter of definition and products

It is not so simple to find a clear definition of the word “robot” neither in common nor in technical language. Many websites seem to take the definition of robots for granted. But there is actually no general consensus on what a robot is and which machines can be qualified as robots.

According to Wikipedia, “a robot is a mechanical or virtual intelligent agent (but the latter are usually referred to as bots) which can perform tasks on its own, or with guidance. In practice a robot is usually an electro-mechanical machine which is guided by computer and electronic programming”. So, the matter of robotics (the discipline dealing with the design, construction, and operation of robots) is related to the sciences of engineering, electronics, mechanics, and involves also software and artificial intelligence.

The Encyclopaedia Britannica, instead, gives a more sociological definition: “any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner”.

Merriam-Webster dictionary gives even three different (and perhaps misleading) definitions:

a) a machine that looks like a human being and performs various complex acts (as walking or talking) of a human being;

b) a device that automatically performs complicated often repetitive tasks;

c) a mechanism guided by automatic controls.

More technical definitions use a different wording and refer to non-human agents or intelligent machines: “the intelligent machine can be a robot, an artificial agent or other machine that implements some functions requiring autonomous decision making. Such a machine consists of the machine hardware, software, and an additional level of abstraction, the machine cognition”.

Last but not least, recently, the ISO 8373, “Robots and robotic devices — Vocabulary”, has just been updated with the description of the general class hierarchy of robot’s types. According to this Standard, a robot is an “actuated mechanism programmable in two or more axes (directions used to specify the robot motion in a linear or rotary mode) with a degree of autonomy, moving within its environment, to perform intended tasks”. The ISO makes a classification of a robot into “industrial robot” or “service robot” according to its intended application.

In general, some of these definitions emphasize the repetition of tasks and activities, often in place of human beings, while others point out the autonomy of the robot. Still others go so far as to seek/identify any additional skills, such as reasoning, planning, adaptation. Indeed, none of these definitions is totally wrong or right, since there are robots very different from each other. Existing so many definitions and approaches, it is easier to understand what a robot is by looking at what it can

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4 http://www.britannica.com/

5 http://www.merriam-webster.com/dictionary/robot

do, its characteristics and tasks. As technical experts teach us, a robot may have many abilities: locomotion, autonomy, the ability to interact, plan and even reason and learn.

Of course, every level and typology of abilities may have different legal implications.

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**LEGALLY SPEAKING**

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**GOOD**

- any tangible movable item, with the exception of:
  - goods sold by way of execution or otherwise by authority of law,
  - water and gas;
  - electricity.

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**NON-HUMAN AGENT**

- entity able to do, considering its actions in the area of legal responsibility.

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**IPR**

- Market

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**Security Standards**

- Consumer protection

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**Data protection**

- Criminal Law

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**E-Personhood**

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Figure 1: robots a matter of definition

Robots are artefacts, instruments in the hands of manufacturer, programmer, owner and user. Legal issues raised by the use of a robot can be traced to different macro-areas, such as the safety of new technologies, especially for their use in workplaces or by carrying out dangerous activities; the placing of the product "robot" on the market and the surveillance of the market, intellectual property rights (who has the intellectual property rights when a robot makes a new invention?). But, on a second layer, especially if autonomous and cognitive, robots can also be seen as agents, as entities which act and react in their environment. In this case, the liability for robot's action may become a crucial point.

For this reason, it is reasonable to split the analysis into two different sides: a) the European law on technical requirements in order to protect consumers; b) the legal responsibility arising from a robot's harmful action.

### 2.2. Autonomy for Philosophy, Engineers and Law

Among the most critical and controversial terms currently used in robotics there is that of *autonomy*. To define today *autonomy* (from Ancient Greek *auto-* meaning 'self' and *nomos* which means 'custom, law', OED) is of critical importance since the term is related to an advanced form of control of artefacts aimed at removing the online dependence on human intervention. With respect other forms of control, such as an automatic or a tele-operated system, which are still dependent on a human operator either for the acquisition of inputs or the making of decisions, an autonomous system acquires inputs and makes decisions by its own.

Therefore, autonomy brings about challenges and tensions which span beyond the robotics fields into ethics and law. Indeed, there is an impellent need to devise a legal framework for regulating the use of autonomous robots, to ensure their safety by means of new standards and risk evaluation procedures, and to establish criteria for ethically and socially acceptable applications. As pointed out in a recent study on drones ‘autonomy is no longer solely a feature of humans. Whether it is a desirable quality for machines will be among the most important policy questions of the coming years’ (Marra and McNeil, 2012).

This complex framework obliges roboticists, lawyers and ethicists to work together within a multidisciplinary perspective in order to confront and support their findings. It is precisely that ‘interdisciplinary’ collaboration the main reason for the current debate on the meaning of the word
autonomy. As a matter of fact, as we shall see, autonomy means different things to different people and sometimes its meanings are mutually exclusive.

Moreover, the terminological complexity surrounding the term autonomy is further increased by the tendency typical of human beings to humanize objects, also known as “anthropomorphism”. In other words, autonomy, likewise intelligence, cognition, and behaviour is among those qualities that human beings attribute to in-animate entities, like cars, computers and also robots.

The confusion generated by anthropomorphism is of many kinds and affects mainly laypeople. For instance, anthropomorphism may be responsible for raising the level of users’ expectations towards the actual capabilities of an autonomous robot, or for making them believe that autonomous robots are technologically independent, namely possessing a "will of their own". In so doing, anthropomorphism generates in the user or beholder an attitude which tends to ignore that inside robots are not mysterious mechanisms (e.g. ghost in the shell) but causal links, such as computer programs, which have been realised by human beings.

Given the fact that robots are physically embodied and that often they are designed to resemble human beings in their morphology and/or behaviour, the effects produced by anthropomorphism on autonomous robots may be very strong.

The scope of this brief section is to shed some light on the usage of autonomy by considering its meaning from the perspectives of robotics engineers, philosophers and lawyers and to highlight some of the consequences which its different connotations may generate.

From the standpoint of the robotic engineer, an autonomous robot can be defined as a robot capable ‘to operate in the real-world environment without any form of external control, once the machine is activated and at least in some areas of operation, for extended periods of time’ (Lin et al, 2011).

In actual facts, taking into account the current advancements of technology, today autonomous robots are often characterised by degrees of autonomy. The terms in the loop, on the loop or out of the loop are often used to mean the level of independence of a robot from a human being during the various phases or tasks into which a goal has been subdivided. On the one hand, there is autonomy, which, as it has been pointed out above, refers to the ability to perform a task without human intervention (in this case the human is out of the loop). There exists also an intermediate level of autonomy, so called semi-autonomy or shared control, in which the accomplishment of a task is shared between a robot and the supervision of a human operator (the human is on the loop). Finally, in tele-operation, the human operator is in the loop, since he/she is in full control of the robot during the execution of a task.

It is not unusual, therefore, to find autonomous robots characterised by multiple degrees of autonomy. For instance, a drone can fly autonomously during navigation but be supervised during ascent and descent phases and tele-operated during a strike task.

The selection of different degrees of autonomy for controlling an artefact is primarily a matter of choosing the right balance between safety and performance, which in technical jargon is referred to as dependability. The right degree of autonomy may be quantified by characterizing the safe operating region within which the system acts appropriately (Antsaklis and Meystel, 1998). However, notwithstanding its dependability, the degree of autonomy may also depend on non-technological factors. Indeed, there might be situations in which autonomy may not be desirable, for instance when there are human beings involved in the task carried out by a robot. In other words, the desirability of autonomy may depend on social (e.g. social resistance by prospected users), legal (inadequacy with respect to the legal system), or ethical issues.

Turning our attention to the meaning of autonomy in the field of philosophy, it is important to introduce the term as being related to self-rule, which is based on two components: ‘the independence of one’s deliberation and choice from manipulation by others, and the capacity to rule oneself’ (Christman, 2011). Hence, in philosophy autonomy mainly refers to the ability to decide one’s own goals. The emphasis is not on how the task is carried out, as it is in robotics, but on why, namely on volition (Haselager, 2005) as well as on the authenticity of the goals that trigger someone to act. Applied to a robot, such an understanding of autonomy would imply the possibility to set and decide its own goal(s).

Such a difference of perspectives brings about the issue of whether total autonomy, both for robots and humans, will be ever possible and even desirable. In philosophy the question of whether human beings can be fully autonomous, namely fully independent from external and internal forces is an over debated issue. It seems that a strong definition of autonomy applies neither to human beings nor to
robots. As a matter of fact, some scholars, such as Martha Nussbaum, see the relational dependence on the other as a relevant element for a more humane definition and understanding of autonomy.

In robotics, absolute autonomy, as it has been pointed out, would imply a conflict between a robot and those who have created and programmed it, which, on its turn, would mean the annihilation of the very raison d'être of robots – i.e. to serve human beings. A completely different scenario, one in which robots can rebel against humans will loom on the horizon. It is not surprising therefore, that looking at the variety of definitions of autonomy currently used in robotics, the possibility of self-generating goals is never contemplated: ‘such robots [autonomous robots] will accept high-level descriptions of tasks and will execute them without further human intervention. The input descriptions will specify what the user wants to do rather that how to do it. The robots will be any kind of versatile mechanical device equipped with actuators and sensors under the control of a computing system’ (Latombe, 1991: IX). Hence, it follows that the rules governing the robot, i.e. the programme and the input descriptions received by the user (i.e. the goal) are the distinguishing features that characterize the understanding of autonomy in robotics. They are the two ways in which human beings currently control the robots, respectively from the inside and outside, and make them still dependent on human beings.

Finally, through the lens of law, the concept of autonomy can be related to several issues, depending on the branches of law (e.g. private, public or administrative) and the legal system considered. According to the Italian private law system, for instance, autonomy is generally understood as ‘one’s own power to rule his/her own interests and to decide about his/her own juridical sphere, in accordance with the limits and duties established in the juridical order’ (Enciclopedia Treccani). On the contrary, the Italian administrative law defines autonomy as ‘the capacity to self-determination and self-rule acknowledged to certain public bodies’ (Enciclopedia Treccani).

On a very general level, and taking into account several branches of law, it is possible to relate the term autonomy to:

- possessing a legal status (having rights and duties),
- having legal capacity (making decisions or taking actions which are valid by law),
- and being legally accountable for the decisions made or actions taken.

Therefore, with respect to robots, from the point of view of law, the notion of autonomy opens the ontological issue of the ‘legal qualification’ of robots according to the existing taxonomies, namely natural person, physical person, animal or things and of the attribution of rights and duties. Furthermore, autonomy would bring to the fore the question of whether robots should be endowed with legal capacity and be considered responsible in case of damages according to civil and criminal law.

2.3. Law and legislation in Europe

Laws and legislation in Europe set up a multi-layered reality. Currently in the European Union as a whole and in each country of the Union laws are the results of a multifaceted law-making process with several law-makers at work:

a) International sources (international treaties and conventions involving also non-European countries: e.g. World Intellectual Property Organization - WIPO - and the WIPO Convention (1967), The World Trade Organization - WTO).

b) Conventions and agreements signed within the Council of Europe (i.e. European Convention on Human Rights).

c) European Union law sources:

a. Regulations (a legislative act of the European Union which immediately becomes enforceable as law in all Member States simultaneously).

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7 Article 288 of the Treaty on the Functioning of the European Union (formerly Article 249 TEC): “To exercise the Union’s competences, the institutions shall adopt regulations, directives, decisions, recommendations and opinions. A regulation shall have general application. It shall be binding in its entirety and directly applicable in all Member States. A directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods. A decision shall be binding in its entirety upon those to whom it is addressed. Recommendations and opinions shall have no binding force".
b. **Directives** (legislative acts of the European Union, which require Member States to achieve a particular result without dictating the means of achieving that result. Unlike Regulations (which are self-executing and do not require any implementing measures), Directives normally leave Member States with a certain amount of leeway as to the exact rules to be adopted.

c. **Recommendations and Opinions** (without binding force).

d) Transnational rules (i.e. legal concepts and standards which flow horizontally across national borders and are adopted in Court decisions and similar).

e) National legislations and law sources (including local legislations)

- Strictly national
- National legislation that transpose international and/or EU sources and rules (such as Directives) into the laws of a State.

![Figure 2: the complexity of European legislation](image)

**2.4. Robot abilities**

In this section, we summarize technical aspects related to activities that can be performed by autonomous service robots.

The aim of this section is to focus on technical problems and possible consequences, and to point out roadmaps to solve them. All the problems mentioned in this section are technological problems that are faced by the research community in their everyday activity, with the aim to obtain more robust and reliable autonomous robots.

As far as legal aspects are concerned, it should be clear what a robot can and cannot do, and in which conditions, so that normal operating conditions could be defined by the manufacturer to state the "range of environmental conditions and other parameters which can influence robot performance within which the performance of the robot specified by the manufacturer is valid." (ISO 8373:2012) In this regards, the first step is to define sound models of the technical aspects to identify all the characteristic features describing the implemented functionalities. At this point it will be possible to define all technical aspects in a standardized way and to evaluate the different implementations. The second step will require defining standardized, unified benchmarks against which producers of parts, as well as full robotic systems will have to evaluate their products, so that a quality level can be guaranteed. It will then be possible to treat devices, and possibly robots, holding a certification in the same way it is done in other market fields.

In the following, we first present the main components, such as sensors and actuators, then the computing system, and finally some of the main functionalities which are needed for autonomous service robots. Our perspective is to highlight the deficiencies in each of them with respect to the issues related to dependability, accountability, predictability of results and standardization/certification issues. We provide also a tentative roadmap to face the aforementioned issues.
2.4.1. Sensors

In general, a robot has a set of sensors that provide data about the environment it has to operate in. Sensors are of uttermost importance in assessing robot abilities. Criticalities may arise for inadequateness or faults of the sensors, and inadequateness of the elaboration of their signals.

2.4.1.1. Range sensors

Range sensors provide the distance from a surface in given directions. The principal range sensors used today are: sonar, laser scanner, infrared, and special cameras (TOF, stereo, and RGB-D cameras). The main problems coming from these sensors are related to their limited range (not only in distance, but also in angle) and to errors in the distance and direction estimation they may produce. Details about prototypical examples are presented in the following.

i. Sonar

Sonar sensors provide a measure of distance from the sensor to a surface able to reflect an ultrasonic wave produced by the emitter. Potential problems affecting their perception are described in the following. Due to poorly-reflecting surfaces (e.g., some clothes, or furniture covering) or very smooth surfaces (e.g., mirrors and glasses) some objects or obstacles may not be detected; for instance, if the signal is used to stop in presence of an obstacle, and this is not detected, the robot can hurt it. The produced ultrasonic wave may be reflected several times by different surfaces before reaching the detector, so that the estimation of the distance can be very different from the real one (e.g., in corners): if the signal is used to map the environment, an inaccurate map is estimated. Finally, any reflecting surface in the volume of perception of the sensor, generally a cone, can be detected, but there is no possibility to distinguish its direction within the volume.

ii. Laser scanners

These sensors measure the distance to laser beam reflecting objects over a direction. If it is moved horizontally, they provide a map of the distance to objects on a planar angle; if moved also vertically, they can scan a solid angle. Among the main problems: the possibility of missing reflection due to absorbing surfaces (e.g. black surfaces or surfaces too enlightened), and the fact that, for planar laser scanners, the detected distances lie on a plane. In the latter case, for instance, if the scanning plane is parallel to the floor, at 30 cm from it, and the scanner is pointed in the direction of a table, it can detect legs of the table, but not the table board; if a robot would rely on this for navigation, it might easily try to go through the table. Due to discrete angular resolution, it might happen that small objects are not perceived when distant from the sensor also when they are within its range.

iii. Special cameras

Special cameras are able to provide an image containing information about the distance of each of the points in the image from the camera system. We do not enter in technical details about them here, but the typical problems are similar to the ones of standard cameras, mentioned here below.

2.4.1.2. Cameras

The sensors embedded in cameras are organized in a matrix of pixels. Many issues are related to the physical sensor, the optics, the electronics, the low-level control of the camera (e.g., automatic adaptation to light intensity), but most of them can be managed by accurate programming of the interpretation of the image signal. Among typical problems with cameras, which may affect the quality of the image interpretation, we mention: the sudden changes in light intensity or different intensity in different parts of the same image, the inadequate resolution of the image (e.g., to recognize distant objects or details), the inadequate field of view.

Typical elaborations of the image allow to recognize coloured areas (problem: colours change with light intensity) and shapes (problem: objects can be partially occluded by others or appear partially in the image …), objects (even at a cognitive level, e.g., a chair, and including faces and body postures), and many others. Computer vision is a rich discipline that has explored many issues needed to implement such a complex process, such as identifying objects and places in an image, but a lot of work has still to be done to get reliable information under any of the common conditions a service robot has to face.
2.4.2. Roadmap for sensors

To improve the quality of sensors improving they dependability and accountability, a first step should be in the direction of formal standardization and characterization, so that it would be possible to define formally and completely their functionality and the range of their operating conditions. This will also make it possible, in a second phase, to define standard benchmarks to evaluate sensors against their ability to provide the desired functionalities. For robotic applications, it would also be important to define functionalities at high level of abstraction (e.g. provide the distance to a person, in a cluttered environment), and have benchmarks suitable to evaluate them. To overcome intrinsic limitation of sensors, multi-sensor fusion is already been tried and will provide interesting results.

- **Formal standardization and characterization.**
- **Definition of functionality and the range of the operating conditions.**
- **Standard benchmarks. Multi sensor fusion capable of provide the required Safety Integrity Level (SIL).**

### ROADMAP FOR SENSORS

2.4.3. Actuators

Usually, mechanical devices that implement actuators are associated to controllers able to obtain from them an action as much similar as possible to that decided at computational level and expected by the designer. Being physical devices, they take some time to reach the desired set point, and this might be a problem in some situations. For instance, if a robot is running at 1m/sec and its sensors detect a person traversing its trajectory, the high level decision of stopping suddenly might be taken in milliseconds, but it might require one or more seconds to reach the set point (null speed), during which time the robot will travel one or more meters. If the robot is a 300 grams cleaner, this might be almost irrelevant, if it is a 80 kg care-bot or a wheelchair, this behaviour might cause injury to people and things.

2.4.4. Roadmap for actuators

Besides the achievement of higher precision and dexterity, an important aspect concerns active and passive compliance: a robot should be intrinsically compliant to external objects so to reduce the possible effects of mis-actuation, accidental contact with people, and unpredicted collisions with obstacles.

- **Higher precision and dexterity.**
- **Active and passive compliance.**
- **Safety aspects with back-drivable actuators with extensive memory handling; energy buffering; new design shapes.**

### ROADMAP FOR ACTUATORS

2.4.5. Computing system

On the robot there might be a certain number of computers, running programs that interpret data provided by sensors, possibly building on them some map or a so-called "world model", merging data with old data, considering a priori knowledge, eventually planning actions, and, finally taking a decision about the actions to be requested to the actuators. Among possible malfunctioning, we mention problems of correctness of the programs, which have to face situations a priori difficult to identify and
even hard to list exhaustively. The problem is well known and faced through specific software production procedures in fields such as space applications and automotive.

2.4.6. Roadmap for computing system
The roadmap to face problems related to computing has already been developed and followed in other fields, and it is only needed to select the degree of quality is needed for the software and hardware controlling a specific robot. Since developing software and hardware with high reliability is expensive, it will be needed to characterize the risks of each robotic application and to require the corresponding software development process and reference hardware platform. Getting all of this low-cost is the real challenge.

**ROADMAP FOR COMPUTING SYSTEMS**

- Characterize the risks of each robotic application and require the corresponding software development process and reference hardware.
- Increase the degree of quality for the software and hardware controlling a specific robot.
- Generic robot controller that accepts all sort of models, control laws, sensor input. Models of behaviors including tolerance to the real world uncertainties.

2.4.7. Self-localization
A robot is designed to perform tasks by moving its body, or, at least, some of its parts. To perform such tasks it is needed that the robot knows where its parts are localized w.r.t. objects and people it has to interact with. As it appears from what written above, the self-localization process depends on data acquisition and interpretation, as well as on reasoning about data and world modelling. Problems with self-localization result in an erroneous position estimate that may affect the achievement of a goal. Among the problems that might occur, we have those related to precision. For instance, the accumulation of self-localization errors may bring a robot to get lost, or a poor estimation of the distance from the table surface might lead a robot to drop a glass from some centimetres to the surface, instead of placing it on. Other problems might be related to the possible similarities among places (e.g., in a hospital) that, according to the available data and their interpretation, cannot be distinguished, so leading to an ambiguous self-localization.

2.4.8. Roadmap for self-localization
The research community has done a lot of work in the field of localization and several solutions, off-board or on-board, exists also as commercial-off-the-shelf. As usual a trade-off between cost, affordability, and set-up burden is needed and the latter should guide future development. Indeed, one of the main limitations to the diffusion of self-localizing robots is due to the complexity of set-up, which greatly influences the quality of the whole process. Making set-up and deployment easier is one of the first steps to face. Robustness is another important aspect to achieve, and the definition of benchmarks will help to characterize it in the operating conditions. The next important aspect to achieve is long-life performance (especially for on-board solutions), with the possibility to comply to modifications of the environment. Finally, semantics will have to be introduced to make the robot to self-localize w.r.t. elements of the word (e.g., a bathroom, an arm-chair, a workbench) that have relevant semantic roles in the applications.

**ROADMAP FOR SELF LOCALIZATION**

- Easier set-up and deployment.
- Robustness and benchmarks to characterise the operating conditions.
- Long-life performance with the possibility to comply to modifications of the environment. Autonomous planning for complex tasks.
2.4.9. Navigation

Navigation, at least in the mobile robotics jargon, is the set of activities that a robot does to move from one place to another. Usually, this requires self-localization, motion planning, motion control, obstacle avoidance. Navigation is usually supported by a map which can be either provided by the designer, or learned by the robot through a mapping activity. When this is performed simultaneously with localization we have SLAM (Simultaneous Localization And Mapping). Navigation, too, relies on data acquisition and interpretation, and on reasoning, but also on actuators and control. Problems with navigation affect its goal of bringing the robot in the desired location, and might be due to all the processes mentioned above, as well as to problems specific to the environment, which may change its structure (open/close passages, people in passages, etc.), if the robot is not able to manage such situations.

2.4.10. Roadmap for navigation

A key point in navigation would be the definition of a standard reference architecture which could be instantiated on the different robots enabling easy integration of robust solutions for each of the components of this complex function. Several efforts have been done in this direction and they have failed to converge toward a single commonly agreed solution. This missing convergence has led to several options with different pros and cons, but no one of them has become the (de-facto) standard. A definitive harmonization of these efforts toward the decision about a single standard which would respect real-time constraints and safety should lead to a single architecture to be compliant with.

2.4.11. Physical interaction

2.4.11.1. Transportation and physical treatment

Some robots can be used to transport people, or to physically treat them. In both cases, a physical interaction is performed, requiring adapting the dynamics of the robot (speed, force) to the task and the comfort of the involved persons.

Among the problems in this area: the possibility that a wrong estimation of position (see above), a possibly incomplete perception or an unsuitable control can make the robot to apply an undesired force (or move at an undesired speed) so that the subject is injured, or suffers, or simply feels uncomfortable with the robot.

2.4.11.2. Manipulation

Service robots can manipulate objects to bring them to the user, or to interact with the users, e.g., to feed them or to give them an object. In this case, most of the problems may come both from wrong localization (w.r.t. the target, or elements around), and wrong speed or force selected to perform the action.

2.4.11.3. Mobile manipulation

Many robots are able to move in the rooms, and, at the same time, manipulate objects with mechanical arms attached to the body. This requires the ability to plan and execute actions for many
actuators in an integrated way, and monitor the execution of the plan from different points of view. For instance, an arm on a wheelchair should be kept within the wheelchair footprint when passing a door, and, at the same time, it should avoid to hit the user seated on the wheelchair, and, possibly, continue to perform its task (e.g., bring a glass of water just taken from the fridge).

2.4.12. Roadmap for physical interaction

Most of the problems are related to sensors, the estimate based on their data, actuators, and control. In physical interaction, passive compliance is an important feature that is being achieved by some systems: this would reduce problems due to wrong estimation and actuation, by making intrinsically compliant the physical contact. Other important aspects already being faced are dexterity and better sensibility.

2.4.13. Non-physical interaction

2.4.13.1. Verbal interaction

Care robots may interact with people using natural language (NL). Problems possibly arising from verbal interaction are related to the goals of this type of interaction, including: missing information transfer (from both sides), and missing (or undesired) emotional effects.

2.4.13.2. Gestural interaction

Gestural interaction is usually performed to induce or understand emotions and signals in the other. We can include among gestural signals: face expressions (also represented on a screen), body movements, and body positioning. Gesture recognition is mainly related to artificial vision, and share its problems. Gesture generation is related to the actuators, their performance and their control at different levels. Problems possibly arising can be missing or misinterpreted signals or emotional relationship.

2.4.13.3. Roadmap for non-physical interaction

For verbal interaction, the next steps will concern NL interpretation from generic users in generic environments, which include signal analysis, as well as semantics. NL interpretation is an open problem since dozens of years at it is coming to its solution within the NLP community. Robotics should harmonize its efforts jointly with NLP community in this direction. For gesture recognition, we will need more accurate movement descriptors and detectors, so to better characterize gestures and recognize them in the different natural situations that may occur.
2.4.14. Learning

In some situations, it is possible to avoid programming the robot, or to feed it with a model, and make it learning models and behaviours by itself. More often, a possibly incomplete or generic model or behavioural module is refined and adapted by a learning/adaptation process. This activity is critical since, while learning, the robot could reach an unstable state, and may not behave as expected. To reduce this type of problems, in other fields such as automotive and white goods, the range of behaviours, and the range of model parameters are defined so to keep the device always in an acceptable, although not optimal state, and then, by interacting with the user, collecting data, and applying learning/adaptation algorithms, the configuration is updated within a set of acceptable configurations.

Learning/adaptation can be done by different techniques: teaching by doing (someone controls the robot to do the desired action), imitation learning (the robot should imitate the correct action shown by some other agent), reinforcement learning (the robot tries different actions in different situations, the effects are evaluated and a reinforcement is provided to the robot that uses it to modify its model), or supervised learning (a set of correct pairs <input configuration, desired output> are provided to the robot, which uses a learning algorithm to generalize a model to produce the correct output from possibly all the possible input configurations). Learning/adaptation can be performed either while the robot is operational in its activity (online learning) or in special situations (batch or offline learning).

Problems in this area come when the final model is not satisfactory, and this may depend on many factors among which: the set of data provided to learning/adaptation process, the way the process has been performed (the teacher …), the learning algorithm and its implementation. This opens a problem of accountability.

2.4.15. Roadmap for learning

Algorithms especially suited to robot learning (in its different aspects) have to be defined keeping into account the learning/adaptation goals and contexts in which they will have to be applied. In particular, as it is done in other application fields, the limits left to the learning/adaptation algorithm should be characterized in order to achieve and maintain always an acceptable performance also in life-long learning.

Learning in well defined circumstances/conditions.
Learning/adaptive control.
The learning modules react flexible to changing conditions.
The behavior is learned within strict pre-defined boundaries.
Adaptation and reinforcement learning.
The learning robotic systems can adapt their behavior to changing situations and altered requirements.
Learning teamwork.
3. Robots’ market law and robots’ consumer law

Hereinafter a big picture of the rules, which can concern robots from a European point of view, is drawn.

The situation of EU laws in the field of robotics can be described as a series of circles having a common centre: the inner circle (constituted by EU Directive 2006/42/EC, which regulates the specific sector of machinery and, according to the commonly shared opinion, can encompass the category of robots considered as mechanical artefacts); the wider circle (constituted by more general measures governing policies to protect health, public safety and consumer interests: the EU Directive 2001/95/EC, the EU Decision 768/2008/EC and the EU Decision 765/2008/EC, which settle the rules on the product safety) and the external circle (which encompasses rights and guarantees recognized by the EU Directive 1999/44/EC on the sale of any kind of consumer goods).

![Robots as products: EU laws on market and consumer protection](image)

**Figure 3: Robots as product: current legislation.**

3.1. The inner circle: the Directive 2006/42 on Machinery

The Directive 2006/42 has the twofold aim of harmonising the health and safety requirements applicable to machinery on the basis of a high level of protection of health and safety, while ensuring the free circulation of machinery on the EU market.

**Scope and definitions**

Article 1 sets out the scope of the Directive, that is to say the products to which the provisions of the Directive are applicable. There are listed seven categories to which the Directive applies:

a) machinery;

b) interchangeable equipment;

c) safety components;

d) lifting accessories;

e) chains, ropes and webbing;

f) removable mechanical transmission devices;

g) partly completed machinery.

Obviously, we focus on the first one, “machinery”, which Article 2 defines as follows:

“machinery’ means:

- an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application,
• an assembly referred to in the first indent, missing only the components to connect it on site or to sources of energy and motion,
• an assembly referred to in the first and second indents, ready to be installed and able to function as it stands only if mounted on a means of transport, or installed in a building or a structure,
• assemblies of machinery referred to in the first, second and third indents or partly completed machinery referred to in point (g) which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole,
• an assembly of linked parts or components, at least one of which moves and which are joined together, intended for lifting loads and whose only power source is directly applied human effort”.

What seems to be essential to be included in this category is to be a product with parts or components linked together in an assembly. The robots, as described above, easily fill in some of these definitions.

**Placing on the market and putting into service**

Article 5 provides a summary of the obligations to be fulfilled by manufacturers of machinery or their authorised representatives. According to this article, before placing their products on the market or putting them into service, they have to:

- ensure that it satisfies the relevant essential health and safety requirements set out in Annex I;
- ensure that the technical file referred to in Annex VII, part A is available;
- provide, in particular, the necessary information, such as instructions;
- carry out the appropriate procedures for assessing conformity in accordance with Article 12;
- draw up the EC declaration of conformity in accordance with Annex II, part 1, Section A and ensure that it accompanies the machinery;
- affix the CE marking in accordance with Article 16.

Therefore, the manufacturer or his authorised representative shall have, or shall have access to, the necessary means of ensuring that the machinery satisfies the essential health and safety requirements set out in Annex I. The means may include, for example, the necessary qualified staff, access to the

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8 Art. 12: «2. Where the machinery is not referred to in Annex IV, the manufacturer or his authorised representative shall apply the procedure for assessment of conformity with internal checks on the manufacture of machinery provided for in Annex VIII.
3. Where the machinery is referred to in Annex IV and manufactured in accordance with the harmonised standards referred to in Article 7(2), and provided that those standards cover all of the relevant essential health and safety requirements, the manufacturer or his authorised representative shall apply one of the following procedures: (a) the procedure for assessment of conformity with internal checks on the manufacture of machinery, provided for in Annex VIII; (b) the EC type-examination procedure provided for in Annex IX, plus the internal checks on the manufacture of machinery provided for in Annex VIII, point 3; (c) the full quality assurance procedure provided for in Annex X.
4. Where the machinery is referred to in Annex IV and has not been manufactured in accordance with the harmonised standards referred to in Article 7(2), or only partly in accordance with such standards, or if the harmonised standards do not cover all the relevant essential health and safety requirements or if no harmonised standards exist for the machinery in question, the manufacturer or his authorised representative shall apply one of the following procedures: (a) the EC type-examination procedure provided for in Annex IX, plus the internal checks on the manufacture of machinery provided for in Annex VIII, point 3; (b) the full quality assurance procedure provided for in Annex X.»

9 Art. 16: «1. The CE conformity marking shall consist of the initials ‘CE’ as shown in Annex III.
2. The CE marking shall be affixed to the machinery visibly, legibly and indelibly in accordance with Annex III.
3. The affixing on machinery of markings, signs and inscriptions which are likely to mislead third parties as to the meaning or form of the CE marking, or both, shall be prohibited. Any other marking may be affixed to the machinery provided that the visibility, legibility and meaning of the CE marking is not thereby impaired».

necessary information, the competency and the equipment needed to carry out the necessary design checks, calculations, measurements, functional tests, strength tests, visual inspections and checks on information and instructions to ensure the conformity of the machinery with the relevant essential health and safety requirements.

Procedures for assessing the conformity of machinery

Article 1211 concerns the conformity assessment procedure that must be carried out by the manufacturer of machinery or his authorised representative before placing machinery on the market and/or putting it into service. The conformity assessment procedure is mandatory; however, for certain categories of machinery, the manufacturer can choose between several alternative procedures (internal checks on the manufacture of machinery, Annex VIII; EC type-examination procedure, Annex IX, plus the internal checks; full quality assurance procedure, Annex X).

CE Marking

Regulation (EC) 765/2008 defines “CE marking” as a marking by which the manufacturer indicates that the product is in conformity with the applicable requirements set out in Community harmonisation legislation providing for its affixing.

By affixing or having affixed the CE marking, the manufacturer indicates that he takes responsibility for the conformity of the product. The CE marking consists of the initials ‘CE’ with the graphic form shown in Annex III. The various components of the CE marking must have substantially the same vertical dimension, which may not be less than 5 mm. The minimum dimension may be waived for small-scale machinery. The CE marking must be affixed to the machinery visibly, legibly and indelibly in the immediate vicinity of the name of the manufacturer or his authorised representative, using the same technique. Where the full quality assurance procedure has been applied, the CE marking must be followed by the identification number inserted by the Notified Body that approved the manufacturer's full quality assurance system.12

The CE marking shall be the only marking which attests the conformity of the product with the applicable requirements of the relevant EU harmonisation legislation providing for its affixing. Article 1613 of the Directive requires the Member States to forbid the affixing on machinery of markings, signs or inscriptions which are likely to mislead third parties as to the meaning or form of the CE markings or both.

11 See under note 2.
13 See 3.
Figure 4: Procedures for the placing on the market

Titles and references of harmonised standards under the directive

The Commission Communication 20.07.2011 to favour the implementation of the Machinery Directive sets out the titles and references of harmonised standards. In particular, the Communication states the application of the standard EN ISO 10218-1:2008 for robots for industrial environments (Safety requirements - Part 1: Robot - ISO 10218-1:2006, including Cor 1:2007). The ISO 10218-2: 2011 (Part 2: Robot systems and integration) specifies the safety requirements for robot’s integration. In particular, this International Standard defines the “safeguarded space” and the “restricted space” established by means, which limit the motion of the machine to protect people from the hazards presented by the robot system. The limiting devices (integral to the robot or external) could be mechanical or non-mechanical. But in case of non-mechanical devices, they have to be characterized by a high performance level.

It is also important to mention the ISO Draft International Standard (DIS) 13482, which is intended to be a harmonised European standard related to safety requirements for robots in personal care applications. This standard would be an interpretation of ISO 12100, which is the general standard for safety of machinery. The ISO (DIS) 13482 defines “personal care robot” as a robot that performs aiding actions and actions contributing directly towards improvement in the quality of life of humans, excluding medical applications. It divides personal care robots in three different classes based on the level of physical interaction with users: 1) mobile servant robot (capable of travelling to perform serving tasks in interaction with humans); 2) physical assistant robot (that assists a person to perform required tasks by providing supplementation or augmentation of personal capabilities); 3) person carrier robot

(with the purpose of transporting humans to an intended destination). This International Standard covers human-robot physical contact applications, describes hazards associated with the use of these robots and provides requirements to eliminate, or adequately reduce, the risks associated with these hazards.

The Machinery Directive’s large scope allows considering that robots can easily be included in the categories of machinery (Article 1, letter a) or partly completed machinery (Article 1, letter g). Therefore, robots’ production and the following placing on the market have to respect the procedures for assessing conformity and the manufacturer has to satisfy all the relevant essential requirements and conditions set out by the Directive (declaration of conformity, CE marking, instructions, technical file).

3.2. The wider circle: the Directive 2001/95 on general product safety

The Directive imposes a general safety requirement on any product put on the market for consumers or likely to be used by them, including all products that provide a service. A safe product is one which poses no threat or only a reduced threat in accordance with the nature of its use and which is acceptable in view of maintaining a high level of protection for the health and safety of persons.

Safe product

A product is deemed safe once it conforms to the safety provisions provided in European legislation, or, in the absence of such rules, if it complies with the specific national regulations of the Member State in which it is being marketed or sold. The product is also deemed safe if it complies with the European standard established according to the procedures in this Directive. In the absence of such regulations or standards, the product's compliance is determined according to the following (Article 3):

a) the voluntary national standards (transposing other relevant European standards), the Commission recommendations (setting out guidelines on the assessment of product safety);

b) the standards of the Member State in which the product is being marketed or sold;

c) the codes of good practice as regards health and safety;

d) the current state of the art;

e) the consumers' safety expectations.

Manufacturer and distributor obligations

Manufacturers must put on the market products, which comply with the general safety requirements. In addition, they must:

• provide consumers with the necessary information in order to assess a product's inherent threat, particularly when this is not directly obvious (Article 5);

• take the necessary measures to avoid such threats (e.g. withdraw products from the market, inform consumers, recall products which have already been supplied to consumers, etc.).

Distributors are also obliged to:

• supply products that comply with the general safety requirement;

• monitor the safety of products on the market;

• provide the necessary documents ensuring that the products can be traced.

If the manufacturers or the distributors discover that a product is dangerous, they must notify the competent authorities and, if necessary, cooperate with them. This obligation to inform the competent authorities is clarified in Annex I of the Directive.

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Member States’ obligations

The Member States ensure that the manufacturers and the distributors comply with their obligations (Article 6). They put in place structures, which are responsible for:

- monitoring product compliance with the safety requirement;
- taking the necessary measures as regards risk products (e.g. prohibiting such products being marketed) and informing the Commission of the details.

Member States set out rules to punish offenders and ensure that consumers benefit from a system, which investigates complaints.

Decision 768/2008 and Regulation 765/2008 on marketing of products

The Decision 768/2008 provides, in the form of reference provisions, definitions and general obligations for economic operators and a range of conformity assessment procedures from which the legislator can select as appropriate. It also lays down rules for CE marking. This Decision establishes clear definitions of fundamental concepts such as “manufacturer”, “distributor”, “importer”, “harmonised standard”, “placing on the market” and “conformity assessment”. The establishment of explicit, single definitions will make it easier to interpret and correctly apply future laws in this field.

Obligations of manufacturers, importers and distributors

In order to be placed on the market, a product must comply with certain essential requirements. The manufacturer must ensure that his products comply with the applicable requirements by carrying out or commissioning a product conformity assessment procedure. The procedures, which are to be used, shall be chosen from among the modules set out and specified in Annex II.

If the product complies with the essential requirements, the manufacturer affixes the CE marking on the product and draws up an EC declaration of conformity. The manufacturer indicates his name (registered trade name or registered trade mark) and his address on the product.

The product must be accompanied by instructions and safety information in a language which can be easily understood.

The importer and the distributor must ensure that the manufacturer has fulfilled his obligations (e.g. check that the product has a conformity marking and that the required documents have been supplied).

Manufacturers (or their authorised representative), distributors and importers must provide the competent authorities with all necessary information on the product concerned in order to ensure product traceability.

Accreditation and market surveillance

The Regulation 765/2008, complementary to Decision 768/2008, envisages the laying down of rules on the organisation and operation of accreditation, in the Member States, of conformity assessment bodies performing assessment of any substance, preparation or other product, transformed or not, to be placed on the Community market.

This Regulation provides a framework for European accreditation policy. Accreditation is characterised by the following (Articles 4, 5, 6):

- there is only one accreditation body per Member State;
- there is no competition between accreditation bodies and conformity assessment bodies;
- accreditation is carried out by a public authority;

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• accreditation bodies operate on a not-for-profit basis and comply with the principles of impartiality and objectivity.

Member States must guarantee effective surveillance of their market. They are required to organise and carry out close monitoring so that the products covered by Community harmonisation legislation meet the requirements for protection of public interests such as health or safety.

The competent market surveillance authorities in each Member State monitor products on the Community market. They are responsible for (Article 18, 19):

• monitoring compliance with product safety requirements;
• following up complaints or reports on product-related risks;
• monitoring accidents and damage to health suspected to have been caused by these products;
• verifying corrective action has been taken;
• following up and updating scientific and technical knowledge concerning safety issues;
• following up on the notification of dangerous products.

3.3. The external circle: Directive 1999/44 on sale of consumer goods

The purpose of this Directive is the approximation of the laws, regulations and administrative provisions of the Member States on certain aspects of the sale of consumer goods and associated guarantees in order to ensure a uniform minimum level of consumer protection in the internal market.

Contract of sale

Consumer goods must be in conformity with the contract of sale. Goods are deemed to be in conformity with the contract if, at the moment of delivery to the consumer, they (Article 2):

a) “comply with the description given by the seller and possess the qualities of the goods which the seller has held out to the consumer as a sample or model;

b) are fit for any particular purpose for which the consumer requires them and which he made known to the seller at the time of conclusion of the contract and which the seller has accepted;

c) are fit for the purposes for which goods of the same type are normally used;

d) show the quality and performance which are normal in goods of the same type and which the consumer can reasonably expect, given the nature of the goods and taking into account any public statements on the specific characteristics of the goods made about them by the seller, the producer or his representative, particularly in advertising or on labelling.”

The seller shall be liable to the consumer for any lack of conformity, which exists at the time the goods were delivered. In the case of a lack of conformity, the consumer shall be entitled to have the goods brought into conformity free of charge by repair or replacement or to have an appropriate reduction made in the price or the contract rescinded with regard to those goods.

Compliance with the commercial guarantee

Any commercial guarantee offered by a seller or producer is legally binding upon them under the conditions laid down in the guarantee document and the associated advertising (Article 6). The guarantee must state that the consumer also has statutory rights and clearly state that these rights are not affected by the guarantee. Furthermore, the guarantee must state its content, in simple and understandable terms, and indicate the conditions for claiming under it, notably its duration and territorial scope and the name and address of the guarantor.

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4. Intellectual Property Rights facing to the Development of Robotics in Europe

4.1. Relevance of IPR with respect to Conception of Robots and their Exploitation

(UTRECHT University, Center of Intellectual Property Rights (CIER) : overview of Intellectual Property Rights related to the development of Robotics in Europe - M de Cock Buning, L. Belder, R de Bruin)

IPR doctrine distinguishes more than nine IPR regimes, all covering different objects of protection. In this section we will propose an overview of the IP-regimes that are relevant in the development of robot-technology: Patents, Copyrights, Databases Rights, Trademark Rights, Industrial Design Rights, Semiconductor Topography Rights and Trade Secrets. National Intellectual Property Rights-regimes are largely based upon or influenced by international conventions, treaties and European regulations and directives. The following section provides a first introduction to the relevance of IPR for the development of robotics in Europe by indicating the significant international/European legislation per object; Object of protection and protection requirements Right holders; Exclusive Rights; Limitations; Relevance for developments in the field of robotics.

4.1.1. Panorama of the Applicable European Intellectual Property Legislations

IPR are likely to be relevant in the whole process of robot development.

Copyright

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<tr>
<td>- Directive 93/83/EEC on the coordination of certain rules concerning copyright and rights related to copyright applicable to satellite broadcasting and cable retransmission (Satcab-dir.)</td>
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Object of protection and requirements for protection: Every literary, scientific or artistic work is copyright protected, as long as it is original (not copied or derived from other works). Within the EU, a second requirement for a work to be copyright protected is that it must be an author’s own intellectual creation. This second criterion implies that the author should have been able to make subjective choices in the creation of the work. Ideas cannot be subject to copyright. The Berne Convention provides a non-exhaustive list of work-categories, amongst which are books, pamphlets, lectures, dramatic works, musical compositions, choreographies etc. Computer programs are also protected by copyright. The EU-Software Directive also allows preparatory material to be protected, under the condition that the computer program is original in the sense that it is an author’s own, intellectual creation. As indicated, original literary or artistic works that are the author’s own, intellectual creation can be copyright protected. No copyright (©) symbol on the work is required.

Right holders & Exclusive rights: Generally, the actual creator of the work is the copyright-holder. The copyright holder has the exclusive rights to make reproductions of the work and communicate the work to the public. The rights holder is the only one who may copy his work, translate it, make adaptations or derivative works from it, distribute it, broadcast it, or rent copies of the work. Article 6 Infosoc-dir. prohibits the circumvention of effective technological measures protecting the right holder’s exploitation rights.

Limitations: Copyright is limited in time and lasts until 70 years after the death of the author. During the protection-period, copyright may be limited to serve certain purposes. General rule is that exceptions to copyright may be provided (by national legislators) in certain special cases which do not conflict the normal use of works and do not unreasonably prejudice the legitimate interests of the right holder. The Berne Convention states that States parties may – under certain conditions - also provide for compulsory licensing mechanisms. Examples of exceptions to copyright are educational purposes; purposes of the well-functioning of democracy and the freedom of speech; as well as for purposes of the preservation of cultural heritage. In view of software-interoperability reverse engineering by means of decompilation may be allowed without consent of the right holder.

Relevance of copyright for the development of robots: Many aspects of a robotic device can be copyright protected. As long as there is originality and an author’s own, intellectual creation, all sorts of (including preparatory material) programming code may fall under this IPR-regime. Also the design of a robot can be copyright protected. Note that for the development of the steering software of a robotic device, permission of the original programmer/right holder can be required.

Databases

Legislation – International:
- Agreement on Trade-Related Aspects of Intellectual property Rights (TRIPS);
- Berne Convention for the Protection of Literary and Artistic Works (BC);

22 Art. 1 BC
24 Art. 9(2) TRIPS; art. 2 WCT. See also P. Goldstein & P.B. Hugenholtz, International Copyright, New York: Oxford University Press 2010, p. 5. (Goldstein & Hugenholtz 2010).
25 See art. 9-12 BC; 6-8 WCT; 2-4 Infosoc-dir.
26 See on this subject Bently & Sherman 2009, pp. 318-327.
27 Art. 1 2006 Term Directive.
28 The three-step test: Art. 9(2) BC; Art. 13 TRIPS; Art. 10 WCT 5(5) Infosoc-dir.
29 See Art. 12bis(2) and 13(1) BC.
30 See Art. 5 Infosoc-dir.
31 Art. 6 Software-dir; also Bently & Serman 2009, pp. 230-231.
- UNESCO Universal Copyright Convention (UCC);
- WIPO Copyright Treaty (WCT);

**Legislation – EU:**
- Directives 2001/29/EC on the harmonization of certain aspects of copyright and related rights in the information society (Infosoc-dir.);
- Directive 2004/48/EC on the enforcement of intellectual property rights (IP-Enforcement Dir.);
- Directive 96/9/EC on the legal protection of databases (Database dir.);
- Directive 2006/116/EC on the term of protection of copyright and certain related rights (2006 Term Dir.)
- Directive 2009/24/EC on the legal protection of computer programs (Software dir.)
- Directive 93/83/EEC on the coordination of certain rules concerning copyright and rights related to copyright applicable to satellite broadcasting and cable retransmission (Satkab-dir.)

**Object of protection and requirements for protection:** Databases can be protected under two IPR-regimes. Whenever the selection or arrangement of data in a database is original and is the own, intellectual creation of an author, a database is protected by copyright.\(^{32}\) Databases are also protected by a *sui generis*-regime provided by the Databases Directive (DD). A collection of independent works, data or other materials, organised in a systematic or methodical way, and individually accessible by electronic or other means, is defined as a database.\(^{33}\) Databases are protected by a databases right (DR) whenever there has been a substantial investment in the obtaining, verification or presentation of the contents of a database.\(^{34}\) Investments in the actual *creation* of data are not taken into consideration. Databases rights arise automatically upon the creation of a database, no registration is required for protection.

**Right holders & Exclusive rights:** The author of a database is the right holder,\(^{35}\) who has the exclusive right to the qualitative or quantitative extraction or re-utilization of the whole or a substantial part of the database. Also the repeated and systematic extraction/re-utilization of insubstantial parts of the database is not allowed without permission of the right holder. Extraction may be considered as the reproduction of the contents of a database. Re-utilization is the making available of the contents to the public, including the distribution or renting of copies.\(^{36}\) The non-substantial extraction or re-utilization may be done without consent of the right holder, given that this is done by a lawful user.\(^{37}\)

**Limitations:** A databases right is valid for fifteen years after the date of completion of the database.\(^{38}\) EU Member States may implement exceptions to the exclusive rights regarding the extraction of a non-electronic database for private purposes only. Also the extraction of databases for the purposes of non-commercial education, or public security and administrative or judicial procedure may be allowed.\(^{39}\)

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32 See art. 3 Databases dir.
33 Art. 1(2) DD.
34 Art. 7(1) DD.
35 Art. 4 DD.
36 Art. 7(1-2).
37 Art. 8 DD.
38 Art. 10 DD.
39 Art. 9 DD.
Relevance of databases rights for the development of robots. Collections of data – for example containing test results, environmental data, GPS-location data etc. – may be protected by a sui generis databases right, as long as a substantial investment in the obtaining, verifying or presentation, in other words: in the creation of the database-infrastructure and the acquisition of the contents, has been made.

Patents

**Legislation – International:**
- Agreement on Trade-Related Aspects of Intellectual property Rights (TRIPS);
- Paris Convention for the Protection of Industrial Property (Paris Convention);
- Patent Cooperation Treaty (PCT);

**Legislation – European:**
- EEC Agreement relating to Community Patents (not in force), 89/695/EEC (CPA);
- Convention on the Grant of European Patents (EPC)

Object of protection and requirements for protection: Any inventions (products or processes) in the field of technology that are new, involve an inventive step and are capable of industrial application can be patented.\(^{40}\) Inventions that are not part of ‘the state of the art’ - which comprises all information that has been published worldwide before, in writing or orally - are considered to be new.\(^{41}\) An invention has an inventive step whenever it is ‘not obvious to a person skilled in the art’.\(^{42}\) Some subject matter is however excluded from patentability, amongst which are: immoral inventions; diagnostic, therapeutic and surgical methods for the treatment of humans and animals; aesthetic creations; discoveries, mathematical methods and scientific theories; schemes, rules and methods for playing games or doing business; computer programs and presentations of information.\(^{43}\) In order to obtain a patent, an application can be filed at the respective national patent offices. To obtain an European patent (which consists of a ‘bundle’ of national patents), an application can be filed at the European Patent Office in Munich.\(^{44}\) After a (lengthy) procedure is run through successfully,\(^{45}\) a bundle of national patents is granted to the applicant.

**Right holders:** The inventor who files the patent application will become the owner of the patent.\(^{46}\)

**Exclusive rights:** The owner of a patent may exclusively produce, import, bring into circulation, rent, deliver or otherwise exploit the patented object,\(^{47}\) as it is defined in the claims.\(^{48}\) If the patented subject matter is a process, the exclusive rights comprise in particular the using, offering for sale, selling and importing thereof.\(^{49}\)

**Limitations:** The maximum term of protection of a European patent is 20 years.\(^{50}\) Article 30 TRIPS states that exceptions to the exclusive rights may be provided that do not unreasonably conflict with the normal exploitation of the patent and that do not unreasonably prejudice the legitimate interests of the patent owner. Art. 31 TRIPS allows States parties – under strict conditions – to arrange for the

\(^{40}\) Art. 27(1) TRIPS, see also art. 52(1) EPC.
\(^{41}\) Art. 54 EPC.
\(^{42}\) Art. 56 EPC.
\(^{43}\) Art. 27(2)&(3) and 52(2), 53 EPC.
\(^{44}\) Art. 75 EPC.
\(^{46}\) Art. 58, 60 EPC.
\(^{47}\) Art. 28(1) TRIPS.
\(^{48}\) See Art. 6 PCT, art. 69 EPC.
\(^{49}\) Art. 28(2) TRIPS.
\(^{50}\) Art. 63(1) EPC.
compulsory licensing of patents. The Dutch legislator has implemented that under certain conditions – in the public interest; in case a patent is not used; or if it is necessary for the application of another patent – a compulsory license can be obtained against the will of the patentee.\textsuperscript{51}

\begin{center}
\textbf{Relevance of Patent Rights for the development of robots.} Many inventions in the field of robotics can be patented, given that they are new (not known of in whatever form, wherever in the world) and add to the state of the art, in a way that the invention is not a too obvious step in the natural process of development. Patentable inventions may lie in specific parts of a larger system, and also in certain specific production methods. Software as such may however not be patented.
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\section*{Trademarks}

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\underline{Legislation – International:}
\begin{itemize}
\item Agreement on Trade-Related Aspects of Intellectual property Rights (TRIPS);
\item Paris Convention for the Protection of Industrial Property (Paris Convention);
\item Madrid Agreement Concerning the International Registration of Marks (MA)
\item Madrid Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks (MP)
\end{itemize}
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\underline{Legislation – European:}
\begin{itemize}
\item Council Regulation 207/2009 on the Community Trademark (CTMR);
\item Directive 2008/95/EC to approximate the laws of the Member States on trade marks (Harmonization-dir.)
\end{itemize}
\end{center}

\textit{Object of protection and requirements for protection:} Any sign or combination of signs capable of distinguishing goods or services of an undertaking is capable of constituting a trademark.\textsuperscript{52} For example words, letters, numerals, names, figurative elements, combinations of signs and colours are mentioned as examples in TRIPS. The CTMR, which allows the registration of trademarks that are valid in the whole European Union, requires in article 4 that \textit{signs} are capable of being represented graphically. Trade marks without a distinctive character, for instance signs describing the particular good or service, cannot be registered.\textsuperscript{53} As indicated, in order to obtain protection for trademarks, signs should be registered. This may be done at a national level (according to national legislation), at an international level (internationally coordinated by the MA or the MP) or, in Europe, at community level (coordinated by the CTMR).

\textit{Right holders & Exclusive rights:} Any natural or legal person, including public authorities may be the owner of a Community trademark.\textsuperscript{54} The owner of a trademark may forbid others to use the same or a similar sign to identify the same or similar goods or services, where such use would constitute a likelihood of confusion of the public.\textsuperscript{55} The owner of a ‘well-known’ community trademark may forbid others to use the same or similar sign to identify other goods or services, which, without due cause, takes advantage of, or is detrimental to, the distinctive character or the repute of the trademark.\textsuperscript{56}

\textit{Limitations:} TRIPS allows States parties to provide limited exceptions to the rights conferred by a trademark, under the condition that exceptions take account of the legitimate interests of the owner of

\begin{center}
\textsuperscript{51} Art. 47 Dutch Patent Act.
\textsuperscript{52} Art. 15(1) TRIPS, art. 4 CTMR.
\textsuperscript{53} Art. 7 CTMR.
\textsuperscript{54} Art. 5 CTMR.
\textsuperscript{55} Art. 16(1) TRIPS, 9(1)(a-b) CTMR.
\textsuperscript{56} Art. 19(1)(c) CTMR.
\end{center}
a trademark and of third parties.\textsuperscript{57} Trademarks protect signs for at least 7 years and can last forever, as long as they are being used by their owners.\textsuperscript{58}

**Relevance of Trademark Rights for the development of robots.** Trademarks can be used to identify (certain aspects of) the outcome of developments in robotics. For example end products, logos, names could, provided that they are non-descriptive signs, be protected. Also, the respective names of working groups could be registered trademarks.

### Industrial Designs

**Legislation – International:**
- Agreement on Trade-Related Aspects of Intellectual property Rights (TRIPS);
- Paris Convention for the Protection of Industrial Property (Paris Convention);

**Legislation – European:**
- Council Regulation 6/2002 on Community Designs (CDR);
- Directive 98/71/EC on the legal protection of designs (Design-dir.)

**Object of protection and requirements for protection:** Article 25(1) TRIPS states that industrial designs that are new and original may apply for protection. The Community Design Regulation arranges for the protection of designs in the European Union. Designs are defined to be the appearance of a (or part of a) product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product or its ornamentation.\textsuperscript{59} Designs that are new (no identical predecessors)\textsuperscript{60} and have an individual character (different from other designs)\textsuperscript{61} that have not solely been dictated by their technical functions\textsuperscript{62} can be protected under the CDR.\textsuperscript{63} Two types of Community designs are distinguished: an unregistered community design is automatically protected after it had been made available to the public.\textsuperscript{65} A Registered Community design is protected after registration.\textsuperscript{66}

**Right holders: & Exclusive rights:** The designer is the first to obtain the design right.\textsuperscript{67} The right holder to a registered design has the exclusive right to use it by, for example, creating, selling, importing or exporting products in which the design is incorporated (or other designs that do not produce a different overall impression to the informed user). Right holders to unregistered designs may forbid others to copy the design.\textsuperscript{69}

**Limitations:** Unregistered Community designs are protected for three years after first making available to the public, registered designs can be protected for 5 years (renewable 5 times) from the date of filing for registration.\textsuperscript{69} Article 26(2) TRIPS leaves room for the limitation of the design right, provided that exceptions do not unreasonably conflict with the normal exploitation of the legitimate interests of the right holder or third parties. Art. 20 CDR allows—under certain conditions—the use of designs

\textsuperscript{57} Art. 17 TRIPS.
\textsuperscript{58} Art. 18 TRIPS, art. 15 CTMR.
\textsuperscript{59} Art. 3(a) CDR.
\textsuperscript{60} Art. 5(1) CDR.
\textsuperscript{61} Art. 6(1) CDR.
\textsuperscript{62} Art. 8(1) CDR.
\textsuperscript{63} Art. 4(1) CDR.
\textsuperscript{64} Art. 1(2)(a)&(b) CDR.
\textsuperscript{65} Art. 11(1) CDR.
\textsuperscript{66} Art. 12(1) CDR: This registry is the Office for Harmonisation of the Internal Market (OHIM).
\textsuperscript{67} Art. 14(1) CDR.
\textsuperscript{68} Art. 19(1-3) CDR, see also 10 CDR for definition of the scope of protection.
\textsuperscript{69} Art. 11, 12 CDR.
Relevance of Community Design Rights for the development of robot. The layout of a robot that is new and has an individual character which is not purely the outcome of a technical process can be protected with a Community Design Right. Besides the total layout, elements of robots that are visible, such as designed limbs, shapes and curves of respective robot-parts can also be protected against copying or ‘borrowing’.  

Topographies of Semiconductors

**Legislation – International:**
- Agreement on Trade-Related Aspects of Intellectual property Rights (TRIPS);
- Treaty on Intellectual Property in Respect to Integrated Circuits (TRIC, not in force);

**Legislation – European:**
- Directive 87/54/EEC on the legal protection of topographies of semiconductor products (Semiconductor-dir).

Object of protection and requirements for protection: Article 35 TRIPS provides for the protection of the layout-designs (topographies) of integrated circuits, in accordance with TRIC. The Semiconductor-dir. (TSD) defines that the topography of semiconductor products can be protected, in so far as it is the result of its creator’s own, intellectual effort and is not commonplace in the semiconductor industry.\(^\text{70}\) A topography is a series of related images representing the three-dimensional pattern of the layers of which a semiconductor is composed and in these series, each image has the pattern or part of the pattern of a surface of the semiconductor product in any stage of its manufacture.\(^\text{71}\) Registration is necessary for the establishment of exclusive rights.\(^\text{72}\) Registered topographies may carry a capital ‘T’ to indicate that they have been registered.\(^\text{73}\)

Right holders & Exclusive Rights: The creators of topography of a semiconductor are the initial right holders.\(^\text{74}\) They have the right of reproduction of the topography and the commercial exploitation or the importation of the topography for that purpose, or of a semiconductor product that is manufactured using the topography.\(^\text{75}\)

Limitations: Topography Rights last up to 10 years after first commercial exploitation.\(^\text{76}\) Article 5(2) TSD allows the private and non-commercial reproduction of a topography without prior permission of the right holder. Also the reproduction for the purpose of analysing, evaluating, or teaching the concepts, processes, systems or techniques embodied in the semiconductor product may be done without permission.\(^\text{77}\)

\(^{70}\) Art. 2 TSD. 
\(^{71}\) Art. 1(b) TSD. 
\(^{72}\) Art. 7(1) TSD. 
\(^{73}\) Art. 9 TSD. 
\(^{74}\) Art. 3(1) TSD. 
\(^{75}\) Art. 5(1)(a-b) TSD. 
\(^{76}\) Art. 7 (3-4) TSD. See also art. 38 TRIPS 
\(^{77}\) Art. 5(3) TSD.
Relevance of topographies for the development of robots. Topographies of semiconductor products that are used in robotic devices, which are new and owned by their creators, may be registered, thus instituting a right against copying of that semiconductor product. In the commercial exploitation of robotic devices, it should be acknowledged that the microchips used in the retail or wholesale robotic devices may be protected, and therefore permission of the right holder may be required.

Trade Secrets

**Legislation – International:** Agreement on Trade-Related Aspects of Intellectual property Rights (TRIPS); Paris Convention for the Protection of Industrial Property (Paris Convention).

Object of protection and requirements for protection: According to TRIPS, Secret information is to be protected.\(^{78}\) Information is deemed to be secret as long as it is not generally known among, or readily accessible to persons that normally deal with that specific kind of information; and the information has a commercial value – because it is secret; and reasonable steps have been taken to keep the information secret.

Right holders & Exclusive Rights: Natural and legal persons have the right to prevent secret information from being disclosed to, acquired by or used by others without their consent, in a manner contrary to honest commercial practices. This is understood to mean 'at least': breach of contract, breach of confidence, inducement to breach an obligation and the acquisition of undisclosed information by third parties who knew or should have known that such practices were involved in the acquisition.\(^{79}\) These TRIPS provisions have not lead to specific European legislation; they can however play an important role on a national level. For instance in The Netherlands, company secrets are protected by criminal law\(^{80}\) and the Dutch Civil Code states that employees who disclose company secrets can be fired.\(^{81}\)

Relevance of trade secrets for the development of robots. Information can – as we have seen – be protected by Intellectual Property Rights. Re-use of such information generally requires permission of the right holder. Information that is not IP-protected can however still be protected in case it is kept secret, which means that it may not be acquired or used in, for instance, a robot-development process.

Ownership of IPR is based on a fundamental principle: in most cases, the rights arise on the head of the creator who is an individual.

However, the economic logic requires an adjustment of these rules especially in the event of a creation made by an employee in the framework of his professional duties. Thus, it may seem evident that the rights belong to the employer who funded the creation.

**4.2. Rules likely to be adjusted**

(C. Huebert-Saintot, CEA-List, Technology Transfer Department)

**4.2.1. Regarding the above mentioned principle related to ownership**

As part of the creation of Europe and to achieve its objectives, a corpus of rules ("EU law") has been established. EU law is supranational law that means that it is incumbent on Member States to transpose the European provision into national law to enable the achievement of the goal set by the EU law.

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\(^{78}\) Article 39 TRIPS.

\(^{79}\) Art. 39(2) and footnote 10 TRIPS.

\(^{80}\) Artt. 272-273 Dutch Criminal Code.

\(^{81}\) Art. 7:678(3) Dutch Civil Code.
However, the EU law does not rule all of legal fields or provide options so that Member States may have different laws on specific subject matters, notably concerning the ownership of a creation realized by an employee.

Initially, intellectual property was an area left to the legislative authorities of the Member States. Indeed, the original Treaty of Rome of 25 March 1957 was not intended to regulate intellectual property. Article 222 of this Treaty stated elsewhere that “This Treaty does not in any way prejudice the rules of the property regime in Member States.”

However, dissemination of intellectual works tends increasingly to exceed the strictly national framework. That is why it appeared necessary to harmonize EU countries’ legislation, in order to ensure that intellectual property enjoys an equivalent level of protection in the internal market. It is the aim of the different CE’s Directives.

When the work is created under an employment contract, the principle mentioned above remains unchanged: the owner is the creator of the work and not the employer. It does not matter whether the work was created at the request of the employer, according to his instructions, in execution of a contract of employment or with his instruments and tools.

This solution is probably unfair and debatable from an economic point of view because, in concrete terms, the rule means that the employer cannot hold the ownership on the work created under an employment contract except if an assignment is made in such contract which must comply with provisions of intellectual property law and public order.

That is why exceptions were made which have been instituted by EU and/or national laws, notably concerning software and patents.

**Concerning software creation** - This is especially true with regard to software creations. Indeed, the devolution of IPR of software created by an employee to the employer was consecrated in France by Law No. 85-660 of July 3, 1985.

A Directive of the European Communities dated 14 May 1991 introduced at European level a common legal regime for software. This Directive adopted the position of French law: Article 2. “Where a computer program is created by an employee in the execution of his duties or following the instructions given by his employer, the employer exclusively shall be entitled to exercise all economic rights in the program so created, unless otherwise provided by contract “.

This text therefore meets the wishes of employers who, if they wanted a software protection by copyright, were hostile to the rule of “employee-creator-owner”.

Note that the text concerns exclusively the economic rights (the employee remains the author of the software within the meaning of IP law) and that the text reserves the right to organize, especially in the contract of employment, a more favourable devolution of the rights to the employee (including a right to remuneration for the employee). However, this case is rare in practice.

**Concerning patents** - If the inventor is an employee, the right to a European patent is defined under the law of the State in which the employee performs his principal activity or in the territory of his employer.

In many countries like Germany and France, the law provides that “inventions of mission” within the framework of the mission entrusted to the employee or made with the means of the employer (financial or human means, equipment, raw materials) are automatically transferred to the employer.

The employer shall pay to the inventor employee additional compensation. The amount of this additional compensation may be fixed or variable and depends on various factors, including the profit from the exploitation of the invention, the value of the invention, the personal contribution of the employee inventor. When the invention is made by an employee outside the scope of his duties and by his own means, the employer may, under certain conditions, and payment of a fair price, claim the patent right or obtain an exclusive license.

In other countries, such as the United Kingdom, the ownership of employee inventions must be set by contract.
4.2.2. By contractual adjustments

Under intellectual property law, owners are granted certain exclusive rights. Like any exclusive right, any intellectual property right reveals its true economic interest insofar as it is exploited.

Intellectual property law allows the holder to exploit his personal property, to oppose exploitation by a third party but also to assign or license his rights. The contracts on the exploitation of intellectual property rights can take various forms: license agreements, distribution, sponsorship, franchise agreements, R & D collaboration agreement, etc.

Other than by an owner exploiting himself his property, licensing is the most common commercialization way. Licensing occurs when a licensor grants exploitation rights over his property to a licensee. A license is also a legal contract, and so it will set out the terms upon which the exploitation rights are granted, including performance obligations that a licensee must comply with.

Subject to compliance with certain legal provisions relating to public policy or competition law for example, the owner is free to exploit his rights and assign them. Under these restrictions, we can mention for example two French law provisions regarding copyright.

In French law, the assignment clause must respect legal constraints of form and substance if economic rights are transferred or licensed in whole or in part: each right transferred must be stated separately and its field of exploitation must be defined as to its extent, destination, territory and duration. All rights not expressly assigned will be considered as reserved

Copyright laws grant to the author economic rights such as rights of reproduction, distribution, adaptation, public performance but also some noneconomic rights known as “moral rights”. Moral rights originated in French law and are representative of the desire of protection of the author. According to these rights, the author has the right of paternity, that is to say the right to claim ownership of the work and prevent others from using his name, the right of integrity which gives author the right to prevent alternation, mutilation or distortion of its work and the right of publication which is the right of the author to decide whether he is going to publish or not his/her work. In French law, moral rights are perpetual, that means that these rights shall be maintained after the death of the author and shall be exercisable by the persons authorized by the legislation of the country (for example the descendants of the author).

Considering the fact that these rights are attached to the author's personality, moral rights are inalienable. Thus, an author is not able to assign his moral rights to a third party.

4.3. The limits of existing rules with regard to the development of autonomous robots

The above mentioned legal IP systems are based on the fact that computers are inert tools, so that current intellectual property regimes usually only apply to humans or legal persons creations and not to creations coming from computers or inert tools. However, artificial technologies have advanced rapidly to the point that intelligent agents do not assist humans in the creation of works, but generate them autonomously. Thus, intelligent agents are capable of creativity.

Than it raises issues about possible protection of "robot generated works" by IPR and on the conditions of such protection (see section 4.3.1) and furthermore on the ownership of such kind of creations (see section 4.3.2) and on the limits of the current rules.

82 Art L 131-2 Code de la Propriété Intellectuelle
4.3.1. The limits facing the conditions of protection by intellectual property rights

4.3.1.1. Patentability of the robot-generated work

The key issue concerns an "invention" which would have been conceived by a robot. This invention might not have the possibility to be protected by a patent.

Indeed, in our case, the invention is not based on a robot-aided work but from a robot-generated work, in other terms the invention is realized independently by the robot without human intervention. And in this case, to obtain patent protection, the inventor should be designated in the application. The designation of an inventor in a patent application is a legal act. It is essential to indicate in the patent application the real inventor because a false designation may result in the loss of the patent.

The inventor must be designated by his name and his address. That implies that the inventor must be a physical person, even if the applicant can be a corporation.

Also, an invention made by a robot, even if the criteria of patentability are met, cannot be protected by patent.

Last but not least, it could be necessary to review the criteria of patentability of a robot-generated work. In fact, TRIPS provides patent protection for any inventions whether products or processes in all fields of technology provided that they are new, involve an inventive step and are capable of industrial application.

An invention involving an inventive step is defined as an invention which involves technical advance as compared to the existing knowledge or having economic significance or both. The invention must not be obvious to a person skilled in the art, in other terms this person must not be able to come to that invention unless he develops some special skills.

Regarding robot's potential high level of intelligence, is this non-obviousness criterion still relevant? Should this criterion be replaced or modified?

And what about the copyright protection?

4.3.1.2. Copyright protection of the robot-generated work

Can copyright be applied to robot-generated works?

Within the EU, the first requirement for a work to be copyright protected is that it is original. Thus, the work will necessary involve intellectual effort and should not be copied or derived from other works.

The second one is attached to the person who created it, in other words it is connected to the personality of the author. In fact, creation is related to the human consciousness: the author should have made subjective choices in the creation of the work.

It appears that if the activity of creation is performed by a machine, without human intervention, there is no creation in the sense of copyright. Human intervention is necessary.
Thus, we can note that, in the absence of human intervention in achieving the creation, a protection by an IPR seems to be difficult to obtain for this creation. With regard to the development of artificial intelligence, there is no doubt that intelligent agents are no longer inert tools but that they can select among several inputs the relevant ones and summarize them. Users of intelligent agents have no control, or if any, a very little one, over the final work created by it.

That is why, it seems to be relevant to adapt the criteria of IP protection in order to grant such protection to robot-generated works.

Another key issue about such robot self-developed invention will be to determine who will be vested of the ownership of these creations.

4.3.2. Ownership of rights

Current IP system is based, on one hand, upon the distinction between authorship and/or inventorship and, on the other hand, on ownership.

In the case of a robot-generated work, the robot itself is in fact the author or the inventor. If a protection by an IPR is provided to a robot-generated works, who will be entitled to the rights thereto? Several possibilities could be envisaged.

The designation of the owner is important particularly because several issues can be identified about their exploitation.

Indeed, who is responsible for damage caused by the robot? Can the owner license or sell the robot as is, in other terms without guarantee of safety? Who is responsible for the acts of infringement committed by an autonomous robot? How control the data collected by the robot, particularly personal data?

4.3.2.1. The computer programmer

The key issue is whether or not the programmer should be considered as the author and so as the owner because he is the one who introduced the original expression into the work.

If the programmer contributes substantially to the creation of the intelligent agent and makes the arrangements necessary for the making of the work, he has no control over the works created by the robot and he cannot conceive that works.

Can we consider that robot-generated works are derivative works so that the programmer is invested of intellectual property rights? The answer seems to be no because robot-generated works do not necessarily meet the requirements for qualification of derivative works. In fact, the original code is not included in the robot-generated works.

Granting ownership to the programmer would mean that he might automatically own everything the intelligent agent is generating. So, why would the user buy the program?

This solution does not seem appropriate due to the economic purpose of the intellectual property.

4.3.2.2. The user

The user seems to be the person most directly concerned by the robot-generated works, lawfully acquired, and capable to create this work in a tangible form.

However, considering the autonomy of the intelligent agent, this solution is not very satisfying because, as already explained, users of intelligent agent have no control over the final work created by this agent, unlike a user with his camera. Also, can a user grant the ownership of robot-generated works because he just pressed a button?

4.3.2.3. The intelligent agent itself

An intelligent agent can independently produce creative works. It seems therefore logical to consider whether the intelligent agent could be the owner of its works. It should be noted that some national laws recognize legal companies as copyright holders so the question is not hypothetical.

This solution is supported by some people and implies that intelligent agent acquires a legal personality.
However this hypothesis raises other issues. In fact, even though an intelligent agent is capable of
creativity, it is not capable of transferring rights to others (for example to negotiate and formalize this
transfer). Moreover, it cannot have standing to sue an alleged infringer of its work. So who will enforce
the copyright owned by an intelligent agent in this case?

In addition, the main purpose of granting copyright protection is to stimulate creation and promote
original works of authorship and/or innovation. Intelligent agents have not to be encouraged to
perform, so granting exclusive rights to robots makes no sense.

4.3.2.4. The investor

As previously mentioned, IP law is based on an economic logic. Thus, should we vest the ownership
of robot-generated works in the robot owner or in the person who makes financial and logistical
contributions for the development of robot-generated works?

a. The robot owner

By analogy with civil law which provides that the owner of a property has a right over its fruits
regardless of who possesses it, we could consider that the owner of a robot should own the works
generated by its robot.

Under this assumption, if a licensee wants to obtain ownership of the potential works generated by the
robot licensed, the parties will have to negotiate and establish a contract providing for this transfer of
ownership.

By this way, IPR will provide incentives to innovators to invest in research and development. Thus,
IPR fosters this virtuous cycle of innovation and creation.

b. The person who makes financial and logistical contributions for the development of
robot-generated works

Following the example of databases protection and considering the main purpose of IPR, it might be
interesting to introduce a sui generis protection law which would vest ownership in the person who
made financial and logistical contributions for the development of robot-generated works.

That person could be the owner of the robot, the licensee or the user. It could be a corporation. In any
case, it could be the person who makes possible the production of the work.

Note that the legislation of the United Kingdom contains specific provisions in this sense defining a
specific regime for work “generated by a computer in circumstances such that there is no human
author”. Pursuant to this law, the copyright belongs to the “person by whom the arrangements
necessary for the creation of the work are undertaken”83.

To conclude, it appears that current IP regimes are still relevant to the development and the
exploitation of inert robots and also to the exploitation of robot-aided works. However, there is a gap
in the law concerning the protection and the exploitation of robot-generated works which has to be
filled.

The specificity of such kind of development works should be taken into account by an adequate legal
framework.

83 Copyright Designs and Patents Act, 1988, s9 (3) UK
5. Labour law and robotics

5.1. Basis of European Labour Law

For the last fifty years national labour law has been being influenced more and more by European legislation. But it is still not fully harmonized. European Labour Law is driven by seven Principles:

- Comprehensive occupational protection,
- cooperation principle,
- Active Role of the individual employees,
- Preventive safety management,
- Obligation to adapt the technical state of the art, and
- Cohered regulation.

After Treaty of Lisbon one of the most important enabling rules, with exception of other competences, can be found in Art. 153 Treaty on the Functioning of the European Union (TFEU). This competence was already implemented in former contracts. Labour law in a common sense needs to be distinguished from safety regulations in the area of labour law. The background of Art. 153 TFEU is to create and strength a common European market by introducing minimum standards related to working conditions.

Article 153 TFEU - (ex Article 137 TEC)

1. With a view to achieving the objectives of Article 151, the Union shall support and complement the activities of the Member States in the following fields:
   (a) improvement in particular of the working environment to protect workers’ health and safety;
   (b) working conditions;
   (c) social security and social protection of workers;
   (d) protection of workers where their employment contract is terminated;
   (e) the information and consultation of workers; EN C 83/114 Official Journal of the European Union 30.3.2010
   (f) representation and collective defence of the interests of workers and employers, including co-determination, subject to paragraph 5;
   (g) conditions of employment for third-country nationals legally residing in Union territory;
   (h) the integration of persons excluded from the labour market, without prejudice to Article 166;
   (i) equality between men and women with regard to labour market opportunities and treatment at work;
   (j) the combating of social exclusion;
   (k) the modernisation of social protection systems without prejudice to point (c).

Until now there are various directives and regulations made by European institutions regulating several areas regarding labour. For example directives on “protection of employees in the event of the insolvency of their employer”, “informing and consulting employees”, “protection of young people at work”, “European Works Council or a procedure in Community-scale undertakings and Community-scale groups of undertakings for the purposes of informing and consulting employees”, etc. Most of them are less important for labour law and robotics, but they have significant influence on the relationship between the employer and the employee. These directives mostly setup only minimal standards so member states can deviate by stipulation a higher standard.

On the other hand there are directives regulating technical details are important for labour law, especially to labour safety law. For example the govern product safety and use of hazardous material. Member states are not allowed to deviate from this norm in general. These directives are passed on the basis of Art. 114 TFEU:

Article 114 - (ex Article 95 TEC)

1.Save where otherwise provided in the Treaties, the following provisions shall apply for the achievement of the objectives set out in Article 26. The European Parliament and the Council shall,
acting in accordance with the ordinary legislative procedure and after consulting the Economic and Social Committee, adopt the measures for the approximation of the provisions laid down by law, regulation or administrative action in Member States which have as their object the establishment and functioning of the internal market.

Article 26 TFEU - (ex Article 14 TEC)
1. The Union shall adopt measures with the aim of establishing or ensuring the functioning of the internal market, in accordance with the relevant provisions of the Treaties.

A function of the internal market is only possible if a proper protection of the single person is achieved. So product safety and hazardous material is governed by European legislation as well. As dangerous materials could be used as working appliances during the working process they influence the employment relationships related to work safety. Most important directives for robotics and labour law are:

- Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits,

But with the idea to protect the employees some other directives were passed in the area of work safety for example:

- Directive 2002/44/EC of the European Parliament and of the Council of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) (sixteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and

These directives aim especially for occupational safety. The national regulations derived from these directives are very often very detailed and give the employer special pre-sets what he has to consider related to the protection of the employee.

Despite the existence of some of these European laws the labour law in the member states labour law is still influenced by national legislation or case law to a high degree. This refers to proceedings, liability or even to safety norms and relationship between the employer and Employers’ Liability Insurance Association. Due to the principle of conferral only some areas of labour law can be regulated by the EU.

Because of the high importance of the national law, the following paragraphs shall introduce some principles of labour law with connection to liability (mostly national law) and work safety influenced by European legislation.

5.2. Labour Law

Image the following record: An Employee was hurt by a transportation robot. It is questionable if the employer has to pay compensation to the employee. If the workers’ health was damaged, in most cases the German Social Accident Insurance pays for compensation because of a legal disclaimer (§§ 104, 105 of German Social Code VI). If the damage was caused through gross negligence the Social Accident Insurance can claim their paid compensation from the employer. But what does gross negligence mean?
The Employer commits gross negligence if he fails to carry out reasonable care in a particular way. Negligence is evaluated in an objective way. So it is important how an average employer had acted. Norms of occupational safety can have an influence on this evaluation. From the contract relationship derive special (secondary) duties, such as duty of care. This duty of care is affected by the norms of occupational safety as well. So, ISO Norms, EC-Directives (Directive 2006/42/EC on machinery) or recommendations made by Employers’ Liability Insurance Association can influence the interpretation of negligence. This can be used as orientation. One could say that an employer who does not follow these rules may act gross negligent. Something similar could be said regarding an employer who does not do a risk assessment. But problems occur where such rules do not exist yet or if these rules are not up to date any more. If there are no norms or recommendations, the employer has to orientate to state of science and technology with the aim to keep risk for health and life especially low.

But additional duties appear in the area of collaboration of employees and robots. The worker has to be instructed properly; he has to know about dangers arising from the machine and the reasonable use of it.

Regarding transportation robots at work several duties may appear and could differ from case to case for the employer. A breach of these duties could lead to liability towards the Employers’ Liability Insurance Association or the Employee itself in cause of non-health damage. By installing the robot in the factory hall the employer has to keep the risk for the worker as low as possible. He has to follow the recommendations made by Employers’ Liability Insurance Association regarding collaborating robots and has to instruct his employees properly (training, manual, documentation, information signs). Referring to the driving feature if the robot moves autonomously he has to prevent that the robot goes off the track. This means for example to ensure that the sensor or a robot-arm for the collision avoiding system work properly. This could be guaranteed through regular services and technical checks. It could be very difficult for an employee to detect such defects because of the complex system.

Regarding the robot working autonomously the employer has to keep an eye on the safety features. If the robot supports the human, an individual risk assessment must be made before installing the workplace. Practically it is important to evaluate not only the setup of the robot, but also the setup of the workstation (pinch points, point of evasion).

Therefor several duties for the employer appear. Problems occur especially if there are no technical rules or recommendations.

Another problem is the question of prove when an accident has happened. Again, as sometimes discussed in liability law, an event recorder or black box implemented in the robot could be helpful to provide information on the circumstances of the accident.

5.3. Labour Safety Law

The use of robots in practical application was once limited to stationary, industry-related robots. The use of such robots assumed strict precautionary measures that sought to protect workers from injury within the robot’s sphere of movement. Recent technological development has changed this with the introduction of more complex industrial robots that can move themselves and work mutually with humans. The same is shown in the development of mobile service robots, which operate in both private and public spaces shared by humans and are increasingly more common. This rapid development may suggest that the future technological application of fully-automated robots that can learn, make decisions, determine appropriate actions, perceive their surroundings, and react with flexibility is a reality.

A producer is required to make a legal assessment of risk when his robot is made to operate in any work environment. This assessment could reach back to a number of legal sources including the EU Machinery Directive or norms for industrial robots. However, the making of such an assessment is unreliable because the current standards regulating the organization and layout of work in businesses that employ robot technology to support production are insufficient. They could lack the stature of law and regulations, and may not reach the level of safety requirements or test procedures for risk assessment.

An employer creates potential hazards when he uses machines or employs industrial robots in a work environment and is thus responsible for any ramifications. In cases involving personal injury, employers often escape liability under legal disclaimer (see above), and liability is often shifted to public accident insurance that entitles the injured person to damages except those arising from pain and suffering. Nevertheless, the possibility to claim recourse against an employer with the help of an
employee’s professional association exists (§§ 110, 111 of German Social Code VII), providing that the damage sustained, having arisen from intentional or gross negligent action, qualifies for insurance.

Under the Labour Protection Law, an employer must recognize certain legal duties that enable a third party to protect himself against danger. These include the obligation of risk prevention, the obligation of risk avoidance, and the obligation of risk removal (Art. 3-5 German Occupational Health and Safety Act), as well as the duties to warn and instruct (Art. 4 Nr. 7, Art. 9, 12, 14 German Occupational Health and Safety Act). In addition to these, he must also recognize risk control duties, organizational duties, duties of selection and supervision, and the duty to notify (Art. 3, Para 2, 6, Art. 9 Para. 2 German Occupational Health and Safety Act). The due diligence required in the design of a workplace with a robot, as well as the respective conduct of a worker within such a workplace, often reaches greater definition by reaching to applicable ISO or DIN norms. The norms established by EN ISO 10218-1, EN ISO 10218-2 and European Directive on Machinery are the most relevant in the design of workplaces with collaborative robots.

Sufficient standards and regulations may lack in some areas. However, this may frustrates the specification of an employer’s duties to implement safety precautions and to maintain a standard of care. Moreover, ISO and safe-regulation norms do not have legal character and thus cannot effect a binding regulation on employers. An employer’s compliance with safety requirements can only be considered an indication that he has acted with care.

Compliance with technically-advanced safety measures does not always provide protection from risk. Indeed, residual risk will always appear in the application of robots because the possibility of a robot's malfunction can never be eliminated. That is why the legal options for employees require a more intensive examination, in particular the refusal to work or the right to demand hazard pay.

The development of autonomous robots will go hand in hand with the development of new approaches for the protection of workers. The idea of a safe work environment may not continue to focus on the application of independent safeguards or warning devices, but rather the role a robot can play in the protection of its surrounding workers.

Technological development in the field of robotics always accompanies new questions of law and safety. The more autonomous a robot is, the more his actions are unpredictable, which raises concerns about the foreseeability about a robot’s behaviour in certain situations and what dangers can arise from it. The potential danger is very difficult to estimate, which encumbers the development of appropriate safety standards and requirements for producers and employers that wish to employ an autonomous robot under the Industrial Safety Regulation.

If a robot malfunctions, the question remains whether this malfunction is the responsibility of a concrete legal person, such as a human. It is difficult to discern or predict whether a malfunction happened due to bad programming, incorrect input of information, faulty operation of a worker, or a wrong “decision” of the robot (see above)

Most humans who come into contact with autonomous robots will not be robot experts. Even if employees are trained to work with a robot, new robotic systems are simply too complex for an employee to be expected to have much more than basic user knowledge. This complicates the determination of an employee’s responsibility when he causes damage to or by mishandling a robot.

5.4. Proposed roadmap for Labour law

Step 1: Fundamentals: clarify following issues:

- Clarify in which area robots should be used?
- Do we really need regulations (vs. over-regulation or self-regulation) and in which fields?
- Consider crucial problems
- In which cases do we need safety regulations for (potential) dangerous robots?
- Should we consider collaborative robots (non-autonomous), as well (see above)?

Step 2: deeper investigation of current regulations, by reviewing

- EU directives (general/safety)
- Implementation of directives into national law
Gaps of EU regulations (analyse competences)
Degree of protection in different member states. Is a derivation given?
Compare national/European rules with others (US/Asia)
Review implementation of the “magic word” autonomy (or other term) in regulations; autonomy not considered by EU directive on machinery or self-regulation (DIN, ISO) until now

**Step 3: Find answers**
- Posing “open” questions which are not answered by current regulations
- Formulate concepts, based on these regulations
- Review implementation of the “magic word” autonomy (or other term); autonomy not considered by EU directive on machinery or self-regulation (DIN, ISO) until now

**5.5. Summary for Labour law and robotics**

It is likely that the use of Robots will increase in the next years. This will also affect the area of labor and its norms and regulations. It could be possible that new technologies (e.g. collaborative robots) will change the current way of how we deal with robots used in a workspace. Especially in the area where there are no regulations or guidelines workers safety is very important. A harmonization of requirements which have to be met in the area of labor safety law might be further done by the European legislation as well.
6. Data Privacy Law & Robots

6.1. Introduction

Robots are partially characterized by having a sensorimotor function; they have a sensory motor that is able to process information acquired from a robot’s surroundings. This information often contains elements about individual human beings, a fact that illustrates how robots can make special strains on privacy law. Additionally, the wide networking of robots that can share information provides a different aspect to the issue. Data protection can no longer be regarded as the simple assurance of technical data or information. Instead, the term must be understood as a protection of the self-determination of information and data.

Technological development constantly provides new challenges to comprehensive privacy. At the origin of European Data Protection Law in 1995, machine-processed data was still stored on Diskettes or CDs. A look seventeen years into the past is a look to a time in which networking personal computers, mobile phones, internet, e-mail, search engines, social networks, wireless, home banking, GPS, or robotics were still in their infancy. The most contemporary issues are those of RFID-chips and biometric data (e.g. iris scans). If these new technologies are combined with a robotics system, new problems may easily arise.

6.2. Legal Sources of European Data Privacy Law

The following section should introduce the most important sources of law regarding Data Protection in the European Union. European rules became more and more important during the course of last year, even though Data Protection is not a main field of duties for the EU. Nevertheless, these regulations and directives were needed for the approximation of laws for the international market.

The Protection of Personal Data was established as an independent fundamental right in Article 8 of the Charter of Fundamental Rights of the European Union. Some important secondary legislation was also created with the “Data Protection Directive” 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data. It aimed on the creation of an equal standard of privacy within the EC. Also noteworthy are the directive 2002/58/EC mainly on questions of public communications networks, directive 2006/24/EC on data retention, directive 2009/136/EC on the right to privacy and the right to confidentiality, and regulation (EC) Nr. 45/2001 on procession of data regarding institutions of the EU.

6.3. Basic Principles of Data Privacy

Some basic principles can be found in the directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data. This directive constitutes the very heart of EC privacy law. Personal data must be:

- processed fairly and lawfully,
- collected for specified, explicit and legitimate purposes and not further processed in a way incompatible with those purposes as originally specified,
- adequate, relevant and not excessive in relation to the purposes for which they are collected or further processed,
- accurate and, where necessary, kept complete and up to date,
- not be kept in a personally identifiable form for longer than necessary for the purposes for which they were collected or further processed.

86 Polenz, Kilian/Heussen, Computerrecht, 1. Abschnitt, Teil 13, I., 2., Rn. 3.
87 Beyleveld, The Data Protection Directive And Medical Research Across Europe (Data Protection and Medical Research in Europe, p. 8.
6.4. Data Privacy in Research and Development

The debate on whether data privacy law constricts scientific research is as old as data privacy itself. Even special regulations on research could not stop the criticism of researchers of various disciplines. In fact, the discussion has reached a new peak.\footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 20.}

Data privacy law is also accused of inhibiting research projects.\footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 19 m.w.N.} This could apply also on projects in the area of robotics. Unreasonable efforts involved with a concerned person’s consent are often cited as a main aspect of critique.\footnote{Menzel, MedR 2006, 702 (702 f.).} In addition, the concerned are often flooded with information and declarations of consent.\footnote{Bochnik, MedR 1996, 262 (263).}

Furthermore, the principle of appropriation is seen as a problem as data can only be used for the purpose defined above. The use of data for either later analysis or new research is not allowed.\footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 19 m.w.N.} Scientists claim that the principle of appropriation does not only apply to a single project but also to the persons involved. Due to this, researchers are seeking more openness.\footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.}

Many researchers also view the regulations as too complex to be practicable. They criticize the depth and differences of legislation and the indefinite legal terms with their large scope of interpretation.\footnote{Bochnik, MedR 1996, 262 (263).} Conducting “data privacy-accurate” research is said to be too bureaucratic, time-consuming, and uncertain.\footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; Rienhoff, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 53; Wichmann, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 58 f.; Mayen, NVwZ 1997, 446 (446); zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.} Some researchers even consider some aspects of data privacy to be overrated compared with the researcher’s needs which have not been sufficiently taken into account.\footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.}

Thus, it is important to examine whether this criticism is legitimate. It is necessary to analyse the data privacy requirements arising from a new research project. Subsequently, it is possible to find out whether those requirements in fact constrict research. However, this text will only cover the essential legal aspects of the topic.

Scientists not only have to pay attention to their national law, but must also deal with requirements arising from EU law. Moreover, research projects often cross national borders. To avoid “forum-shopping”, in which the most adequate law is being chosen, an equal law standard throughout the EU is important. The directive 95/46/EC on personal data sets such a standard. In the following, the directive will be analysed with special attention to its regulations on research.

Article 8 par. IV of the directive states that Member States may, for reason of public interest, law down exemptions for data processing. From recital 34 arises an explicit accentuation of scientific research. It is questionable, whether scientific research is generally of public interest. The general possibility of creating exemptions leads to the conclusion that the interpretation in this case has to be very restricted.\footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.}

Article 27 states that the Member States and the Commission shall encourage the drawing up of codes of conduct intended to contribute to the proper implementation of the national provisions adopted by the Member States pursuant to the directive, taking account of the specific features of the various sectors. Codes of conduct are provisions that trade associations and other bodies establish to rule the conduct of their members. As the range of organizations who underlie this possibility is very widespread, scientific associations easily come into consideration under the widespread range of organizations that underlie this possibility.\footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.}

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\footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 20.} \footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 19 m.w.N.} \footnote{Menzel, MedR 2006, 702 (702 f.).} \footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; Rienhoff, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 53; Wichmann, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 58 f.; Mayen, NVwZ 1997, 446 (446); zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.} \footnote{Wagner, in: Hamm/Möller (Hrsg.), Datenschutz und Forschung, S. 16 f.; zit. n. Pöttgen, Medizinische Forschung und Datenschutz, S. 19.} \footnote{Bochnik, MedR 1996, 262 (263).} \footnote{Bochnik, MedR 1996, 262 (263).} \footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 56.} \footnote{Pöttgen, Medizinische Forschung und Datenschutz, S. 57.}
An important consideration behind this is that every sector is aware of its special needs and should therefore be self-regulatory. This concerns robotics in special. Scientific associations are given the possibility of regulating their handling of personal data according to their field of research. Associations can find practical and appropriate solutions in a way which would not be possible with abstract national law.\textsuperscript{99} Abstract law has to be applicable for all areas and must be phrased abstractly, leading to a certain degree of indeterminacy. Another effect of sector-specific regulation is that complicated, detailed rules become dispensable.\textsuperscript{100} Abstract law only quotes a common denominator whereas the codes of conduct state the details.

Technical development moves very rapidly, especially concerning anonymity of regulation (also, “anonymization”). Thus, a flexible system of codes of conduct makes handling this new situation faster and more flexible. This enables the research sector to find ways of anonymization that are up to date and which fit their needs\textsuperscript{101}

Despite the advantages codes of conduct provide, they remain simple regulations without a binding character: they do not bind third persons or courts.\textsuperscript{102} The intention of codes of conduct is to implement or clarify valid law without being able to diverge from it. Under Article 27 par. II states, codes of conduct can be approved by national authorities. However, the national legislative organs can establish a legislative character. Thereby a code of conduct can be changed to binding national law.\textsuperscript{103}

### 6.5. Data Privacy in Use and Application of Robots

Privacy is also important in the area of use and application of robots. The following thoughts may be transferred on the aforementioned topic of research and development as well.

The maxim “all data belongs to the individual” must be respected because the principles mentioned above are applicable. Privacy should preserve the interest of the weaker party in asymmetrical relationships of power.\textsuperscript{104} This is of importance concerning the use and application of robotics because asymmetrical relationships of power can often be found in this regard: This is true for the use of care robots in hospitals or AAL-systems\textsuperscript{105}, as well as for robot companions for personal assistance, assistant robots at work\textsuperscript{106}, and even small service robots that only operate in private spaces. The following paragraphs will provide a sketch of the most important influence from EC law on privacy in the area of robots.

An aspect of privacy, especially with focus on the principle of processing personal data lawfully and fairly (Article 6, par. I, lit. a Directive 95/46/EC), is the security of data precession (Art 16, 17 95/46/EC).\textsuperscript{107} There is a very close relationship between both aspects because without security of data, privacy would hardly impossible.\textsuperscript{108} With exception of availability (the system should perform its specific functions as expected), integrity (system should fulfil its functions in correct order, side effects must be taken into account), confidentiality is an important issue of data security.\textsuperscript{109} Confidentiality may be defined here as the assurance that other non-authorized persons or even third parties are not allowed having knowledge of the collected data.\textsuperscript{110} This could require a physical or virtual access control, encryption, control of data’s forwarding, or input or dividing of data into different sections

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\textsuperscript{99} Pöttgen, Medizinische Forschung und Datenschutz, S. 58 m.w.N.
\textsuperscript{100} Pöttgen, Medizinische Forschung und Datenschutz, S. 58 m.w.N.
\textsuperscript{101} Pöttgen, Medizinische Forschung und Datenschutz, S. 59.
\textsuperscript{102} Pöttgen, Medizinische Forschung und Datenschutz, S. 59 m.w.N.
\textsuperscript{103} Pöttgen, Medizinische Forschung und Datenschutz, S. 59 m.w.N.
\textsuperscript{104} Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 2.
\textsuperscript{105} Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 2.
\textsuperscript{106} Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 2.
\textsuperscript{107} Regarding labour law, there are special regulations on Employees Data Protection.
\textsuperscript{108} Compare as well: recital 46 95/46/EC.
\textsuperscript{109} Gola/Schomerus, Bundesdatenschutzgesetz, § 9, Rn. 1; word privacy is sometimes used as a synonym for data safety in the area of protection of personal rights.
\textsuperscript{110} Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 2.
regarding the area of use. The requirements on data security have to be met with special regard to the specific area of application.

Another significant aspect of privacy is transparency (Article 10, 11, 7 95/46/EC). Data subjects should have the chance to observe the procedure of data processing. A user must be sure on about the type of data being processed, whom it belongs to, how they are spread, and the purpose for which the data is analysed. The basic requirement of consent (Article 7 95/46/EC), one of the most important requirements for personal data procession, is related to transparency. Under Article 7 95/46/EC, consent must be given “unambiguously”. The legal consent, defined in Article 2, lit h 95/46/EC, may be further shaped by national privacy legislation of the EC member states. This could lead to a different demand regarding consent and, as a result, to differentiating levels of privacy throughout the member states. For the use of robots, this means (normally there is no other regulation which would substitute the requirement of a consent) that the subject of data processing must be informed of all the issues in the process in advance.

The data subject must also have the ability to interfere. In other words, he must have the legal right to object to data processing (Article 14 95/46/EC). The objection is only possible in the cases of Article 7 lit. e, f 95/46/EC (performance of a task carried out in the public interest or purposes of the legitimate interests pursued by the controller). Furthermore, general opinion recognizes that data subjects could indeed object to this consent afterward. Thus, a data subject must be in control of processing the data, and an objection to data processing must be generally possible. This could lead to the idea of a “private mode” for robots, which may allow the collection of data to be switched off. Moreover, each data subject should have a single person in charge, a “SPOC: Single-Point-Of-Contact”, such as a “data processor” to contact in case of intervention or information.

### 6.6. Proposed roadmap for Data Privacy Law

Comparison: Current EU privacy law / Draft for European Data Protection Regulation (what has changed in the draft? Have autonomous systems been taken into consideration?)

- Necessity of special regulations for autonomous robots
  - Comparison to other areas with special regulations regarding privacy law:
    - Special ways of gaining data (e.g. observation of public areas)
    - Special kinds of content (e.g. information on health status)
  - Possible regulations for autonomous robots
  - Possible contents for self-regulation (e.g. for privacy by design)
  - Comparison with jurisdiction and research in other legal spheres
  - Connection to other fields of law (e.g. negative correlation between provability and data protection)

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111 Gola/Schomerus, Bundesdatenschutzgesetz, § 9, Rn. 22; this are only examples (mostly form the German law), compare as well Art. 17 95/46/EC.
112 Dammann/Simitis, EG-Datenschutzrichtlinie, C. Einleitung, p. 79.
113 Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 2.
114 Furthermore the German translation of Art. 7 95/46/EC and Art. 2, lit h 95/46/EC could be interpreted in another way than the English version.
115 Consent must be given by a capable person, data processor has to inform the data subject sufficiently, the information has to be exact enough.
116 Regarding the German law.
117 Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 4.
118 Rost, Datenschutz bei Ambient Assist Living (AAL) durch Anwendung der Neuen Schutzziele, p. 4.
6.7. Summary for Data Privacy Law & Robots

The chapter on privacy law issues starts with new problems arising from the use of modern robotic systems. Their sensorimotor function and their integration in networks lead to a threat of the individual’s right of informational self-determination. A short introduction on the legal sources and main principles of data privacy law show the complexity of the issue. In the next part, concrete problems of researchers and developers are illustrated. The possibility of drawing codes of conduct as a way to provide roboticists more reliable rules is described. Following, the use and application of robots is being analyzed to bring the aforementioned technical and legal issues together.
7. Criminal Law, Europe & Robots

7.1. Introduction

Currently, there is no common substantive criminal law in the European Union. Thus, the question arises, whether a harmonization within the European Union is possible at all. For a long time, criminal law was seen as a protected area of national law,\textsuperscript{119} which cannot be affected by European law.

This was changed by the Lisbon Treaty and the accompanied creation of legislative competence in criminal law on a primary law basis.\textsuperscript{120} Despite the fact that these new competencies regulated in Art. 83 par. 1 of the Treaty on the Functioning of the European Union are limited to certain felonies, some experts conclude, that a harmonized criminal law is no longer unthinkable.\textsuperscript{121}

However, a harmonized European criminal law is still a long way off. Even though the Lisbon Treaty led to an inversion regarding the legislative competencies, it seems too early to speculate about definite contents.

7.2. Substantive law – common principles

Regarding substantive law, it has to be referred to the different existing European legal systems of the member states. But although these legal systems are different, there are some common main principles which exist in every criminal law system in the European Union.

Regarding criminal liability, many parallels to the fundamentals of civil liability exist. Nevertheless, compared to the principles of civil liability, the aim in criminal law is not compensation of damage but punishment of the perpetrator by state authorities. Of course, regarding this issue, a robotic system cannot be the perpetrator who has to be punished (yet). However, there are other persons that can be considered as perpetrator: the producer, the programmer, the seller or the user of the robot.

Assuming that none of these persons intentionally causes damage to someone, there is still a risk of criminal liability arising from negligence. This kind of criminal liability can be grounded on every stage of the production process and use of autonomous machines, including research and development. The more autonomous and potentially dangerous a machine is, the more it can be foreseen during the research phase, that it may later bring harm to humans. The use of robots for military purposes or the use of autonomous cars are reasonable examples. Liability for negligence normally would not extend to people involved in the development and production process of robots who act with reasonable care.

The standard of care is usually determined by a person's expected form of behaviour in a given situation, such as those regulated in ISO and DIN standards for the technology sector. There are, however, two important things to note.

Firstly, the various areas of robotics have no such standards by which one can determine an expected form of behaviour because the machines they would be relevant to are still in development. In such cases, the general-social standard of rationality is usually applied; i.e. “how would a rational person have acted to avoid damage in a similar situation?” This very vague standard can only offer little help in complex technological fields such as robotics, which is why it is necessary for all areas of robotic research to define internal regulations.

Secondly, it should be noted that such special norms can only show an indication of whether a person was acting in a manner consistent with a standard of care. Criminal law is not simply an accessory to the regulations of non-governmental groups and must always consider overall social morality next to any special standards. Thus, if certain internal rules do not contradict social expectations and standards of rationality, and if any party in question should have recognized this, then liability for negligence must be included in the determination of the guiltiness of its action. It is therefore important that such norms of a social sub-grouping always tie back to general standards.

\textsuperscript{119} Schack, ZZP 1995, 47.
\textsuperscript{120} Satzger, Internationales und Europäisches Strafrecht, § 8, Rn. 18 ff.
\textsuperscript{121} Satzger, in: EuropStrafRecht, § 9, Rn. 6.
7.3. Extraterritorial offenses

However, regulations on which national law is applicable as well as the judicial cooperation within the European Union are omnipresent. Specific questions in the field of criminal law arise when – regarding the crime in question – the place of action is not the same as the place of result. Related to robots, situations could occur in which the person who controls the robot is not located in the same country where the robot is acting. The existing regulations for applying national criminal law to extraterritorial offenses seem, for the moment, to be sufficient regarding those cases. The principles of jurisdiction such as the territoriality principle or the personality principle could be applied like in the cases in which a user controls a conventional machine.

7.4. Proposed roadmap for Criminal Law

Because a harmonized European criminal law is currently not possible, only national regulations can be analysed and compared.

7.5. Summary for Criminal Law, Europe & Robots

At the moment a common substantive criminal law does not exist in the European Union. Even if the Lisbon Treaty provides the opportunity to create a harmonized criminal law it actually seems still too early to speculate about definitive contents. Regarding substantive criminal law, it has to be referred to the different existing European legal systems of the member states. Despite the differentness of these systems, there are common principles for many criminal issues in the different criminal law systems or parallels to regulations in the civil law.
8. Conflicts and litigations involving robots

We can now consider the dynamic side of robotics: robots as agents in a human environment. The purpose of civil liability is to identify the party responsible for reparation of the infringement of another party's right or interest.

It could be a matter of "contractual" or "non-contractual" liability. Contractual liability arises when, even though damage does not occur, a robot does not conform to contractual obligations, e.g. does not have the promised features. Non-contractual liability arises when an agent, in this case a robot, causes damage due to the violation of a right which is legally protected regardless the existence of a contract (e.g. physical integrity). As these fields are mostly regulated by national legislations, we provisionally set up our analysis on Principles of European Contract Law (PECL\textsuperscript{122}) and the European Civil Code project (ECC\textsuperscript{123}).

The interest in a European Civil Code came about at the turn of the century, after two European Parliament resolutions (in 1989 and 1994). Initially, interest in the project spread at an academic level. The first established group is the "Commission on European Contract Law" (Lando Commission), which worked on Principles of European Contract Law (PECL). The first part of the PECL was published in 1995, followed by Part II in 1999 and the final Part III in 2003. In 1994 UNIDROIT had already published Principles of International Commercial Contracts. Subsequently, in 2001, the European Commission proposed to widen the study also in other areas of private law, more than just contract law and a "Study Group on a European Civil Code", composed by a group of academics and researchers in private law from different Member States, was created. The aim was to "produce a codified set of Principles of European Law for the law of obligations and core aspects of the law of property". The two groups have worked on a comparative analysis of legal systems of Member States in order to conceive a uniform European law system, finding the principles that Member States hold in common to overcome existing diversity.

These two texts can be taken as the most useful legal tools to start a discussion at European level. If a European Civil Code is ever to be officially decreed, this will most certainly not happen through a EU Directive, as it is not an EU question (at least in general terms). The ECC will probably be implemented as a national (purely internal) law or will work as a set of legal concepts and standards, which flows across national borders in the typical way of transnational law.

8.1. Contractual liability

Contractual liability is disciplined by the PECL. Under Article 1:301 of PECL, ‘non-performance’ is qualified as "any failure to perform an obligation under the contract, whether or not excused, and includes delayed performance, defective performance and failure to co-operate in order to give full effect to the contract". The article specifically states that an 'intentional' act includes an act carried out recklessly.

After a general part dedicated to formation of contract, validity and other legal rules, Chapter 8 examines non-performance and remedies. Non-performance is fundamental (Article 8:103 PECL) if:

(a) strict compliance with the obligation is of the essence of the contract; or
(b) the non-performance substantially deprives the aggrieved party of what it was entitled to expect under the contract, unless the other party did not foresee and could not reasonably have foreseen that result; or
(c) the non-performance is intentional and gives the aggrieved party reason to believe that it cannot rely on the other party's future performance.

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\textsuperscript{122} "Commission on European Contract Law" (Lando Commission), which worked on Principles of European Contract Law (PECL). The first part of the PECL was published in 1995, followed by Part II in 1999 and the final Part III in 2003. See the official website: http://frontpage.cbs.dk/law/commission_on_european_contract_law/ (visited on 20th November 2011).

\textsuperscript{123} In 2001, the European Commission proposed to widen the study also in other areas of private law, more than just contract law and a "Study Group on a European Civil Code" was created. See the official website: http://www.sgecc.net/pages/en/introduction/index.introduction.htm (visited on 20th November 2011).
Article 8:108 PECL disciplines non-performance which cannot be attributed to a debtor: A party’s non-performance is excused if it proves that it is due to an impediment beyond its control and that it could not reasonably have been expected to take the impediment into account at the time of the conclusion of the contract, or to have avoided or overcome the impediment or its consequences. However, clauses limiting or excluding remedies for non-performance are acceptable if their content is not contrary to good faith and fair dealing (Article 8:109).

Firstly, we must focus once again to consider the robot as a simple product. In this point of view, the robot is the object of the contract of sale between the seller/manufacturer and the buyer/user. The seller must comply with legal rules governing this institution.

PECL discipline non-contractual liability, defining the formation and validity of the contract, the “non-performance” and remedies.

Furthermore, it must be remembered that the robot can be regarded as a “consumer good”, thus falling within the framework set by Directive 1999/44/EC. The buyer is therefore protected by various provisions on commercial guarantees and remedies in case of lack of conformity seen above (par. 3.3). In this “static” dimension, the robot looks like a mere object of exchange, a product or a commodity. The application of traditional rules on liability for breach of contract does not seem to cause any problem.

In conclusion, the existing legislation, both at national and European level, does not seem to require any addition or modification in relation to the fact that the object of a contract is a robot.

8.2. Non-contractual liability

One of the most interesting issues about robotics and law regards the non-contractual liability arising from a robot’s harmful conduct, when a person suffers a “legally relevant damage” due to the action of a robot regardless the existence of a contract. We can consider two cases. In the first, a robot causes damage because of its manufacturing defects. In the second, a robot causes damage simply by acting or reacting with humans in an open environment.

8.2.1. First case: the robot causes damage because of its manufacturing defects

The product liability Directive 85/374 establishes the principle of strict liability (liability without fault) of the producer in cases of damage caused by a defective product. If more than one person (manufacturer, supplier or importer) is liable for the same damage, this is joint liability.

Article 6 states that a product is defective when “it does not provide the safety which a person is entitled to expect, taking all circumstances into account, including: (a) the presentation of the product; (b) the use to which it could reasonably be expected that the product would be put; (c) the time when the product was put into circulation”.

For the purposes of the Directive, “damage” means (Article 9) damage caused by death or by personal injuries; damage to an item of property intended for private use or consumption other than the defective product itself, with a lower threshold of € 500.

The injured person must prove (Article 4) the actual damage, the defect in the product and the causal relationship between damage and defect. As the Directive provides for liability without fault, negligence or fault on the part of the producer or importer does not need to be proven.

The producer is freed from all liability if he proves (Article 7): “(a) that he did not put the product into circulation; or b) that, having regard to the circumstances, it is probable that the defect which caused the damage did not exist at the time when the product was put into circulation by him or that this defect came into being afterwards; or c) that the product was neither manufactured by him for sale or any form of distribution for economic purpose nor manufactured or distributed by him in the course of his business; or d) that the defect is due to compliance of the product with mandatory regulations issued by the public authorities; or e) that the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered; or f) in the case of a manufacturer of a component, that the defect is attributable to the design of the product in which the component has been fitted or to the instructions given by the manufacturer of the product.”
It is worth noting that also ECC provides a general rule in case of defective product, which is almost the same of the Directive 85/374/EC. Furthermore, it defines “product” using the same wording of the Directive: “a product is not defective merely because a better product is subsequently put into circulation”.

Of course, this Directive can be applied also in the case that the defective product is a robot.

8.2.2. Second case: the robot causes damage simply by acting or reacting with humans in an environment.

Although the Directive on manufacturer’s liability is a landmark in the field of robot liability, it is still based on the now incorrect assumption of the robot as a mere product, as an object. The problem is that, as we mentioned in previous parts, the new generation of robots is equipped with adaptive and learning ability. These features involve a certain degree of unpredictability in the robot’s behaviour. The robot’s conduct, although attributable at the program set by the programmer or the manufacturer, could not entirely been planned in its specific details because of the increase of experience made by the robot on its own.

What happens if damage is not derived from a defect of the robot, but from its behaviour? We could imagine a case in which a robot with adaptive and learning capabilities is let free to interact with humans in a non-supervised environment. Any engineer specialized in robotics would say that nowadays such a thing is not entirely safe because the robot could react to new inputs received in an unpredictable way. If, because of the reaction to these inputs, the robot cause an injury to a human being, the question of the attribution of liability will not be easy.

May the manufacturer still be considered responsible for this? Yes, of course, if the behaviour was set as standard by the manufacturer. However, what about robots with learning capabilities, which are able to "learn" new behaviours and reactions through their experience and interaction with the environment?

There are not, currently, ad hoc tort rules for robots, and a fortiori there are no specifics ones for cognitive robots. The legal framework should be traced to the traditional categories of liability. ECC does not regulate the responsibility of the keeper for the damages caused by things in his custody, as it is generally foreseen by national legislation.

The provision of such a situation is important in cases involving a robot. If the restrictive approach that treats them as mere objects is follow, this will be the only rule certainly applies in cases of damage.

The application of Article 3:203 ECC on the responsibility of the owner of animals may appear more controversial, because it could be argued that a robot has nothing to do with an animal. But in legal terms, the characteristic that seems to distinguish objects and animals is the ability to move freely in the surrounding space. Note that an analogy between an animal and a moving object has already been used in the US Courts.

But, even, a step further might be made. The parental model might been assumed, assimilating cognitive robots to children who learn during their own path of growth. Minors act out of upbringing and should be guided by their parents, robots act on the behaviour taught and must be educated by the user.

Some basic criteria could be considered linking the producer’s or user’s liability to the degree of instruction given to the robot: the greater a robot’s learning capability the lower a manufacturer’s responsibility; the longer the duration of a robot’s education, the greater the responsibility of its owner/teacher. In any case, acquired abilities (resulting from education) should be set apart from

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125 See, e.g., Popov v. Hayashi, decided by the California Superior Court, December 12, 2002, # 4005545: www.findlaw, in which the judge McCarthy decides the dispute on the right to possession of a baseball seized by several spectators at a baseball game by using some previous cases involving the capture of animals fleeing. Walton, “Similarity, and preceding argument from analogy”, in AI & Law, 2010, 18, 217-246.
attitudes strictly depending on learning abilities. The Court should also ascertain the cause of the malicious behaviour of the robot and, consequently, the person to whom it is due.

The basic definition of ECC (Article 1:101) is that “A person who suffers legally relevant damage has a right to reparation from a person who caused the damage intentionally or negligently or is otherwise accountable for the causation of the damage”. The essential elements are legally relevant damage; intention or negligence; causation. Article 2:101 gives the definition of “legally relevant damage” as a loss or injury if: a) one of the following rules of this Chapter so provides; b) the loss or injury results from a violation of a right otherwise conferred by the law; or c) the loss or injury results from a violation of an interest worthy of legal protection.

Loss can be both economic and non-economic: the first one includes loss of income or profit, burdens incurred and a reduction in the value of property; the second one includes pain and suffering and impairment of the quality of life.

With regard to a physical person, loss can be caused by personal injuries but also by infringement of dignity, liberty and privacy.

Article 2:101 gives the definition of “legally relevant damage” as a loss or injury if:

A person causes legally relevant damage intentionally (Article 3:101) when he causes such damage either: a) meaning to cause damage of the type caused; or b) by conduct which that person means to do, knowing that such damage, or damage of that type, will or will almost certainly be caused.

Otherwise, a person causes legally relevant damage negligently (Article 3:102) when the damage has been caused by conduct which either: a) does not meet the particular standard of care provided by a statutory provision whose purpose is the protection of the injured person from the damage suffered, or b) does not otherwise amount to such care as could be expected from a reasonably careful person in the circumstances of the case.

Moreover, the ECC makes provision for certain cases of accountability without intention or negligence, like, as we are interested here, the accountability for damage caused by employees and representatives and the accountability for damage caused by defective products that has been seen above. These are cases of strict liability, because they consider a regardless of culpability, because of their inherently dangerous. In these cases, the plaintiff need only to prove that the damage occurred and the causation, without the need to prove the intention or negligence of the person accountable. The defendant is in a disadvantage position, because he has to give a hard liberation proof, generally the fortuitous case.

A person who employs or similarly engages another is accountable for the causation of legally relevant damage suffered by a third person when the person employed or engaged (Article 3:201): a) caused the damage in the course of employment or engagement, and b) caused the damage intentionally or negligently, or is otherwise accountable for the causation of the damage.

According to the general rule of causation (Article 4:101) the damage is to be regarded as the consequence of that person’s conduct or the source of danger for which that person is responsible. In cases of personal injury or death the injured person’s predisposition with respect to the type or extent of the injury sustained is to be disregarded.

Where the injured person contributes by his own fault to the occurrence or extent of legally relevant damage, reparation is to be reduced according to their degree of fault (Article 5:102: Contributory Fault and Accountability).

Chapter 6 considers remedy as the reinstatement of the person suffering the legally relevant damage in the original position. Reparation may be in money (compensation) or otherwise, as is most appropriate, having regard to the kind and extent of damage suffered and all the other circumstances of the case.

Another solution may be to equip cognitive robots with an ethical code of conduct which enables them, through a learning algorithm trained on a series of examples (example-based learning), to understand which behaviour is right and which is wrong according to a hierarchy of values.  

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126 See e.g. ANDERSON-ANDERSON, The Good Robot, Sciences, 2010, 508, 90-95. The authors have worked on NAO (http://www.aldebaran-robotics.com/en/Nao.php) implementing an ethical code.
If research in this field demonstrates the real utility of an ethic code in addressing the behaviour of robots capable of autonomous decisions, then its installation will become a specific responsibility of the manufacturer.

But the code of conduct could be modulated on the basis of the specific situation in which the robot will operate, and thus could be individually agreed with the owner/end-user (e.g. a robot that operates as an auxiliary in a hospital should have a code of conduct completely different from the dust-robot which works in streets).

The absence or the inadequacy of such a code of conduct depending on the user could be equated with lack of supervision, or bad teaching. Moreover, we could envisage assigning the developing of codes of conduct to a guarantee institution, such as an ad hoc set up committee, along the lines of the International Organization for Standardization, responsible for defining technical standards (ISO).

The subject of all these provisions of the ECC is the “person”. Can we assume that “person” indicates, actually, the “author” or “agent” relating to the autonomous part of robot which, ex hypothesis, cannot be traced (because it is not a simple artefact) to its owner? In this case, there should be a legislative intervention aimed at extending the applicability of the discipline also to entities that are not currently recognized as legal subjects?

Can we draw the robot’s legal subjectivity starting from a general reasoning about responsibility arising from a robot’s action? Continuing to treat the robot as a mere res is ultimately inadequate, because it seems that producer, programmer, owner and user are assuming the role of “external controller” of an entity that seems to be capable of expressing embryonic but growing levels of autonomy and subjectivity.

This is a general question referable to any legal system.

of conduct based on general principles of the North American bioethics (beneficence, non maleficence, justice, autonomy). The learning algorithm of the robot processes, after “studying” a number of cases submitted by researchers, a general principle of behaviour that allows the robot to choose among three possible actions, such as which do and in what order.
9. Exploration track: non-human agents and electronic personhood

9.1. Introduction
In the context of robotics, questions of legal responsibility are difficult to answer.Traditionally in both, civil and criminal law, a person is responsible for damages if they were caused by personal misconduct. The application of this traditional approach to autonomous systems becomes increasingly more difficult as advancement in robotic technology decreases the overall interaction between man and machine. Programming now allows robots to gain and analyze experiences, to be influenced by the user, and to make “free” decisions based on situative circumstances. This means (at least) some behaviour of autonomous robots is becoming less foreseeable and can no longer be tied back to the concrete actions (and mistakes) of a certain human being. This can be exemplified considering these important questions: Who is the driver of an autonomous car, man or machine? Who operates self-flying planes or drones? These and other questions about responsibility / liability for human-machine-interactions will, in the next few years, be discussed not just in philosophy / ethics, but also in jurisprudence.

Therefore, it is argued that strict differentiation between man and machine (“man-machine-dualism”) is no longer acceptable. Instead, man and machine should be considered simultaneously and their actions should be seen as cooperation, because technology has now inextricably linked the two together. This approach does not intend to make machines the carriers of full rights or duties. Rather, it intends to understand the changes of certain concepts (e.g. “action”, “liability”) assist in a person’s (esp. a user’s) understanding whether he is free or partially free of liability in the application of various types of robots.

9.2. Non-Human Agents on their way to a new status
When focusing on non-human agents, one should distinguish Softwareagents and embodied robots. Recently, the legal status of Softwareagents has been subject of intense debate. Only some of the ideas surrounding the legal status of Softwareagents can be transferred to embodied robots, such as a person’s use of an autonomous system in the conclusion of a contract.

The following section will give a legal evaluation of this issue concerning The Principles of European Contract Law (PECL, Prepared by the Commission on European Contract Law). This evaluation will show that electronic entities could have a minimal status under the current law. Considering this, the idea of electronic personhood will not be such a far-reaching step.

9.3. Software Agents
The proper legal evaluation for the conclusion of a contract with a Softwareagent has been a topic of discussion for a number of years. A Softwareagent could be described as computer program that can take over a task for its user, having a certain amount of artificial intelligence to perform this task partly autonomously and an ability to interact with its environment in a reasonable way. In this respect, Softwareagents are able to act as a representative of the user. This is why they are sometimes described as Robots in the Internet. A contract’s conclusion requires an agreement (Article 2:101 PECL) consisting of offer and agreement (Article 2:201 et sqq. PECL). Offers and agreements are declarations of intention (hereinafter “statements”) and must be the private expression of a person’s will, addressed to another person, and directed to achieve a certain legal consequence. The use of

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128 Schweigofer, Vorüberlegungen zu künstlichen Person, in Schweigofer, Menzel, Kreuzbauer (Hg.), Auf dem Weg zur ePerson, p. 46.
129 John: Haftung für künstliche Intelligenz, p. 15.
130 Schweigofer, Rechtliche Aspekte der Robotik, in Christaller, Thomas et al. (Hg.), Robotik: Perspektiven für menschliches Handeln in der zukünftigen Gesellschaft, p. 144.
131 Wettig/Zehendner: The Electronic Agent: A Legal Personality under German Law?, p. 2.
a Softwareagent in the conclusion of a contract could be legally evaluated simply as the use of a tool, messenger, agent, or following the rules of blank-statement.\(^{132}\)

General opinion sees Softwareagents as “tool”\(^{133}\). In this sense, a human author uses a computer and software as a tool to create a statement. Such a statement is called an agent-statement and is considered to be a type of so-called “computer-statements.”\(^{134}\) Computer statements can be traced back and attributed to a user through a user’s general recognition and general consent in the use of a computer statement.\(^{135}\) Nonetheless, there is still some disagreement about whether the statements of Softwareagents may be categorized as a computer-statement; Softwareagents are autonomous, intelligent, and have the ability to interact, which means they ultimately have the ability to influence the parameters and effective strategic solution in the conclusion of the contract. The outcome of a Softwareagent’s operation is thus not entirely foreseeable for a user, even if the user is aware of the machine’s programming and all relevant circumstances.\(^{136}\) This is an important difference to computer-statements; the operations and outcomes of computer-statements are always foreseeable.\(^{137}\) Moreover, a user cannot influence the machine operations of a Softwareagent, which is a necessary qualification of a computer statement.\(^{138}\)

This question of proper categorization leads to another discussion regarding the status of these agents as messengers (communicator of a statement, see also Article 1:303 PECL par. 5).\(^{139}\) Messengers simply carry the statement of a user to another contracting party. Full legal personhood or the ability to bear full legal rights is not necessary for being a messenger. Additional requirements for messengers also come to the fore in the consideration of Softwareagents. Foremost, the other party would have to be aware that a Softwareagent is involved in the formation of the contract so that transparency is maintained. Furthermore, the concept requires that a messenger have no potential effect on the content of the statement. Softwareagents act autonomously and can influence the content of the statement. Thus, the categorization of a Softwareagent under the concept of a messenger is not sufficient.

Another alternative is the evaluation of such systems as agents under the law of agency (Article 3:101 et seqq. PECL). The concept of agency could include autonomous Softwareagents because it only requires a statement made by an agent within the authority of a principal. This concept requires personhood, thus an analogous application of this concept to Softwareagents is not possible: the current law of agency (Article 3:102 par. 1) requires a “person” who may be held liable under Article 3:204 PECL. The reason for this is because an agent who acts without or outside its authority should be liable to the other contracting party. The agent must have a certain legal competence with regard to the question of liability; otherwise a gap of liability could appear.

The consideration of Softwareagents as messengers or agents under agency law brings another aspect into the discussion: the application of laws on minors: Minors have limited contractual capacity, but may act as agent (agency law) or messenger. When acting as agent, a minor could become liable if acting outside of his authority and without a previous agreement of a legal representative.\(^{140}\) In case no agreement exists, the other contracting party might suffer damages that are not traceable to the action of an authority. If there is an agreement, the Softwareagent cannot be found liable because no legal competence exists. If the action in consideration can be categorized as that of a messenger, the aforementioned points would be important.

\(^{132}\) John: Haftung für künstliche Intelligenz, p. 68; Softwareagenten im elektronischen Geschäftsverkehr p. 171.

\(^{133}\) Gitter: Softwareagenten im elektronischen Geschäftsverkehr, p.172f.

\(^{134}\) Spindler/Anton in Recht der elektronischen Medien, Vorbem. zu §§ 116 ff, Rn. 9f.

\(^{135}\) Spindler/Anton in Recht der elektronischen Medien, Vorbem. zu §§ 116 ff, Rn. 6.


\(^{139}\) Sturma, Zusammenfassung und Handlungsempfehlungen, in Christaller, Thomas et al. (Hg.), Robotik: Perspektiven für menschliches Handeln in der zukünftigen Gesellschaft, p. 213; Schweighofer, Vorüberlegungen zu künstlichen Person, in Schweighofer, Menzel, Kreuzbauer (Hg.), Auf dem Weg zur ePerson, p. 52.

\(^{140}\) This is related to German Law: § 179 III, S 2 BGB
Excursus - Softwareagents as Electronic Slaves: Another approach could be to see such Softwareagents as objects with limited legal capacity following the law of slave in ius civile. In Roman civil law, slaves had no capacity to bear rights and obligations while acting under his own name. They had no legal right to enter into contract on their own behalf but were able to enter into contract as agent for their master. Thus, the actions of a slave could be attributed to the master. This same logic could apply to the consideration of robots because slaves and robots are similar in two main respects: they both have a limited capability of legal acting and rights or obligations while acting in their own name. But this approach is not transferable to the current legal system. Concepts of European Civil Law do not recognize the concept of limited capability for legal acting and have no function for the recognition of legal responsibility without attributing to rights and obligations.

Another approach is to apply the rules of “blankstatement” on Softwareagents. “Blankstatement” is a concept between agency and messengerhood. A blankstatement-donor gives a signed paper to the blankstatement-taker. The taker can complete this form and hand it over to the other contracting party. The blankstatement-donor has no further influence on the contents of this statement, and the blankstatement-taker does not need to have any legal competence. Rules on agency could be analogously applied to this concept as well. Applying the idea of a bankstatement to the consideration of Softwareagents, this could mean that the Softwareagent completes a statement for “signature” by the user, for example through an electronic signature. This could be a possible solution to the problems arising from the closing of a contract with the use of electronic entities. But even this approach has some difficulties because the law on agency does not readily fit in all cases.

9.4. Robots

An important characteristic of robots is their existence in the “real” world instead of just in a virtual world. Because of this, the idea of embodiment becomes important. There are several understandings of this term. Here it is understood as a concept which requires a direct link between the system and the environment. The idea behind embodiment is the assumption that intelligence cannot really exist in abstract algorithms, but rather requires a body. This new idea revolutionized the design of robots with artificial intelligence. The concept of embodiment has many different implications. On one hand, it could help to make electronic entities more intelligent. On the other hand, it influences the social awareness of these entities, meaning that they are seen and recognized as real, embodied partner in a certain interaction or cooperation (e.g. a contract). Furthermore, they are not as limited in their abilities regarding way of communication or the input of the environment as Softwareagents.

Keeping this in mind, it is possible to transfer most of the statements about Softwareagents to physical robots. Physical robots should be seen as “more than tools” and be viable to receive a certain higher degree of legal status. This would not necessarily mean to give them special rights or obligations similar to electronic personhood (see below) but would help to overcome the problems of evaluating robots as simple tools by creating a different legal approach. This applies especially to embodied robots because they have certain abilities in addition to those of Softwareagents.

9.5. Electronic Personhood

A further step to solve some of the legal problems of robotics is to consider “electronic personhood” for embodied robots or/and software agents. Advances in robotics and artificial intelligence require legal...
categorization of these entities. As laid out, the traditional concept of responsibility may fail in these situations, because under this concept, a machine is just a “thing” (or tool). As discussed earlier, this denies the consideration of some new approaches and is largely insufficient.

Machines cannot and should not, at least for the moment, have the legal status of humans. But still, it is possible to establish a special legal category for robots: electronic personhood. At this point we refer to another successful legal concept, the “legal person”. Legal personhood, e.g. of companies or corporations, ultimately means bundling of capacities, material and financial responsibilities. In many ways, legal persons experience the same treatment that humans receive under the law, while they are not given the same legal status as humans in other respects. Also, the category of legal person does not cover all groups: The law decides to which group a legal status is prescribed. This concept has been quite successful for dealing with corporations, holding at least the legal person liable as well as ensuring that not one person (e.g. the owner) is liable for all harm caused by the corporation. In some countries, even criminal liability of corporations has been established.

A similar approach is plausible for at least some “autonomous” machines. Robots are neither humans nor animals but can develop a certain artificial personality, a certain scope of action, and a certain scope of decision-making.\(^{150}\) Thus it is possible to create a legal status, which would only be a “tangible symbol” for the cooperation of all the people creating and using that specific robot (in the same way as just described for corporations). Jurisprudence could establish some autonomous machines as having the status of an “electronic person” with specific rights and obligations. This would apply only to particular contexts, and would include autonomous machines having a certain degree of legal autonomy. It would be appropriate for all machines with artificial intelligence that automatically make decisions or somehow interact with other people, such as through the making of contracts or through the causing of damage to a person’s legal interests. This legal personhood for robots would as well just be the bundling of all the legal responsibilities of the various parties (users, sellers, producers, etc…). Actually, this bundling is the main reason why a new classification for these machines is necessary. In practice, this would mean that each such machine would be entered in a public register (similar to the commercial register) and would obtain their legal status at the moment of this registration. A change in the participants of the machine’s assets (most importantly in the case of selling the machine) should have no impact on the machine’s legal personhood.

A certain financial basis would be affixed to autonomous machines, depending on the area of application, hazard, abilities, degree of autonomy, etc. This sum of money would be raised from producers and users alike, and would be collected before the machine was put into public use. The amount of money could also be limited to have an \textit{electronic person} Ltd.\(^{151}\) This amount could be called the “assets” of a robot or autonomous machine. The law should also require a registration number attached to each machine that is clearly visible (or recognizable in other ways, e.g. with electronic agents). The register would allow people interacting with the robot to be informed about the machine’s amount of liability, shareholders, characteristics and other information of the machine (owner, abilities, dangers, areas of use, etc.).

This legal structure would have some notable effects. If an autonomous machine made a contract it would be an agent that acted on behalf of someone else or even itself be a partner to the contract. It could therefore be held under the terms of the contract and could be sued in court under civil law (using its identification number). In each individual case it would have to be decided if the robot should have more or less duty and thus be more or less (financially) liable. The decision would depend on the degree of third-party participation. In this case, a robot would nonetheless be covered by its assets or the assets of its greater work force. The performance of the other party would either enter into the assets of the electronic person (the admissibility of this aspect would need special legal regulation) or be distributed to the users. If an electronic person causes an injury to a third person, whether connected to a contract or as a tort, he can still be sued directly. This would mean more legal certainty than at the moment – and probably even more than without electronic personhood.

Basically, judgments handed down in civil law against electronic persons would be covered by his assets. However, it seems plausible that in certain cases the transfer of this payment could be issued to those involved in the creation or use of the machine. This should be the case in clear and identifiable situations, especially when a specific malfunction of the machine could be attributed to a...
grossly negligent or willful misconduct. So if a specific human is clearly responsible for damage caused by the machine, there is no need to sue the electronic person (it could still be possible to sue both, the electronic and the natural person, depending on the circumstances).

If one decides for introducing the concept of electronic personhood, it has to be discussed which machines should be given “electronic personhood”. One possible solution is to include all unattended systems that perform tasks specific to their special character that cannot be foreseen and controlled in advance.  

Some further questions yet to be answered are: When does the legal personhood start and end? Which rights and obligations come with it? What restrictions are useful? Who is in charge of a register?

All these details will have to be discussed in future and to be regulated either on EU or on national level (or both). But first one has to decide to introduce the concept of electronic personhood. Although there seem to be many convincing arguments for this concept, at the end of the day it is, of course, a political decision.

9.6. Artificial Humans

Another alternative for the law is to categorise robots as artificial humans. This currently discussed concept is still vague and it is very likely that it would only be important in the distant future. It is based on ontological and moral considerations on “status”-questions. In contrast to the attribution of legal personhood, in these discussion one tries to define the characteristics an entity should have to be seen as artificial human. Proposals for such criteria include moral authority/entitlement, social capacity/reality, and legal convenience/expediency. Others require mobility, at least three of the five senses (taste, smell, touch, sight, hearing), autonomous intelligence (ability to learn), and consciousness (intentionality, identity, room for reasoning). Another opinion demands intentionality, responsiveness for reasoning, ability to have 2nd order wishes, sanity, distinction between intended and foreseeable consequences of actions as requirement to see artificial entities as being entitled to personhood.

These criteria must be questioned. First, some of them do not fit other legal persons (corporation or companies). Some may fit to humans, but even this is a question of interpretation. Furthermore, assuming some of them are applicable on humans, applying them onto other entities is problematic. Besides, it is still unclear how to prove the presence of these criteria for a concept of action and liability if humans are not able to prove whether they can themselves be considered to fulfil these criteria.

Further questions must also be considered for categorising artificial humans: Who is allowed to create or despatch? What is to consider about out-dated entities? Who records birth and death? Who can be considered the ruler of the entity?

Still, the general question remains whether we should follow the idea of artificial humans and set up strict requirements an entity must match to be categorised as such, or whether we should mainly focus on the usefulness and the social acceptance of “electronic personhood” as discussed above. Better arguments speak, at least for the moment, for the latter alternative.

152 Hanisch, Haftung für Automation, p. 208.
153 Sturma, Zusammenfassung und Handlungsempfehlungen, in Christaller, Thomas et al. (Hg.), Robotik: Perspektiven für menschliches Handeln in der zukünftigen Gesellschaft, p. 213; Schweighofer, Vorüberlegungen zu künstlichen Person, in Schweighofer, Menzel, Kreuzbauer (Hg.), Auf dem Weg zur ePerson, p. 52.
154 John: Haftung für künstliche Intelligenz, p. 376.
155 Schweighofer, Vorüberlegungen zu künstlichen Person, in Schweighofer, Menzel, Kreuzbauer (Hg.), Auf dem Weg zur ePerson, p. 51; Schweighofer, Rechtliche Aspekte der Robotik, in Christaller, Thomas et al. (Hg.), Robotik: Perspektiven für menschliches Handeln in der zukünftigen Gesellschaft, p. 143.
156 Matthias, Automaten als Träger von Rechten, p. 44f.
157 Schweighofer, Rechtliche Aspekte der Robotik, in Christaller, Thomas et al. (Hg.), Robotik: Perspektiven für menschliches Handeln in der zukünftigen Gesellschaft, p. 143.
9.7. Summary
Until recently, Softwareagents and Robots have been seen as “tool” (object) in law, in the context not only of contract conclusion but also of torts law or liability within a contract. But other approaches are possible and maybe even necessary, with the consequences of assuming a legal status of these entities. New concepts such as “electronic personhood” can solve some fundamental problems in the area “robotics and law”. Thinking about artificial humans is a premature effort. At minimum, such concept has to be subjected to more consideration to be of use.

9.8. Proposed roadmap for Regulation of Artificial Agents and Electronic Personhood
One alternative:
1. Practical solutions of singular cases (liability, insurance, robot-registrar)
2. Assuming a status: electronic personhood

Proceeding in creating legal rules on electronic personhood:
Step 1: Clarify bases
- Research in other jurisdictions (other European Counties/US/Asia) for possible solutions regarding the use of Software Agents and other Artificial Agents
- Review solutions already discussed. Proving this concepts and review implementation into national law through European jurisdiction (competences, usefulness, necessity of a European regulation)
- Review other areas of law which are affected esp. European (e.g. for artificial agents this could be: e-Commerce, data protection, stock exchange etc.)

Step 2: Collecting all arguments pro and contra both alternatives
Step 3: Writing specific rules for both alternatives

The chapter on “personhood” starts from the assumption, that traditionally in both, civil and criminal law, a person is responsible for damages in the case that the damages were caused by personal misconduct. The diagnosis of actual legal situation indicates that this traditional cannot be applied to autonomous systems because they have become – and will become – more and more unpredictable and uncontrollable. This raises many questions about the concepts of responsibility / liability for human-machine-interactions. Therefore one has to ask if the strict “man-machine-dualism” is still plausible. One aspect of this problem is that man and machine should be considered simultaneously and, as a consequence certain concepts (e.g. “action”, “liability”) might have to be changed. New concepts (e.g. “electronic personhood” as analogy to legal personhood of corporations) might present some solutions to these problems while thinking about artificial humans surely is a premature effort.
10. Principles of robotics: a vision from common law

There is no political debate to introduce legislation specific to robots in the United Kingdom, and the academic discussions on the social implications tend to focus on ethical or philosophical questions. This reflects the general approach of the common law with its emphasis on piecemeal problem solving, based on past experience with similar issues ("precedent based system). In this approach, legislation increases rather than decreases in most cases uncertainty, as it "cuts off" the reservoir of past experiences from which lawyers could otherwise draw their solutions. While robots seem to be new, Law, in this view, does not so much lead social developments and shapes them rather it reflects already established ("common") social normative practices. In times of uncertainty created through a new social practice, common law has a tendency to favour in addition to self-regulation approaches that at least initially trade in costs for clarity and predictability – on this basis, the common law developed e.g. strict liability regimes to deal with changes in the way in which we introduced animals into private spheres (e.g. liability for dangerous dogs) and to the extent that the limited discussion on robotics can serve as a guidance, such an approach, which facilitates pricing for the insurance industry, can ultimately improve social acceptability and serve everybody's interest: users are reassured through a beneficial liability regime, developers can protect themselves through insurance, while insurers will demand robust standards and codes of practice. Regulation through free markets and self-regulation, pushed by insurance pricing and enabled by a clear liability regime, seems very much with the spirit of the UK approach to regulation in general.

While there is no perceived need therefore to create new, targeted legislation, there is a much greater role of self-regulation and industrial standards emerging (which will eventually solidify in law, after we, as a society, developed an understanding of how to interact with robots). Social and political discussion should flank these self-regulatory approaches. To foster this debate in September 2010, the Engineering and Physical Sciences Research Council experts in technology, the arts, law and social sciences from UK discussed robotics, its applications in the real world and its impact in the society. The study resulted in the production of a document available at (Principles of robotics) the definition of five principles for robotics.

1. Robots should not be designed solely or primarily to kill or harm humans.
2. Humans, not robots, are responsible agents. Robots are tools designed to achieve human goals.
3. Robots should be designed in ways that assure their safety and security.
4. Robots are artifacts; they should not be designed to exploit vulnerable users by evoking an emotional response or dependency. It should always be possible to tell a robot from a human.
5. It should always be possible to find out who is legally responsible for a robot.

The messages intended to be conveyed were:

1. We believe robots have the potential to provide immense positive impact to society. We want to encourage responsible robot research.
2. Bad practice hurts us all.
3. Addressing obvious public concerns will help us all make progress.
4. It is important to demonstrate that we, as roboticists, are committed to the best possible standards of practice.
5. To understand the context and consequences of our research, we should work with experts from other disciplines, including: social sciences, law, philosophy and the arts.
6. We should consider the ethics of transparency: are there limits to what should be openly available?
7. When we see erroneous accounts in the press, we commit to take the time to contact the reporting journalists.

As indicated in the report, “the rules are presented in a semi-legal version; a more loose, but easier to express, version that captures the sense for a non-specialist audience and a commentary of the issues being addressed and why the rule is important.”
We can observe, like Burkhard Schafer indicated it in his presentation at the Federal Ministry of economics and Technology in Berlin on November 2\textsuperscript{nd} 2012 that this study represents a bottom up approach about legal issues in robotics where social and political discourse shapes the law’s attitude to specific, litigated problems. This is according to the common law mentality in usage in UK. For this approach, it is of less concern what (abstractly, philosophically) a robot “is” There are no references to specific capacities of the robot or an attempt to capture the normative essence of a robot through an ontology. Rather, the emphasis is on how people perceive certain artifacts and relate to them (hence the rule on distinguishing robots from humans, something that could as well be argued for very simple, mechanical toys used with disabled children)

The result is that these principles can be accepted by a wide community and provide a vision quite complementary, and not contradictory, to the top down approach chosen in this document.
11. Conclusions, priorities and suggestions for further proceedings

This proposal for a green paper is one of the first documents on issues of law and robotics. This document can be considered as a reference for lawyers as well as a for robotics people interested in these issues. This document is incomplete on purpose. It does not pretend to cover all issues on this topic. Many questions are still worth to be investigated in order to clarify some matters and propose some solution to overcome the identified issues. The next paragraphs present a summary of suggestions for actions to be undertaken and follow up proposition to this proposal for a green paper in order to favour the growth of robotics sector in Europe.

The list below is a summary of the elements of roadmap provided in the chapters above. For further details refer to the dedicated chapters.

- Consider possible protection of "robot generated works" by IPR and on the conditions of such protection, on the ownership of such kind of creations and on the limits of the current rules.
- For Labour law issues, clarify in which area robots should be used, do we really need regulations (vs. over-regulation or self-regulation) and in which fields? Consider crucial problems. In which cases do we need safety regulations for (potential) dangerous robots? Make deeper investigation of current regulations, by reviewing EU directives (general/safety), Implementation of directives into national law, gaps of EU regulations (analyse competences), Compare national/European rules with others (US/Asia).
- Compare current EU privacy law with draft for European Data Protection Regulation: what has changed in the draft? Have autonomous systems been taken into consideration?
- Examine in detail the issues with non-contractual liability: what happens if damage is not derived from a defect, but from a robot's behaviour? There are not, currently, ad hoc tort rules for robots 
- Investigate the way in which electronic personhood or artificial agent principles could be implemented and how to proceed in creating legal rules on electronic personhood.

In addition to these suggestions, one frequent suggestion is to harmonize the legislation concerning robotics in Europe. Industries are confronted to different regulation and legal constraints which represent barrier making difficult the emergence of new markets.

For civil law regimes, the more impacting the legal hindrances, the easier it will be to change to current legislation. It will be difficult to change legislations for specific case studies or applications. This has two consequences:

- It is important to consider legal issues in a top down approach rather than to start from case studies 
- It is interesting to make links between robotic issues and other sectors of activity: transport sector and urban autonomous robots,

The above remarks are in line with the tendency in European law now to develop law in a way that is technology neutral, in order to avoid becoming outdated by technological developments. It is a matter of treading very carefully when thinking of adding new law with regard to robot technology. Besides, a working legal and normative framework has yet to be explored in full with regard to its relevance to robot technology.

These are issues that are to be explored in the coming years. One feeling is that this exploration process should be guided by the principle of subsidiarity, and lead to norms and regulations that are developed in a dialogue between all stakeholders.
12. Appendix A – Communication


13. Appendix B - Bibliography


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15. Appendix D – Glossary

In this section we provide some definitions, as they are commonly used in the technical community. None of them is “carved in stone”, and some of them can be easily source of endless discussions. Let’s take them as a way to “feel” concepts shared in the technical community. Some of the definitions reported below are derived from documents available from the EUROP site where you can also find other definitions. Other sources of definitions are the ISO document ISO 8373:2012 (Robots and robotic devices — Vocabulary) as well as ISO/DIS 13482 (Robots and robotic devices — Safety requirements for non-industrial robots — Non-medical personal care robot)

Actuator

An actuator is a device that can produce force or torque that can be used to move parts of a robot. These can be: pneumatic actuators, electrical motors, etc.

Agent (legally speaking)

An entity able to do, considering its actions in the area of legal responsibility.

Autonomous robot

An autonomous robot is able to perform a task in a possibly incompletely known environment without human intervention during the process. In the community, this is often opposed to “programmed robot”. Both “autonomous” and “programmed” robots are programmed, in the sense that are controlled by a computer that executes instructions to make them acting, but a “programmed” robot is intended to work in a very well known, possibly structured, environment such as a production cell in a car factory, performing a repetitive well specified set of actions. For this latter kind of robots, a normative corpus is already available, so we will not consider them: they usually have to work in places where people are not allowed to enter when they are operating. In general, they are considered as devices, similarly to milling machines and the like. Most autonomous robots are programmed robots and this implies a predictable and deterministic behaviour when facing a given situation described by known values for the inputs. Beside errors in the program or intentional presence of random actions, the only source of unpredictability resides in the uncertainty of perception and uncertainty of actuation. For instance, let us assume our autonomous robot is supposed to grasp a red ball, if it is not able to distinguish red from orange because of insufficient lighting, then the final outcome might not be correct; at the same time if the ball is slippery our robot might miss the grasp resulting again in an incorrect (unexpected) result. Finally, a possible source of unpredictable behaviour (at design time) is the case of learning robots. Sometimes, an autonomous robot is also called a “robotic agent”, putting in evidence the ability to select actions.

Behaviour

Robot behaviour is the way of acting of a robot as perceived by an external observer. This can be described at a low level (e.g., “the robot is entering a door”) or at high level (e.g.: “the robot is monitoring the health status of its owner”). Sometimes it can be described by establishing a relationship between observed situations and actions. (e.g., “the robot avoids obstacles that are on its path to the goal”, or “the robot goes to its owner when it is asked to”). Often the term “behaviour” is also used to refer to the “behavioural modules” that implement behaviour, i.e. a set of programs or operational knowledge that, when operative, can implement the behaviour. Often, many “behavioural modules” are implemented on a robot and each of them is triggered by a specific situation.

Care robots

Def. CR1: Care robots are able to support people with disabilities and elderly in improving their way of living. This includes wheelchairs, feeders, system to move people, robotic arms to bring or get objects, but also exoskeletons and robots to provide psychological aid.

Def. CR2: Care robots are able to take care of people. This includes also robots able to interact with people, in general able to understand, or at least manage, the essence of “taking care”, such as robotic companions and some robotic pets.
Civil law

It is a legal system originating in Western Europe, within the framework of late Roman law. Its most relevant feature is that core principles are codified into a referable system which serves as the primary source of law.

Civil liability

Legal liability which is not in criminal law. This liability may be in contract, tort, restitution, or various other sub-areas.

Cognitive robot

A cognitive robot is an autonomous robot that exploits processes analogous to cognitive processes. In particular, this term is referred to robots able to reason.

Common law

It is a legal system originating in UK and mostly used in almost all English-speaking countries. The intellectual framework comes from judge-made decisional law which gives precedential authority to prior Court decisions on the principle that it is unfair to treat similar facts differently on different occasions (doctrine of judicial precedent).

Consumer law

An area of law which regulates relationships between individual consumers and the businesses that sell those goods and services.

Contractual liability

This kind of civil liability arises when there is any failure to perform an obligation under the contract, whether or not excused, and includes delayed performance, defective performance and failure to co-operate in order to give full effect to the contract.

Criminal Law:

The area of law in which it is decided if someone has committed a criminal offence and is criminally liable for it.

Data privacy law

The area of law that covers the protection of the right to privacy with respect to the processing of personal data.

European Directive

A legislative act of the European Union, which requires Member States to achieve a particular result without dictating the means of achieving that result. A Directive normally leaves Member States with a certain amount of leeway as to the exact rules to be adopted.

European Regulation

A legislative act of the European Union which immediately becomes enforceable as law in all Member States simultaneously

European Recommendation

A legislative act of the European Union without binding force.

Green paper (Green paper)

A green paper released by the European Commission is a discussion document intended to stimulate debate and launch a process of consultation, at European level, on a particular topic. A green paper usually presents a range of ideas and is meant to invite interested individuals or
organizations to contribute views and information. It may be followed by a white paper, an official set of proposals that is used as a vehicle for their development into law. See also white paper

**Labour Law**

Laws which address the legal rights of, and restrictions on, working people.

**Learning**

Process of modification of the knowledge base of the robot gained through the interaction with the environment (including people) that may produce a persistent change in the robot behaviour. This includes learning data, such as a map, and learning behaviours, such as mappings from data to actions.

**Legal Person**

An entity possessing legal rights and obligations – legal personhood is subscribed to entities by the legislator (based on practicability and social acceptance)

**Negligence**

A deficit of taking the required care in a situation in which there is a duty to take care causing injury to another person.

**Non contractual liability**

This kind of civil liability arises when an agent intentionally or negligently causes damage due to the violation of a right which is legally protected regardless the existence of a contract (e.g. physical integrity).

**Personal data**

Any information relating to an identified or identifiable natural person.

**Planning**

*Planning is the computation and selection of tasks, policies and procedures for goal-directed robot behaviour*. This includes path planning, motion planning, grasp planning, task planning, mission planning and resource coordination. Planning often requires reasoning. Once a plan is done, its execution is monitored and eventual problems may lead to re-planning (e.g. when an obstacle is detected on a planned path). A robot able to represent and acting to achieve a goal is called a “rational (robotic) agent”.

**Reasoning**

*Process of modification of the knowledge base of the robot through (logical) manipulation of the available knowledge*. Typically, the available knowledge consists of data, both collected through sensors and given by people, models (e.g., a model of the world, an ontology, etc.), inferential knowledge (such as induction or deduction rules), and relationships among pieces of knowledge. Reasoning elaborates these pieces of knowledge augmenting the knowledge base with the inferred elements. It can be considered a way to explicit knowledge implicitly contained in the knowledge base. Among reasoning activities, we may consider planning (see below) and classification.

**Sensor**

A sensor is a (electronic) device able to detect or measure a physical/chemical quantity and convert it to a signal. Robots can use these signals as input to their computational activities that will produce commands to the actuators. They are the means to perceive the situation the robot is facing and take decisions, i.e., run specific subroutines of their program.

**Tele-operated robot**

A tele-operated robot is composed of a set of parts moved by engines operated by people through specific interfaces. The actions of these robots are completely controlled by people, through interfaces like a joy-stick, or even a smart phone. In the most complex (but still common) cases, signals from these interfaces are input to a computational unit that translates them to controls for the actuators. This category includes surgical robots, traditional electrical wheelchairs, tele-operated toys, as well as some robots mentioned in advertisements as “care-robots”, such as people-movers, and personal elevators. Some issues may arise when to implement a given
movement (e.g., a cut in a surgical operation) the robot controller has to take decisions that may affect movements of its parts not directly tele-controlled (e.g., collisions with the patient body of external parts of the robot arm.

**White paper (White paper)**

A white paper is an authoritative report or guide that helps readers understand an issue, solve a problem, or make a decision. White papers are used in two main spheres: government and B2B marketing.

White papers published by the European Commission are documents containing proposals for European Union action in a specific area. They sometimes follow a green paper released to launch a public consultation process.

See also green paper.

**Work Safety Law**

Area of the law to protect safety, health, and welfare of workers.
16. Appendix E – Experts and specialists that took part in the green paper elaboration

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Country</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beck</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>Assistant-Professor of Law</td>
</tr>
<tr>
<td>Belder</td>
<td>Utrecht University</td>
<td>The Netherlands</td>
<td>Assistant-intellectual property law</td>
</tr>
<tr>
<td>Bonarini</td>
<td>University Politecnica de Milano</td>
<td>Italy</td>
<td>Professor in robotics</td>
</tr>
<tr>
<td>Boscarato</td>
<td>University of Pavia</td>
<td>Italy</td>
<td>PhD student in law</td>
</tr>
<tr>
<td>Caroleo</td>
<td>University of Pavia</td>
<td>Italy</td>
<td>PhD student in law</td>
</tr>
<tr>
<td>de Cock Buning</td>
<td>Utrecht University</td>
<td>The Netherlands</td>
<td>Professor of Copyright- and Media Law</td>
</tr>
<tr>
<td>de Bruin</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>Junior researcher</td>
</tr>
<tr>
<td>Eck</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>PhD Student</td>
</tr>
<tr>
<td>Edwards</td>
<td>University Strathclyde, Glasgow,</td>
<td>United Kingdom</td>
<td>Professor of Internet Law</td>
</tr>
<tr>
<td>Fitzi</td>
<td>University of Oldenburg</td>
<td>Germany</td>
<td>Professor in social sciences</td>
</tr>
<tr>
<td>Guhl</td>
<td>Kuka</td>
<td>Germany</td>
<td>Project Manager</td>
</tr>
<tr>
<td>Günther</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>PhD Student in laws</td>
</tr>
<tr>
<td>Hilgendorf</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>Professor of law and legal philosopher</td>
</tr>
<tr>
<td>Huebert-Saintot</td>
<td>CEA List, Robotics Lab</td>
<td>France</td>
<td>Head of technology transfer department</td>
</tr>
<tr>
<td>Labruto</td>
<td>Alenia Aermacchi</td>
<td>Italy</td>
<td>Project Manager</td>
</tr>
<tr>
<td>Leroux</td>
<td>CEA List, Robotics Lab</td>
<td>France</td>
<td>Manager ICT &amp; Health</td>
</tr>
<tr>
<td>Löffler</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>PhD Student in laws</td>
</tr>
<tr>
<td>Mathias</td>
<td>Philosophy Department, Lingnan University, Hong Kong</td>
<td>Hong Kong</td>
<td>Senior Teaching Fellow</td>
</tr>
<tr>
<td>Matteucci</td>
<td>University Politecnica de Milano</td>
<td>Italy</td>
<td>Professor in robotics</td>
</tr>
<tr>
<td>May</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>PhD Student in laws</td>
</tr>
<tr>
<td>Moeller</td>
<td>Kuka</td>
<td>Germany</td>
<td>Head of patent and trade mark at Kuka</td>
</tr>
<tr>
<td>Münch</td>
<td>University of Würzburg</td>
<td>Germany</td>
<td>PhD Student in laws</td>
</tr>
<tr>
<td>Pegmann</td>
<td>RUrobots</td>
<td>United Kingdom</td>
<td>Head of RUrobots</td>
</tr>
<tr>
<td>Salvini</td>
<td>Scuola Sant’Anna</td>
<td>Italy</td>
<td>Researcher in ELS issues of robotics and project manager of</td>
</tr>
<tr>
<td>Name</td>
<td>Role</td>
<td>University</td>
<td>Country</td>
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<tr>
<td>Santosuosso Amedeo</td>
<td>Professor of Law, Science and New Technologies and President of ECLT Center at the University of Pavia, judge at the Court of Appeal of Milan</td>
<td>University of Pavia</td>
<td>Italy</td>
</tr>
<tr>
<td>Sharkey Amanda</td>
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<td>University of Sheffield</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Sharkey Noel</td>
<td>Professor of Artificial Intelligence and Robotics</td>
<td>University of Sheffield</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Schafer Burkhard</td>
<td>Professor of Computational Legal Theory</td>
<td>Edinburgh University</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Van den Berg Bibi</td>
<td>Philosopher of technology. Professor of law</td>
<td>University of Leiden</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>Wendel Anne</td>
<td>Administrator</td>
<td>EUnited</td>
<td>Germany</td>
</tr>
<tr>
<td>Winfield Alan</td>
<td>Professor of Electronic Engineering</td>
<td>University of England Bristol</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
### 17. Appendix F – List of events and meetings organized on Legal issues in robotics

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-March-10</td>
<td>San Sebastian, Spain</td>
<td>European Robotics Forum, Workshop on <em>Ethical, Legal and Societal issues in robotics</em> introduction of the action to the robotics community</td>
</tr>
<tr>
<td>2011-May-01</td>
<td>Vasteras, Sweden</td>
<td>European Robotics Forum, Workshop on <em>Ethical, Legal and Societal issues in robotics</em> – Robots in our lives, how and why?</td>
</tr>
<tr>
<td>2011-July-22</td>
<td>Würzburg, Germany</td>
<td>Agenda for a green paper on legal framework for robotics in Europe,</td>
</tr>
<tr>
<td>2011-November-03</td>
<td>Würzburg, Germany</td>
<td>Privacy, Civil and Criminal law issues, case studies</td>
</tr>
<tr>
<td>2012 January-14</td>
<td>Pavia, Italy</td>
<td>A top down approach on legal issues in robotics, plan for a proposal on green paper,</td>
</tr>
<tr>
<td>2012-March-05</td>
<td>Odense, Denmark</td>
<td>European Robotics forum, Workshop on <em>ELS issues in robotics</em> - focus on legal issues in robotics,</td>
</tr>
<tr>
<td>2012 September 13</td>
<td>Fontenay-aux-Roses, France</td>
<td>Meeting on the elaboration of the green paper</td>
</tr>
</tbody>
</table>