MSc Program
Engineering Management

Robotic's law

A Master's Thesis submitted for the degree of
“Master of Science”

supervised by
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Vienna, 31.03.2019

Affidavit

I, **IRINA DJORDJEVIC, BSC**, hereby declare

1. that I am the sole author of the present Master's Thesis, "ROBOTIC'S LAW", 65 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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ABSTRACT

The development of robotic technology is starting to influence every segment of our lives, therefore, some boundaries should be set in order for robots to coexist with people and interact with them. In this paper, first, general classification of robots will be presented, along with some real life examples. Next, it will be talked about liability rules, product liability and the current Council Directive 85/374/EEC, which is currently used in the case of defective products. Following this introduction part, the issues surrounding liability in robotics will be discussed, along with most problematic application areas of robotics and possible solutions will be suggested. Current practice on European civil law rules on robotics and its suggestions will be analyzed as well. Afterward, it will be talked about the influence of law regulation on robotics and the importance of regulating this field, in order to support scientific growth and development. Finally, three case studies are chosen and they will be discussed.

INTRODUCTION

The development of technology is taking place in such a speed, that until we realize that something new came to the market, and get use to that, something else is already coming. The innovation in robotics is happening very quickly. In just a few decades we moved from unintelligent industrial robots, used just at the production level, to smart, cooperative robots, which can interact with humans and participate in everyday life.

Application of new robotic technologies is very wide. Robots are being used in automotive industry, medicine, as care robots for elderly and disabled etc. In all these application fields, they are collaborating close with humans, and their actions affect people to a wide range. Moreover, due to the huge improvement in the field of robotics in the last decade, robots are able to perform tasks, which make them almost equal to humans. Their ability to learn by themselves from its previous experience and from interaction with people, makes it hard to determine who is to blame in the situations where robot cause a damage to a third party.

For instance, robots are used in surgical areas, where every wrong movement could be deadly for the patient. Even with the highest precision, robots are not perfect and hundred percent reliable, therefore a mistake can occur. Moreover, robots are also used for care of elderly and disabled, and every sudden movement could hurt them. There are also some ethical questions arising from this. Is it ethical that a robot is taking care after a person, or can a person, especially helpless one, get too attached to a robot? Some of the modern robots, especially the ones used as care robots, have humanoid shape, which makes them even more human-alike.

In previous time, the responsibility was usually ascribed to the operator of the machine, if the machine operated as specified by manufacturer. In the cases when machine did not operate as it should, the responsibility would fall on the manufacturer. This principle was very clear and easily implemented. However, if as said before, a machine is able to learn from its previous experience and interaction with humans, then a human does not have control anymore over the behavior of a robot, so how it is possible to determine who is responsible for the harmful behavior? To what extent can we hold the producer, programmer or the operator liable for the actions of the machine, which is capable to learn by itself? If no legal solution would be found for this problem, we would have a big responsibility gap, which would lead to a chilling effect on the technology and very expensive lawsuits from the injured parties.

It is obvious that the basic concept of liability would be changed, in order to find suitable solution for these problems. The question is should traditional legal doctrines be applied or new legal categories will be created. Is a robot capable, due to its high intellectual abilities, to take the responsibility? Would that be possible and ethical? Or would human still stand behind it and take the consequences?

Liability and law regulation are social concepts, which in its basis have human behavior. Humans have the capacity to be held liable, since they are able to comprehend the consequences of their action and therefore, punishment would certainly have some influence on them, but can we say that also for robots? On the other hand, the development of highly intelligent machines and the lack of control over them by the developers calls in question the basis of the liability concept.

The Committee on Legal Affairs delivered the "Report with recommendations to the Commission on Civil Law Rules on Robotics from the Committee on Legal Affairs of the European Parliament of January 27 2017" with recommendation on European civil law rules of robotics. In the report some basic concepts and problems are discussed and based on that some recommendation are given in order to adapt the legal framework to the ever-changing field of technology.

In the following sections of this paper, we will focus mostly on the liability rules in the field of robotics and answer some questions and offer some new solutions that could be implemented along with current liability rules.

First, we will discuss the development of robotics, which robots are currently available on the market, and real application examples. Afterward, the basic liability concepts will be mentioned. The notion of strict liability and what does product liability mean. Moreover, the Council Directive 85/374/EEC of 25 July 1985 will be discussed, its deficiencies in the field of new developed technologies and the extent to which it can still be used.

The issues surrounding liability in robotics are numerous, especially in different fields of use. For instance, it is not the same if we need to regulate self-driving vehicles and computer integrated surgical systems. Computer integrated surgical systems are used by professionals, who have to be trained especially for that in order to save lives. On the other hand, any person in daily life could use a self-driving vehicles.

Another very sensitive field is the field of robotic prostheses. It is something people have to live with in their everyday life, something that becomes part of their bodies. They use it to perform very different tasks, which cannot be predicted in advance by the manufacturer. Due to this unpredictable use, there are numerous possibilities of something going wrong.

Moreover, the influence that legal regulation has on the technology is of a great importance. If the rules regulating robotics are too strict, the technology will have problem with moving forward. However, if there are no regulations in a certain field, that can make a chilling effect on the technology, since the developers would not feel safe to develop something that could afterwards put them in a risky situation.

Hence, there is always a question, should law regulation be formed as a soft law, which is not binding and can be implemented on voluntary basis, or there is a need for strong legal framework.

1. CLASSIFICATION OF ROBOTS

There is still no generally accepted definition of a robot, in spite of the fact that there is a general consent to the properties, that a robot possesses. These properties are to work autonomously, meaningfully and successfully. The desire to design a machine that would replace human in jobs that are too dangerous, too hard or too monotonous, was always there. Therefore, the machines often took humanoid look. Although in the past there are examples of mechanisms that are able to realize very complex movements, such devices cannot be called robots, because they can only perform the task they are designed for. It is expected from a robot to realize a variety of different tasks. In order to achieve this, the robot must have information about its own state and the environment, which it receives through sensors, whose signal should be processed sometimes in a very complex way. In the past there were no conditions needed in order to achieve this. For the emergence and beginning of the development of robotics, the development of the theory of computer and electronics management was of the crucial essence. Therefore, their development is closely linked. (Borovac et al., 2017).

The table below lists some of the key moments of the previous development of robotics. Although the wide spectrum of robotics development is included, this field is still expanding.

Year	Accomplishment
1898.	Nikola Tesla publicly demonstrated the radio-controlled model of the ship
1946.	George Devol developed first magnetic controller; Pennsylvania University launched “Eniac”, first modern computer
1952.	On MIT the NC machine was developed. That was the first machine that had both software and hardware integrated in the same device
1954.	Joseph Engelberger, student of the Colombia University, bought the rights to Devol’s robot, and launched first robotic company- “Unimation”
1956.	The term “artificial intelligence” is introduced to scientific terminology
1962.	General Motors installed the first robot, from the company “Unimation” in the maintenance work of the casting machine
1968.	Mobile robot “Shakey” with elements of artificial intelligence was developed on SRI
	Professor Vukobratovic set the theoretic principles of a two legged walk
1972.	Cincinati Milacron developed T3, first commercial robot
1973.	First programing language for robots was developed on Stanford
1973.	(WAWE)
1976.	RRC device for assembly was developed in Charles Draper laboratory on MIT

	ASEA offered on the market two industrial robots on electric drive
1977.	First PUMA robot, from the “Unimation” company was installed in
1978.	General Motors
	SCARA (Selective Compliant Robot for Assembly) developed in Japan
1979.	Professor Vukobratovic published papers on recursive modeling of
1980.	dynamics of open kinematic coolers and synthesis of dynamic robot
	control
	First robot, who can read musical notes and play organ, named Wabot-2,
1984.	was developed on Waseda University
	On Waseda University, the walk of a two-legged robot was relized
1986.	Companies ASEA and BBC Brown Boveri formed ASEA Brown Boveri
1987.	(ABB)
	Researching 8-legged robot Dante I went into the crater of the volcano
1992.	Erebus in Antarctic
	Honda publicly introduced autonomous humanoid robot P3
1997.	In Japan started a big project “Humanoid”
1998.	Company “Intuitive Surgical” introduced robotic system for laparoscopic
1999.	surgeries, “Da Vinci”
	First humanoid robot ASIMO, from the Honda company, was developed;
2000.	Sony introduced its humanoid robot SDR (Sony Dream Robot)
	Robotized probes Spirit and Opportunity were launched on Mars
2003.	The robot, which can play flute, was introduced at the Waseda University
2007.	First information about the state of the nuclear reactor in Fukushima after
2011.	the disaster was collected with the help of mobile robots

Table 1 Key moments in development of robotics, (Borovac et al., 2017)

There is not one common definition of robot. According to the definition given by standard ISO 8373:2012 industrial robot is “automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.” According to the Japan Robot Association (JARA) robots can be classified in the following way:

- Manual-Handling Device, that are handling the material;
- Fixed Sequence Robot, that can realize only fixed, ahead programed series of movements;
- Variable Sequence Robot, that can realize series of movements that can easily be modified;
- Playback Robot, that can memorize the movement and use it again later;
- Numerical Control Robot, that have manual training devices by carrying out a series of defined positions

- Intelligent Robot, that can sense the environment and they fulfill a task, even in changed circumstances.

Robot technology took two important paths: industrial and domestic. Industrial robots must be capable of sensing the environment and have a certain level of intelligence in order to perform tasks precisely and in a controlled manner. However, domestic robots, in order to be useful need the same characteristic. Hence, sensory perception and intelligence are inevitable parts of any advanced robot. Sensory perception include vision, tactile sensing, range finding, navigation and voice communication (Staugaard, 1987).

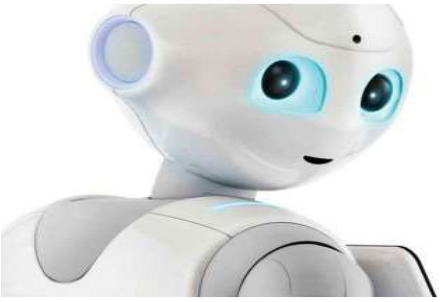

Figure 1, Smart robot, Source: https://www.generationrobots.com/en/402422-pepper-for-business-edition-humanoid-robot-2-years-warranty.html

Figure 2, Smart communicating robot, Source: https://www.thetimes.co.uk/article/robots-learn-about-tea-and-sympathy-to-care-for-elderly-plz7kzzn7

The new generation robotics raise number of issues, including ethical and legal ones. The European document on robot civil law rules on robotics recommends to propose a common definition and classification in order to precisely attribute responsibilities. Currently robots are generally classified as:

- Industrial and
- mobile robots

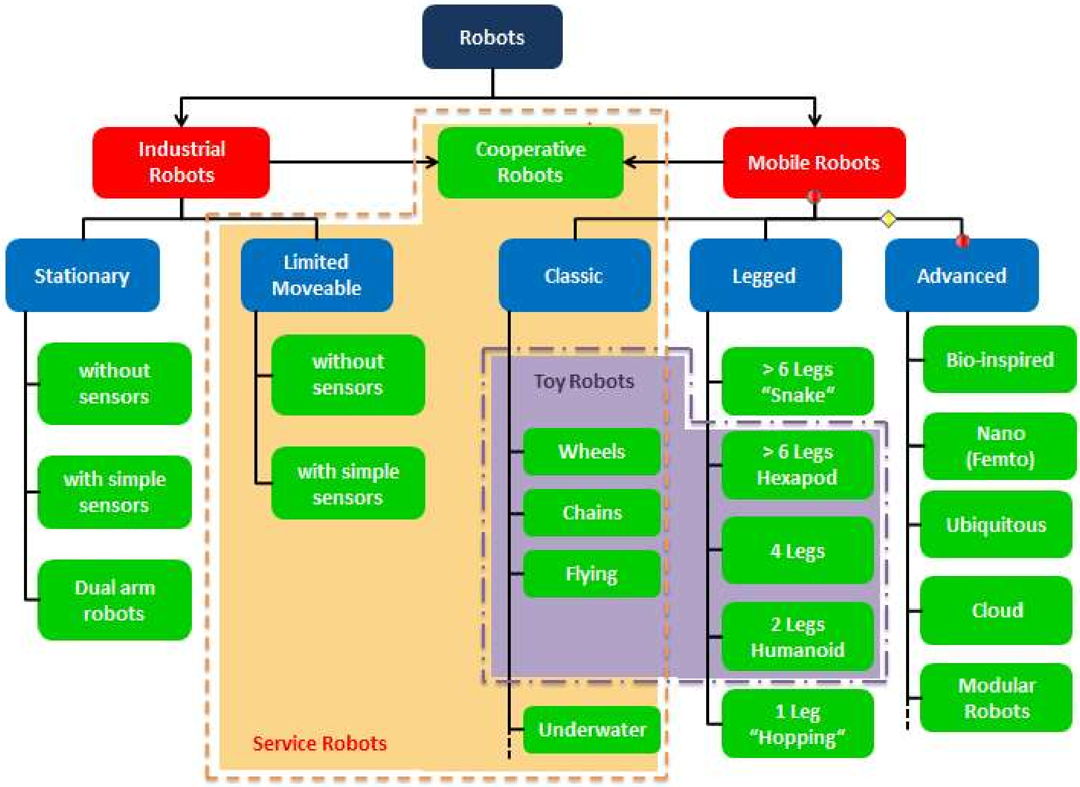

Figure 3, Classification of robots (Kopacek, 2018)

Conventional industrial robots are now used just on the production level. The improvement of external sensors, micro devices and embedded systems helped the development of intelligent, mobile and cooperative robots. This advancement in technology offer a possibility to a robot to see, hear, feel, speak, smell like humans and to complete a number of innovative tasks. The "starting points" for the development of the intelligent robots are conventional, stationary industrial robots, mobile, unintelligent platforms and walking machines. Stationary industrial robots are used now for assembly and disassembly operations, cleaning etc. Mobile, unintelligent platforms can be applied in a number of fields. The core of this platform is an on-board PC, and to this platform different kind of devices (arms, transportation equipment, communication systems) cam be implemented. Walking machines are usually 4-legged or 6-legged (multiped), only in some cases they have 2 legs (biped), while working on two legs is very complex and unstable. Biped machines are the basis of humanoid robots. Moreover, these intelligent robots are able to work together on a common task, such as assemble of a car. The task is divided into a number of different subtasks, that could be carried out by at least one agent. Intelligent robots in the industry are working together with humans on common tasks in a cooperative way (Kopacek, 2005).

1.1 INDUSTRIAL ROBOTS

For the development of industrial robotics the invention of transistors in 1947. and integrated circuits in 1959. was crucial. This enabled miniaturization, increasing the reliability of the computer and its application in robot management. In 1961, George Devol got his patent number US 2988237 approved. It was a machine for material handling. This event, followed by establishment of research robotic laboratories across United States, Europe and Japan, represent the beginning of industrial robotics.

The reason for using industrial robots are various. They could be used for the improvement in the quality of the goods, for improving work conditions, for cuttings costs, or ease of switching to the production of another product (flexibility). Robots achieve better results than human, when it comes to tasks where high accuracy positioning, high repetition repeatability, fatigue tolerance elimination, reliable measurement and quality control using sensors are important. Moreover, if the job requires a number of repetitive and monotonous tasks, if there is a need for heavy lifting, if it requires high level of concentration even after a long period of work, then the implementation of automation and robotization should be considered. Typical examples of these kind of tasks are packaging and palletization (Borovac et alia, 2017).

Industrial robots are defined based on various characteristics. As said before, the definition given by ISO 8373:2012 says that an industrial robot is “automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.” They are also defined base on a degree of mobility and liberty. Any point in space has three degrees of liberty, which means that three movements are sufficient to reach any point. However, with only three movements, only a robot with same orientation of the gripper would reach a point. In order to reach each point in the working space with any orientation, three additional axes must be added if there are no obstacles. The degree of mobility and the degree of liberty are not always the same. The degree of mobility are for instance the number of movements that the joints complete, which can be higher than the degree of liberty of the system. These kind of systems are redundant systems.

However, by increasing the number of axes, the risk of an error is also increased. That is why it is recommended to limit the number of axes to those that are really needed. A seventh and sometimes an eight axis is added when it is important to increase the workspace.

Industrial robots are used in a variety of fields, such as:

- **Handling:** This can include picking and placing from conveyor line to packaging. They can manage different products, from car doors to eggs.
- **Palletizing:** The robots can load cartons or other packages onto a pallet in a defined pattern.

- **Cutting:** Laser, plasma and water jet cutters are, because of their dangerous nature, usually used with cutters.
- **Finishing:** For a quality finish, multi-axis robots can grind, trim, polish and clean any kind of material.
- **Sealing and gluing:** Robots are usually used for this in car industry to seal in windows, but also in packaging processes for automated sealing.
- **Spraying:** Because of the hazardous nature of paints, robots are used for painting instead of humans. They usually have thin arms, because they need maximum access and movement fluidity.
- **Welding:** They are used for seam and spot welding, because they produce very precise welds.

The next classification would be into “not autonomous” and “autonomous” robots. Industrial robots generally belong to “not autonomous” robots, since they have a previously defined purpose and are used only for that one purpose.

1.2 MOBILE ROBOTS

A mobile robot is a robot that is capable of movement. It is capable to move around in its environment and is not fixed to one physical location, it can work automatically or can be controlled by a computer or an operator. On the other hand, industrial robots are usually more-or-less stationary.

First industrial stationary robot was introduced in 1961, which was followed by space and military mobile applications since 1970ies. Present commercial mobile robots could be found in all kind of different fields. They are used in hospitals to move materials, in warehouses, but they are also found in industrial, military and security settings. Moreover, there are domestic robots, entertainment robots and robots who are able to do household tasks.

Mobile robots could be classified base on different kind of criteria. According to the environment in which they operate, they can be classified as land or home robots, aerial robots and underwater robots. According to kinematics they could be classified as legged robots, sliding frame robots, wheeled, snake like robots and chain-tracked robots. Legged robots could be one-legged to multiple-legged robots. If we consider autonomous levels, mobile robots could be autonomous or semi-autonomous. Finally, according to application mobile robots could be classified as service robots, entertainment robots, research, space, civil or military robots.

The components of a mobile robot are sensor, user panel, control computer, power supply, ultrasonic/infrared, passive wheel and active wheel. The basis of a concept for mobile robot is the Mobile Robot Platform, which can be divided in four basic systems:

- Locomotion system
- Driving system
- Main control system
- Communication system.

The platform can be modified by adding different peripheral systems and tools, in order to perform different tasks or functions. These tools, that can be added, can be very different. However, they could be divided into two big categories:

- Conventional tools (screw drivers, drilling tools etc) and
- Special tools.

The function of a conventional tool is actually the same as the function of tools for manual operations. The only thing different is the design, since they are connected to the mobile platform. However, when a special tool is installed, the mobile platform is changed from regular to specialized mobile robot platform. If these installed tools are heavy, then they cannot be very flexible. Therefore, there is only one degree of freedom applied, and the others are realized by the mobility of a platform. Tool changing systems help robot achieve very different tasks, they have to be light, simple and reliable, and they are installed at the end of the robotic arm. Navigation is also an important part of a robotic system, and it uses sensors integrated in the platform. Moreover, if there is a need to transport different items from one place to another, there is a need to integrate special storage systems or devices in the platform. Also, some special communication systems can be installed (Kopacek 2005).

1.2.1 REAL APPLICATION EXAMPLES

One of the real application examples is the Pyxis MedStation System, which is a leading automated dispensing system supporting decentralized medication management. It can transports pharmaceuticals, lab specimens, equipment and supplies, meals, medical records and radiology films back and forth between support departments and nursing floors. It uses barcode scanning to help ensure

Figure 4, Pyxis MedStation System. Source https://sbir.nasa.gov/SB

accurate medication dispensing, it prevents loading of the wrong medication and has alerts for high risk medications. It has an odometric navigation system, also supported by ultrasound and laser. It can adapt easily to unstructured environment, gets on and off elevators without assistance. It has simple user-interface and it is also flexible and easy to program. It operates with a battery.

Another real application example is Wheelesly – a Robotic Wheelchair system. The idea behind this project was to develop a robotic wheelchair system, which could help its user in navigation in indoor and outdoor environments. It is a semi-autonomous system and the robotic system can ask its user for help, when it has difficulty navigating. System does not use map for navigation, therefore, the user is not limited to a particular location by the need of maps. The target users are the people who are not able to manage a joystick. Some of them are just not able to make fine corrections when using a joystick, and others are completely unable to control a wheelchair with any device (Yanco, 1998).

Figure 5 Wheelesly – Robotic Wheelchair system, Source: http://robotics.cs.uml.edu/research/wheelesley.php

It consists of an electric wheelchair, computer, sensors and a Macintosh Powerbook that is used for the user interface. The user is able operate in three modes: manual, joystick and user interface. In manual mode, the wheelchair functions are as normal electric wheelchair functions. In joystick mode, the user commands through a joystick and the robot will avoid objects in the requested path. In user interface mode, the user interacts with the robot only through the user interface.

1.3 SMART AUTONOMOUS ROBOTS

Autonomous robots operate in total autonomy, independent from human intervention. They can easily adjust themselves to new environment, which was not familiar to them. They are also able to take decision autonomously in unexpected situations. Autonomous robots are usually programmed with algorithms that need techniques of artificial intelligence. The question is also what is exactly artificial intelligence. The most accepted definition of the artificial intelligence is the one given by Marvin Minsky, which which defines artificial intelligence as „the science of making machines do things that would requier intelligence if done by a man“ (Minksy, citeted by Staugaard, 1987).

In theory, smart robots represent the generation of robots that are not tied to production lines anymore, but are able to adapt to changes in their surroundings. Since they left the factories, adjustments needed to be made, so they could function in a highly unpredictable environment. However, it was impossible to program how to act in every possible situation, so a certain level of autonomy had to be provide.

The European Parliament resolution on civil law rules on robotics recommends that the Commission "propose common Union definitions of cyber physical systems, autonomous systems, smart autonomous robots and their subcategories by taking into consideration the following characteristics of a smart robot:

- the acquisition of autonomy through sensors and/or by exchanging data with its environment (inter-connectivity) and the trading and analysing of those data
- self-learning from experience and by interaction (optional criterion);
- at least a minor physical support;
- the adaptation of its behaviour and actions to the environment;
- absence of life in the biological sense;“ (European Parliament resolution of 16 February 2017)

Defining a robot, especially a smart autonomous one, is not an easy task. For instance, a surgical robot cannot completely fall into a category of smart autonomous robot, since it is operated by a practitioner. Therefore, a human participates in a decision making process. However, the European Union has to consider surgical robots, especially as regards robot safety and surgeon training in robot use. Another example are autonomous drones, which are always remotely piloted by an operator, so they are also not falling into category of smart autonomous robots, but need to be considered as regards to privacy, safety, security and personal data protection issues.

The European Parliament resolution a robot's autonomy as "the capacity to make an informed, un-coerced decision about the terms of interaction with robots;" (European Parliament resolution of 16 February 2017). The term "intelligent robot" is also used in the 2012 technical standard in Paragraph 2.28 of EN ISO 8373 in relation to "Robots and robotic devices – Vocabulary", which states that an intelligent robot is a robot that is "capable of performing tasks by sensing its environment and/or interacting with external sources and adapting its behavior".

2. LIABILITY RULES

In this chapter, we will explain the strict liability regime, different types of strict liability. Further, we will discuss the difference between strict liability regime and negligence. Finally, we will look at the Product liability directive 85/374/EEC.

2.1 NOTION OF STRICT LIABILITY

Strict liability simply means “liability no matter what”. It is liability without a fault and the injured party needs only to prove the existence of a damage, without the need to prove the fault of the injurer. Strict liability is based on a theory of risk. If an activity or a certain thing cannot be fully controlled, the person who performs the activity or is an owner of a dangerous thing will be held liable even if it is not his fault that an accident occurred. The justification for that lies in a fact that that person created increased danger and should bear the consequences if something happens. However, this does not mean the fact that there is a fault represents an obstacle, it just means that the responsible person would be held liable, even if it is not his fault.(Karanikić Mirić, 2016)

The European legal system recognizes two very different approaches to regulate strict liability. One way is to have one general norm regarding strict liability, and the other is to introduce the strict liability into a legal system through a special regulation. First example we can find it in French law. The Article 1384(1) of French Civil Code has a general norm regarding strict liability for damages from things owned or controlled by the person responsible. This example is not so often in practice (Karanikić Mirić. 2016).

Another solution is find in German, Austrian and Swiss law. In these legal systems strict liability presents an exception to the rule that the responsibility for the damage cannot be constituted without a fault.

Some legal systems in Europe that have the ad hoc approach are considering to implement just one legal norm for strict liability for increased risk (Karanikić Mirić. 2016).

2.1.1 LIABILITY FOR DANGEROUS THINGS AND DANGEROUS ACTIVITIES

A dangerous thing is a thing, which by its position, use, characteristics or just mere existence represent a danger for the environment (Karanikić Mirić. 2016). The liability for dangerous thing can also be called the liability for created or maintained risk. The court should asses whether a thing is dangerous or not. When doing that, the judge will take into consideration whether a certain thing creates a higher risk for an accident to happen or the risk that an accident will occur is normal, but damage that could arise form an accident is unusually big. A risk can be understood as a possibility that an accident will occur, or the likelihood of a damage being abnormally big (Karanikić Mirić. 2016).

A dangerous activity could be understood as a human activity, that when done in a normal way, and this will say the way it was performed by a reasonable and attentive person, poses an increased risk of environmental damage, or generates an increased risk of harm to others. If the activity is such that a reasonable and attentive person will not accept to do it, if he is not specially trained for it, then it is relevant sign that the activity represents an increased risk of harm when it is done in a professional manner. Further, this means that the activity is dangerous if it creates an increased risk of damage, even when it is done by a reasonable and attentive expert. Dangerous activities should also include those that are not dangerous on a regular basis, but they become dangerous due to the dangerous circumstances under which they are carried out (Karanikić Mirić. 2016).

2.1.2 PRODUCT LIABILITY

Product liability is a modern form of strict liability for damages derived from things that are mass produced, used or consumed. When someone produces and releases a thing with a defect, that is, a defect that generates an increased risk of damage to the environment, then it is responsible for the damage caused by this deficiency, regardless of fault. The produced thing is not dangerous by itself, yet, it becomes defective based on a fact that, because of which it is not safe enough, even if it is used in a way a reasonable and attentive man would do. Defect or a flaw is not reflected in the fact that the thing is not conforming to the contract, but in the fact that it is not safe in a described way. If the damage arises from that deficiency, the producer is held strictly liable, irrespective to the fact that he maybe did not know about the defect, and in some legal systems, regardless of the fact that it could not have been known for the defect at all.

The reasons for applying strict liability regime in the case of a product defect are various. First, the manufacturer is best informed about the features of his own product. Second, by selling this product he is gaining economic benefit. Moreover, he can insure himself from the risk (Karanikić Mirić, 2016).

If a manufacturer has a reason to suspect that a product could do harm, if used in a particular way, he is then required to give an adequate warning of the danger. His duty to warn depend on different factors, such as foreseeability of the use in question, the type of danger involved, and the foreseeability of the user's knowledge of the danger. If a manufacturer fail to adequately warn or adequately communicate the warning to the user, then he will be held liable. In assessing the failure to warn, the location and presentation of the warning would be taken into consideration. If the plaintiff fail to tread the instruction given by a manufacturer, then the manufacturer would not be held liable. However, if a plaintiff proves that the manufacturer failed to give a warning, the plaintiff's failure to read the warnings may actually be evidence of the inadequacy of the warning (Brannen et alia, 2012).

The development of strict liability regime for the producers of things with a defect, as a special form of strict liability, has been encouraged by a tragedy that, at the end of the sixties, which was caused was caused by a massive use of a drug with teratogenic effects, under a name *thalidomide*. The company *Grünenthal* developed a substance, which was prescribed as an antiemetic, especially to pregnant women suffering from strong morning sickness. This lead to the birth of couple of thousand babies with severe body deformities. This tragic event speeded up work on the Strasbourg convention on liability for damage to products in the event of a personal injury or death adopted in 1977 in the Council of Europe. This convention later served as a backbone for Council Directive 85/374/EEC of 25 July 1985, concerning liability for defective products.

2.1.3 DEVELOPMENT RISKS

As said before, a producer is liable for damage coming from a defective product, regardless of his fault, or the fact that he was unaware of the existence of the defect. The fact that a producer knew or could have known that a product was defective has no legal significance. However, “the institution of development risks defense enables the producer to excuse himself from liability for damage from a defective product by proving that the defect was undetectable even by applying the highest level of scientific and technical knowledge at the time when the product was put into circulation” (Karanikić 2005: 118). The producer is not liable for the damage that arises from a defective product, if it was objectively impossible to know about the defect.

The exemption from liability in these cases is often illustrated by a case from Dutch court practice. During a heart surgery, a patient received blood transfusion, which was contaminated with the HIV. The Dutch court considered the blood contaminated with a virus as a defective product. However, the blood supplier succeeded to prove that the presence of the virus in the blood could not have been discovered according to the state of scientific and technical knowledge at the time when the blood was delivered. At the time of the ruling it was 1999, and it was possible to discover HIV in a blood, but back in 1996, when the surgery took place, this was not possible according to the state of scientific and technical knowledge. The court ruled that, although the supplier of the blood had behaved in accordance with the highest level of scientific and technical knowledge, it was impossible to discover the presence of the virus in the blood, and that the supplier was therefore not liable (Karanikić, 2005).

The Council Directive 85/374/EEC of 25 July 1985 on liability for defective products also contains the institution of development risk. Article 7(e) states that a producer shall not be liable if he proves “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”.

2.2 COUNCIL DIRECTIVE 85/374/EEC ON DEFECTIVE PRODUCTS

The Council Directive 85/374/EEC of 25 July 1985 on product liability established the principle of liability without a fault for the European producers. According to the Directive, if a defective product causes damage to a consumer the producer will be liable even without negligence or fault. In the Article 2 of the Directive the meaning of a product is explained as “all movables, with the exception of primary agricultural products and game, even though incorporated into another movable or into an immovable. 'Primary agricultural products' means the products of the soil, of stock-farming and of fisheries, excluding products which have undergone initial processing. 'Product' includes electricity”.

All producers involved in the production process should be made liable. Regarding to the Article 3 a “Producer” is “the manufacturer of a finished product, the producer of any raw material or the manufacturer of a component part and any person who, by putting his name, trade mark or other distinguishing feature on the product presents himself as its producer”. Moreover, a producer is also a person who imports a product for any form of distribution, that is in connection with his business. However, if a producer cannon be identified, a supplier of the goods shall be treated as a producer.

The burden of proof lies on an injured person. His obligation is to prove the existence of a damage, the defect and the causal relationship between a defect and the occurred damage. A product will be qualified as defective if “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.“

„The safety which a peson is entitled to expect“ is a very broad term, and could be easiliy interpreted in a wrong way, especially when it is regarding new technologies. It is hard to set a standard for the technologies that are just being developed, and are not that familiar to a wider circle of people.

A producer can be exempted from liability if he proves that did not put the product into circulation, the defect appeared after the product was put into circulation, the product was not manufactured to be sold or distributed for profit, or for any purpose within the usual transactions and practices of their business, the defect is due to compliance of the product with mandatory regulations issued by public authorities, 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 the defect of a component was caused during the manufacture of a final product. The producer's liability may also be reduced if the injured party is at fault (Council Directive 85/374/EEC of 25 July 1985).

One of the reasons for the producer to be exempt from liability is the institute of development risk, which was previously explained. The producer will not be liable, if he manages to prove that the defect of the product was undetectable in the time when it was put into circulation, even with the implementation of the highest scientific and technical knowledge. The development risk actullay solves the dilemma, who will be liable for the damage caused from the moment the product was put into circulation till the moment it discovered that the product is defective, in the cases when the defect was impossible to discover.

According to the institute of development risk, the risk of the subsequent knowledge about the existance of the defect of the product will bear the damadged party, if at the time the defect which caused the damage was impossible to know of, according to the state of scientific and technical knowledge (Karanikić, 205).

However, in the Article 15 (1.b), Directive leaves the possibility for the member states not to implement the development risk defense in their national regulations. Only Luxemburg and Finland fully used this possibility.

According to Article 9, the Directive applies to damage caused by death or personal injuries, or the damaged caused to private property.

In the European Parliament Civil law rules on Robotics it is stated, in Paragraph AH, that the Directive 85/374/EEC can cover only damage caused by a robot's manufacturing defects. Moreover, in the Paragraph AI, it is explained why the Directive would not be sufficient in the future, saying that "the current legal framework would not be sufficient to cover the damage caused by the new generation of robots, insofar as they can be equipped with adaptive and learning abilities entailing a certain degree of unpredictability in their behaviour, since those robots would autonomously learn from their own variable experience and interact with their environment in a unique and unforeseeable manner". Therefore, the new legal solutions must be found (European Parliament resolution of 16 February 2017)

2.3 NOTION OF NEGLIGENCE

In the law, negligence is defined as carelessness, which causes damage to a person or property. Negligence may arise either from acting carelessly, or from failing to act when legally obligated to do so. There are four elements of negligence: duty, breach, damage and causation. An injured party is obligated to prove the existence of all four elements.

The first element, duty, requires that the defendant conform to a certain standard of conduct for the protection of others against unreasonable risks. A legal duty to act may arise from a statute, from an administrative regulation, from a contract, or just from a case where a foreseeable zone of risk is present.

Second element, the existence of a damage, means that the injured party must suffer some kind of damage and prove its existence. He must prove that his property was diminished, or that its enlargement has been prevented, or that he has suffered physical or mental pain or fear, or that he has suffered property damage in the form of ordinary damage or loss of profit or non-pecuniary damage. It is enough that he proves the existence of just one form of the damage.

The third element means that the defendant did not fulfil his obligation. In order to exercise the right to compensation for damage based on subjective responsibility It is necessary to establish the guilt of the pest. Pests of pests exist in cases where the damage is caused intentionally or due to negligence. The damage is cause intentionally when the defendant who knowingly exposes the plaintiff to a substantial risk of loss. However, the damage is caused due to negligence if the defendant fails to realize the substantial risk of loss to the plaintiff/claimant, which any reasonable person in the same situation would clearly have realized. In the case of strict liability this element is missing (Antić, 2012).

Finally, the forth element, is causation. In order for liability to result from a negligent act or omission, it is necessary to prove not only that the injury was caused by that negligence, but also that there is a legally sufficient connection between the act and the negligence. The guilt of the pest is a subjective element, and the causality between the harm and the unlawful action of the pest is the objective binding element. Only in connection of these two elements a concrete obligation is created between the pest and the injured party (Antić, 2012).

The difference between negligence and strict liability regime is the lack of one main element - breach. In the strict liability regime, a person will be held liable, even if it is not his fault that an accident occurred.

3. ISSUES SURROUNDING LIABILITY IN ROBOTICS

Due to a huge technological progress in the last decade, the robots are today able to perform such tasks that make them in certain cases almost equal to humans. Moreover, the robot's ability to learn from experience and by interaction is slowly tearing down the boundaries between the man and the machine. Given these abilities it is likely that the robots will be making more and more mistakes and real-life damages while performing their tasks, just like humans are doing. Even if the available technologies may become increasingly precise, they will not cancel the eventual fall, collision or mistake. The more intelligent robots get, the more complicated is the work they are assigned to do. For instance, if a care robot has to lift a patient from the bed, every mistake made by it can be really threatening for a patient. Moreover, there is a going trend of using a surgical robot, that performs interventions of high precision and on small-sized locations, without the visual and manual difficulties, that a surgeon would meet. In this case any sudden and uncontrolled movement could be deadly for a patient. It is very important that a robot, in each case, receives very precise information (Di Viggiano, 2018).

For the robotics, the safety issues are linked with their software and design. While it is not really harmful if there appears to be a flaw in office applications, a flaw in machinery, such as a car or a robot, could be fatal. For instance, in August 2010, the US military lost control of a helicopter drone during a test flight for more than 30 minutes. The drone was headed towards Washington DC, violating airspace restrictions, meant to protect the White House. In October 2007, a semi-autonomous robotic cannon used by the South African army malfunctioned, killing nine "friendly" soldiers. The reasonable question would be, is it possible to develop a robot that can distinguish threatening behavior from the not threatening, how would a military robot know who is a "friendly" soldier and who is not, or who are the civilians? (Lin et alia, 2011).

Since the usage of smart autonomous robots is rapidly growing, there is a need to define some legal boundaries. In the next table we can see the forecast of the growth of the smart machine market.

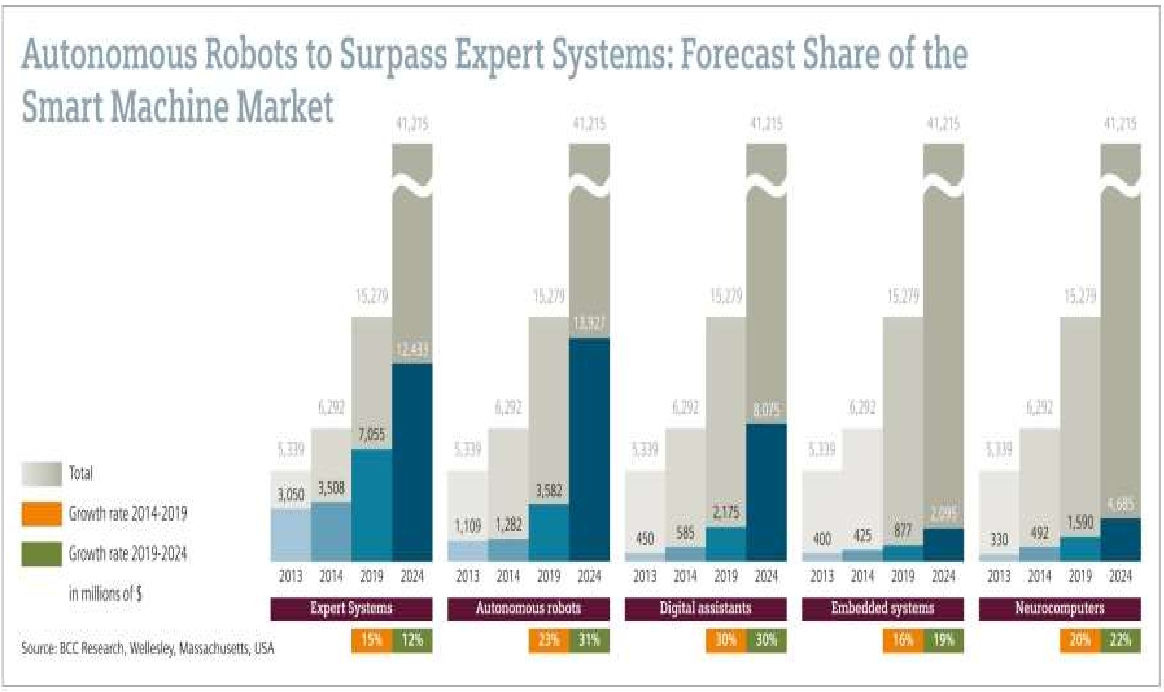

Figure 6, Forecast Share of the Smart Machine Market, Source: https://www.siemens.com/innovation/en/home/pictures-of-the-future/digitalization-and-software/artificial-intelligence-facts-and-forecasts.html

The question that arises from this is who will take the responsibility in these cases? Will that be a human responsible for a robot, a robot or a new legal category should be created, with its own specific features and implications? It is not easy to understand who could be held liable in the case in which the robot has reached such level of autonomy and independence, that there is no place left for a human error. (Di Viggiano, 2018) It is hard just to apply traditional legal doctrines, such as product liability or negligence, while the more complex technology is, the harder it is to find one person to blame for the damages that are caused. People using the autonomous robots could blame the manufacturer, and the manufacturer could claim that the operator of the robot could intervene to avoid the damage. In these cases, some kind of "grey area" could occur, and it would be hard to determine the contributing causes of damage. Level of caution can also be changed, for example, in cases of autonomous vehicles, pedestrians may take more risks, and drivers of traditional cars may act more aggressively, while they would expect that an autonomous vehicle will in any case follow all the rules. (Holder et alia, 2016).

Another question is whose law should be applicable, since law, ethical and cultural norms vary from one country to another. This could require international policies, treaties, or even international law and enforcement bodies. Problems like that already came up in the US military. The US refused to sign the aforementioned landmine ban, also known as the "Ottawa Treaty", also the US assumes that the robotic drones attacks in Pakistan are legal, while many other countries disagree. (Lin et alia, 2011).

It is clear that the artificial intelligence will challenge the very concept of liability. In the basis of liability lies the responsibility, responsibility for its own actions. To be responsible means to be capable of making moral decisions, distinguish right from wrong, think rationally and be aware of the consequences if doing something wrong. Being liable also means being legally responsible.

Liability and law itself are social concepts created by humans and for humans, and therefore, could be understood only by humans. The capacity to be held liable depends to a high degree on comprehension of how the world and the society function. However, development of highly intelligent information processing AI applications having the freedom to make own decisions call in question the basis of the liability concept. The lack of control of the developers of the AI software is becoming a huge problem. If a machine operates by itself and make decisions, without an assistance from a human, and by doing that some negative consequences happen, either the manufacturer or an operator of the machine is held liable. However, if they did not have any control over the machine, it would be unjust to hold them liable. That kind of unfairness would result in unwillingness to work and proceed with further research and development of the AI systems. That would all affect the development of science (Krausová, Hazan, 2017)

If a robot will reach that degree of autonomy and intelligence, that it could be capable of making its own decisions, then the possibility to have an own legal personality becomes real. For instance, we should consider that there is ongoing work in integrating computers and robotics with biological brains. Human brain and body have human rights, and if we replace part of them with something else, without damaging its functions, then it means that also the artificial parts have human rights. At one point in the future, we will maybe have more artificial than human parts, making the organism more robotic than human.

A legal personality is a term, which is always connected to humankind, gained by birth. To be a legal person means to be subject of rights and duties. The legal personality is the capacity for legal relations. (Smith, 1928) That would mean that a robot could be held liable for his actions, and surely, this opens another question-is that possible, and if it is, does it make sense to sanction a robot? A sanction has two purposes- retribution and prevention. Retributive purpose of a punishment is to punish someone proportionally to his crime and to rebalance any unjust advantage gained by ensuring that the offender also suffers a loss. On the other hand preventive purpose is to prevent people from committing an offence. In both cases a certain level of consciousness is required. There is no point in punishing a robot, which is not aware of the consequences that it has to suffer. However, a human cannot be strictly liable for the actions of a robot that is able to learn by itself.

In early 2017, the European Parliament adopted a resolution with recommendations on Civil Law Rules on Robotics. It is suggested in the resolution to form a new legal status- an electronic person. The plan is to give the status of an electronic person at least to the most sophisticated autonomous robots, and making them responsible for any damage they may cause, and possibly applying electronic personality to cases where robots make autonomous decisions or otherwise interact with third parties independently (European Parliament resolution of 16 February 2017). Traditionally, when assigning an entity legal personality, we seek to assimilate it to humankind, like with animal rights, arguing that animals are conscious beings, capable of suffering and hence, they should have a legal personality. As robots are not conscious beings, they don't have feelings and they cannot understand the consequences of their acts, it is not logical to assign a legal personality to a robot for that reason.

On the other hand, there is a case when a legal personality is given to an entity, because this assignment would grant an entity a legal life. In this case, the legal personality is assigned to a non-human entity, based on a legal fiction. A legal person is then able to act in the legal sphere, but behind it, there is a real person representing it. That kind of concept could also be used in the case of robots.

However, the motion for a resolution is implying that the robots could do things and decide without any intervention of a human. In paragraph Z it is said that thanks to the technological advances today's robots are able to perform activities that was in the previous time only associated with humans, such as the ability to learn from its previous experience and take quasi-independent decisions. Paragraph AA defines the robot's autonomy "as the ability to take decisions and implement them in the outside world, independently of external control or influence". Moreover, the Report suggests that a robot should be held liable itself, saying in paragraph AB, stating that the more autonomous and independent robots are, the less they can be considered just as tools in the hand of the operator.

Considering all this it is clear that the direction we are going in is to have robots with its own legal personality one day. As said before, to be a legal person means to be a subject of rights and duties. The problem with a robot would be to decide what kind of rights should be assigned to a robot? Should a person harming a robot be held liable for that? How would that classify? Should the right to equality with humankind or the right to retire also be assigned to a robot? Could a military robot refuse to fulfill some of his duties because it is too dangerous, or could a robot demand a compensation for an injury suffered at the work place?

For all those reasons it is inappropriate to assign a robot a legal personality and make it equal to a human being. Assigning person status to a nonliving entity would call into question Europe's humanist foundations, since the humankind would be brought down to a level of a machine. There should be some boundaries left between man and a machine, and robots should be there only to serve the humanity.

The European RoboLaw Project, named Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, started in 2012. and lasted for two years. The main objective of the Project was to investigate the ways in which emerging technologies in the field of robotics influence the content, meaning ant setting of the law. The Project provided guidelines on regulating robotics.

The main things discussed are, among others, weather robots deserve a special case, are just extant laws sufficient or should rather sui-generis law be created. Other considerations were also about liability, how such rules should be used and shaped, in order to favor the development of technology.

Simply applying the EU Directive 85/374/EEC on Defective Products could in some cases produce a technology chilling effect. Moreover, it can raise the costs of compensation. This negative effect could further lead to delay of development of robotic technologies. For instance, in the case of driverless vehicles a variety of other factors should be taken into consifderation, such as street rules, other vehicles, passengers. Since the current technology is not producing fully autonomous vehickles, and since there is currently just a certain amount of the vehicles in use on the streets, it would be unfair to impose a strict standard of liabilty on the producer. This action would just stop further development of tachnologies. However, when the technology advance sufficiantly to produce fully autonomous car, the producer could feel safe assuming liability for all accidents caused.

Similar thing is happening with robotic prostheses. A robotic prosthesis, because of its purpose, represent a special kind of robotic device. The unlimited number of ways in which it can be used, and the interaction of the brain and the machine makes it hard to foresee ex ante all the potention harmful consequences. Therefore, the producer is completely to all the consequences that a malfunctioning of a machine can make.

Policy decisions should be founded on two major factors – technology push and safety. Policy measures should be taken to stimulate robotic applications, and decrese and liabilty risk. Not all robotic applications should be treated the same when it comes to liabilty. For instance, in the case of prostheses, a liabilty exemption can be considered, combined with creating a fund for the cases of injuries made by a robotic prostheses (Palmerini et alia, 2016).

3.1 SELF-DRIVING VEHICLES

Different areas of human life have been affected with development of technology. The biggest improvements today are definitely being made in the auto industry, but we are still just at the beginning. The direction that we are going in is to have a fully autonomous car, which would not need a driver. There are number of reasons for investing in this kind of technology. First of all, it would eliminate mistakes in traffic made by drivers, such as tiredness, lack of experience, driving under the influence etc. Another thing is that it would help to include in the traffic people, that are unable to drive by themselves. For instance, blind people, old people, disabled ones. Also, it could improve traffic efficiency by smartly disturbing traffic among lanes. On the other hand, different kind of mistakes would appear. Since automated cars are designed by humans as well, it is not impossible that some kind of error occurs. The challenge is to reduce these risks to an acceptable level. The question is what would be an acceptable level of safety? It is clear that we should not take the step back in safety. It should be at least as safe as it is to drive a not automated car (Mrčela, Vuletić, 2018).

As said before, the goal is to have a fully autonomous car that would be able to navigate without human intervention to a predetermined destination over roads that have not been adapted for its use. We still have not reached that level of autonomy. Instead of that, we currently have on the market functionalities that are built into existing human driven cars. For instance, these functionalities are adaptive cruise control, park assist and lane keeping. Adaptive cruise control adjust the speed of the car to that of the car driving in front of it. If there is not any car driving in front, it adjusts the speed to the speed set by the driver. Park assist can parallel park a car without an intervention of the driver, and lane keeping warns the driver when the car wanders out of the lane he is driving in. All these functionalities are there just to increase the comfort of the driver, and the driver is at any time in full control of the vehicle. As of May 2013, the National Highway Safety Administration (NHTSA) has defined five levels of automation for the auto industry (NHTSA PRELIMINARY STATEMENT, supra note 16, at 4–6.). These levels are shown in the table below.

NHTSA Levels of automation					
	Level 0	Level 1	Level 2	Level 3	Level 4
Name	“No Automation”	“Function-Specific”	“Combined Function”	“Limited Self-Driving”	“Full Self-Driving”
Control	Driver is in complete control at all times.	One or more control function is automated.	At least two primary control functions are automated and work in unison to relieve driver of control in certain situations.	Driver can cede full control of all safetycritical functions under certain conditions.	Vehicle performs all safetycritical driving functions.

Operation	Driver is solely responsible for safe operation and monitoring the roadway.	Driver is solely responsible for safe operation and monitoring the roadway, but can cede primary control or be assisted in certain situations.	Driver is responsible for safe operation and monitoring the roadway and is expected to be available to take control on short notice.	Driver can rely heavily on vehicle to monitor for changes in the roadway that require driver control. Driver is expected to be available for occasional control.	Vehicle monitors the roadway conditions for an entire trip.

Table 2 Levels of automation, Source: Adeel Lari Frank Douma Ify Onyiah, Self-Driving Vehicles and Policy Implications: Current Status of Autonomous Vehicle Development and Minnesota Policy Implications, Minnesota Journal of Law, Science & Technology, 2015

We find ourselves currently in the level 2 of automation. Car can take over multiple functions from the driver, and is intelligent enough to weave speed and steering systems together using multiple data sources. Howevere, the system can give over the control at any moment and the driver should be ready to intervene and take cotrol over the vehicle if needed. He is also still responsible for safe operation and monitoring the roadway. An example of these combined functions could be adaptive cruise control in combination with lane tracking. The system demands from a driver not to take his hands from the wheel more than few seconds. In contrary, the functions stop working. In that way, the system involves the driver and takes care that he is ready to take control at any time.

Figure 7, Smart autonomous vehicle, Source: [*https://www.automotive-iq.com/autonomous-drive/articles/top-5-smart-mergers-acquisitions-race-autonomous-cars*](https://www.automotive-iq.com/autonomous-drive/articles/top-5-smart-mergers-acquisitions-race-autonomous-cars)

Having known all this, the next logical question is who is responsible in a car accident caused by a Self-Driving Car? This question draw a lot of attention, since the accidents involving Self-Driving Cars already happened.

The first recorded case of a pedestrian fatality involving a level 3 self-driving car was the death of Elaine Herzberg, occurred in the evening of March 18, 2018, in Tempe, Arizona, United States. She was hit by an Uber taxi, which was operating in self-driving mode with a human safety backup driver sitting in the driver seat. After the collision, Herzberg was taken to the hospital, where she died of her injuries. Following her death, Uber suspending testing of self-driving vehicles in Arizona. Of course, this case arose many questions regarding regulations in the field of the Self-Driving Vehicles.

Besides this tragic incident, other incidents involving a self-driving car have already occurred before, where the injured party was the driver. On January 20th, 2016, the driver of a Tesla Model S was killed in Handan, China. It happened when the car crashed into a stationary truck. The Tesla was following a car in the far left lane, when the car in front moved to the right lane to avoid a truck stopped on the left shoulder. The Tesla did not react immediately to a changed situation and did not slow before colliding with the stopped truck. The driver's family filled a lawsuit against the Tesla dealer who sold the car. Following that Tesla released a statement, which said that they have no way of knowing whether or not Autopilot was engaged at the time of the crash.

Another tragic accident involving a Tesla engaged in Autopilot mode took place on May 7, 2016, in Williston, Florida. The driver was killed when his car crashed into a wheel tractor-trailer. The accident happened when the tractor-trailer made a left turn in front of the Tesla at an intersection and the car failed to apply the brakes. The car continued to travel after passing under the truck's trailer for another 270 m. It was travelling at a speed of 119 km/h. Tesla stated that this is the first Tesla's known Autopilot-related death.

Another accident occurred on January 22nd, 2018, in Culver City California, when a Tesla Model S crashed into a fire truck parked on the side of the freeway. Luckily, the accident was not fatal. The driver stated that the Autopilot was on. While the accident was investigated, Raj Rajkumar, who researches autonomous driving at Carnegie Mellon University, stated that "The radars they use are apparently meant for detecting moving objects, and seem to be not very good in detecting stationary objects".

On March 23, 2018 another fatal accident occurred in Mountain View California, at the carpool lane exit, when the Tesla's Model X crashed into the narrow concrete barrier. Following the crash, it was struck again by two following vehicles, and then it caught on fire. Autopilot appeared to be confused by the road surface marking.

These accidents are just showing us what kind of problems the advance in technology is bringing. With this progress in the field of artificial intelligence the drivers are being more and more relaxed, and they rely on the vehicles to do all the work. Of course, the advantages that this development is bringing are far greater than the disadvantages, but we should be ready also for the negative effects that can be caused, and try to find solutions on time.

First step in finding a solution is to identify the problem and make a definition of what needs to be regulated. Four of the US states have enacted legislation that defines autonomous vehicles. The RoboLaw project made a table of the core elements of definitions of every state.

	Nevada	**California**	**Michigan**	**Florida**
Means	vehicle is also enabled with artificial intelligence and technology that	vehicle equipped with technology that	a motor vehicle on which automated technology has been installed, either by a manufacturer of automated technology or an upfitter that	Any vehicle equipped with autonomous technology

Purpose of the means	allows the vehicle to carry out all the mechanical operations of driving	has the capability of operating or driving the vehicle	enables the motor vehicle to be operated	that has the capability to drive the vehicle on which the technology is installed
Way of operating the means	without the active control or continuous monitoring of a natural person	without the active physical control or monitoring of a natural person	without any control or monitoring by a human operator	without the active control or monitoring by a human operator

Table 3, Definitions of Self-Driving Vehicles, Source: robolaw_d6.2_guidelinesregulatingrobotics_20140922.docx

The form of all definitions is similar. There are means mentioned, their purpose and the way they work. The important thing is to look at the way in which they operate. In each definition, it is mentioned that the vehicle is operating *without* control or monitoring of a human. The strictest is the definition in Michigan, which is saying that the vehicle is operating without a control or monitoring by a natural person. Other definitions just say that the vehicle is operating without an active control or monitoring by a natural person. That leaves the place for human to participate in operating the vehicle if there is a need for that. However, these definitions do not include any partially automated cars, so the direction in which we are going is clear. At some point in the future we will have only fully autonomous cars and the drivers would sit there just like passengers. Therefore, it is important to define roles, determine fault and fix compensation for harm in the cases of the Self-Driving Vehicles.

This imposes a question who will be held liable in these situations. Will that be the operator, the owner, or the manufacturer? Will insurance cover accidents made by a Self-Driving Vehicles? Either the rules of negligence or the rules of strict liability should be applied. Negligence assigns fault based on specific conditions of the case and number of criteria. The strict liability assigns fault based just on the existence of a violation under the law. Since we are considering here the non-contractual liability regarding the product liability, the Directive 85/374/EEC can cover only damage caused by a robot's manufacturing defects and on condition that an injured party is able to prove the actual damage, the defect in the product and the causal relationship between damage and defect.(European Parliament resolution of 16 February 2017) Therefore, strict liability framework will not be sufficient in these cases, and it is more likely that the negligence will be the legal framework under which Self-Driving Vehicles will operate. The theory of negligence consists of the next five elements: 1) duty of care; 2) breach of duty of care; 3) cause of harm; 4) physical harm; 5) proximate cause. The question is who has the duty of care in a situation involving a Self-Driving Vehicle? From how this question is answered depends who will be held liable, a manufacturer, corporate entity owning or providing Self-Driving Vehicles for rent, the operator or private owner, or the responsibility will be shared among these parties (Lari et alia, 2015).

What is important is that the new liability framework does not negatively affect the further development of the technology. Therefore, we should focus a little bit on the product liability. The standard for product liability is “the safety a person is entitled to expect” (Council Directive 85/374/EEC of 25 July 1985). In each case all the circumstances should be taken 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.

These circumstances just show that it is not possible to expect that the product will never cause any damage. It is also the case with regular cars. You are not entitled to expect that it will never be broken or cause any damage, but there is some level of safety that you are entitled to expect. The question is how high is that level when we talk about Self-Driving Vehicles? Surely, it should not be lower than the level of safety in a regular car. It should be at least as safe as a regular car. More precisely, it could be put in the following way:

“1. The automated car should statistically be safer than human drivers, or

2. The automated car should be safer than the best human driver.” (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014)

The first standard would just mean that the Self-Driving Vehicles statistically cause less accidents than the cars driven by humans. It is the minimum standard that could be accepted. The second standard means that the automated car is at least as good as the best human driver, and if the accidents however happens, the best human driver would not be able to avoid it either.

3.2 COMPUTER INTEGRATED SURGICAL SYSTEMS

New discoveries in the field of technology enabled surgical improvement and helped overcome the difficulties that are set in front of a human surgeon. The initial purpose of a robot in the field of medicine was to improve the quality and precision of surgical procedures. First appearance of the robot in surgery is related to the birth of the Minimal Invasive Surgery in the 80’s. Minimal Invasive Surgery is a procedure, where doctors use variety of techniques to operate with less damage to the body. Minimal Invasive Surgery helps in reducing the pain, shorten hospital stay and minimize the complications. It is done with one or more small incisions, using small tube, tiny cameras and surgical instruments.

The task of a surgical robot is to complement the actions of human surgeons and help them operate with precision, flexibility and control. Also it helps in minimizing mistakes, that are characteristic for humans, such as insufficient precision, tiredness etc. Moreover, it can provide an optimized interventional plan.

First, the statistical information and preoperative patient's specific information are gathered, and then it is applied to an actual patient. The procedure is carried out with an assistant of a robot, managed by a surgeon. Only one surgeon in an operating room is managing the robot, others in the operating room do not interact directly with a robot.

The advantages of a computer-integrated surgical systems are numerous. With the help of surgical robots, morbidity rate could be significantly reduced by eliminating human mistakes. The advantages are the following:

- Improve the precision and geometrical accuracy;
- Eliminate possible disturbance, such as hand tremor or tiredness;
- Improve surgical safety, preventing the surgeon to make a damage unintentionally;
- Allows less invasive procedures, while also providing the immediacy of an open surgery;
- Enhance clinical research thanks to a number of quality data collected and processed;
- Reduce the costs of clinical interventions, by reducing the healing time;
- Allowing performing operations in difficult circumstances or hostile environments.

Of course, some disadvantages need to be considered:

- The lack of haptic feedback; this kind of feedback is crucial for tissue identification, for instance distinguishing normal tissue from cancerous one. This downside is trying ro be overcome by installing sensors into the surgical instruments, that would help the surgeon to get a better feeling.

- The cost of initial purchase and maintenance, but also the costs of training the surgeons. (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014)

Surgical robots are currently used in diagnosis, therapy and surgery in different fields of medicine, such as neurosurgery, orthopedics, general laparoscopy, percutaneous, steerable catheters, radiosurgery, emergency response. As said before, surgical robots are linked with the development of Minimal Invasive Surgery. Traditional manual laparoscopic procedure has more than a few downsides. The laparoscopy allows just a two-dimensional vision from a conventional monitor, it permits a poor hand coordination, which decreases the dexterity of a surgeon. Moreover, the laparoscopic instruments are long and rigid, so if a hand tremor appears, in these cases it would just be amplified. In the laparoscopic procedures the workspace reachable with the instrument's tips is limited, since there are fixed abdominal entry points in the patient's body. The other problem is the instability of the camera, which makes it hard for a surgeon to concentrate. We should not ignore also the body position of the surgeon during the procedure, which is very uncomfortable. The robotic-assisted laparoscopictechnology is focused on overcoming these limitations.

Currently the most spread telemanipulator is the Da Vinci System. This system is composed of two units:

- the surgeon's console unit, that holds the display of the system, the user's interface and the electronic controller;
- four slave manipulators: three for tele manipulation of surgical tools and one equipped with an endoscopic camera (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014)

Figure 8, Da Vinci Surgical System, Source: https://www.tmfhc.org/care-treatment/surgery/da-vinci-robotic-surgical-system/

The downsides of the traditional laparoscopic procedures with the Da Vinci surgical system are significantly reduced. For instance, the Da Vinci system offers a surgeon a three-dimensional vision, the technology that connects directly the movement of the surgeon's hand with the movement of the instrument's tip inside the patient, which makes it much easier for a surgeon to have the whole picture of the procedure while he is performing. With the steadier tools tips, the potential hand tremor of the surgeon is also reduced.

The first studies on surgical robots were founded by the US Army, in a wish to develop a technology that would allow surgeons to operate wounded soldiers in the hostile environments from a distant and safe place. The idea was to move the wounded soldiers to a vehicle that has robotic surgical equipment, which can be operated remotely by a surgeon from a safe distant. This would also decrease the costs of

Figure 9, Da Vinci Surgical System-hands, Source: http://www.robotheadandnecksurgery.co.nz/da-vinci-surgical-technology-faq expensive trainings for the doctors that need to work in these kind of environments and also avoid the risk of these doctors to be wounded or even killed. This idea, however, was never realized (O'Sullivan et alia, 2018).

All this improvements in technology open also some other questions. Who is to blame in the situation where an artificial intelligence can make a decision by itself? Not knowing the answer to this question undermines patient trust, places doctors in unenviable position and it can also affect the future investments in this field.

Normally, in the case of a medical malpractice, all the members of the surgical team are responsible. The part of liability of each surgeon can be different, depending on that who made which decision and in that way harmed the patient's health. However, this institute would be hard to implement in the case of Surgical-integrated systems, since there is always just one doctor in the operating room who is performing the procedure and managing the system. The surgeon who controls the robot acts based on the privileged information, that other members do not have. Knowing that, it should be highly unfair to hold all the surgeons in the operating room jointly responsible, so the liability rules should be excluded for the surgeons who are not at the master console. Furthermore, the framework for the liability should not be strict liability, because the surgeon is acting jointly with an AI system, and all circumstances should be taken into consideration. It is more advisable to apply negligence standards that provide more elasticity (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014).

3.3 ROBOTIC PROSTHESES

Each year significant number of people suffer the loss of a limb. The effects that this loss has on the quality of their life is tremendous. It interferes with every sphere of their everyday life. Therefore, it is of a huge importance to find a solution for people in this hard situation. The biggest attention currently is directed onto providing a sense of touch for the people wearing prosthetic hand. It can be noticed that the progress is being made fast in this field. The new techniques allow devices to be more sensitive to the actions of the user. A team of engineers at the Johns Hopkins University has created an electronic skin, that layered on the top of a prosthetic hand brings back a real sense of touch. (https://techxplore.com/news/2018-06-e-dermis-pain-prosthetic.html). Another group of scientists has developed an electronic glove with sensors that could give robotic hand the ability to feel (https://techxplore.com/news/2018-11-electronic-glove-robots.html).

The prostheses is so much more than a pure technical object. Firstly, it is a body part, while it replaces part of the body and also a body-technique since it require learning and using of new body techniques (Jarrase et alia, 2015). It is used very often, in everyday life and in home, which is not that common for robots. Moreover, robots are usually managed by experts, however, prosthetic robots usually use people without any experience in this field. Finally, it is also visible to others.

The group of robotic prostheses includes prostheses, orthoses and exoskeletons. Although they all have differences, they can be grouped together under the name of hybrid bionic systems. Hybrid bionic systems are systems that have both technical (i.e. prostheses, orthoses or exoskeletons) and biological (i.e. human or animal) components. They include: 1) artificial systems with biological elements or subsystems, where the biological system is a complementary element to the technical system or 2) biological systems with artificial elements or subsystems, in which the artificial subsystem, is a complementary element to the biological system. (Micera et alia, 2006).

Hybrid bionic systems differ from each other on three levels: 1) level of hybridness, 2) level of augmentation and 3) level of invasiveness. The first level depends on the vicinity between the artificial device and human body. It can work separately from the body or it can be anatomically connected to the human body. The second level depends on the number of human capabilities enabled by this device. Finally, the third level is connected to the level of connection to the nervous system. For instance, prostheses can be controlled "by using signals recorded noninvasively (as the electromyographic (EMG) signal) or by implanting electrodes in order to interface invasively the CNS and PNS. At the same time, the robotic system can be tightly connected to the user (as an exoskeleton) or remote from her/him (as in teleoperation)" (Micera et alia, 2006: 1754)

However, as mentioned before, prostheses, orthoses and exoskeletons differ from each other. A prosthesis is defined as 'a device that physically replaces a missing body part, which may be lost due to physical injury, disease, or congenital conditions' (OED, 2014). An orthosis is 'a brace, splint, or other artificial external device serving to support the limbs or spine or to prevent or assist relative movement' (OED, 2014).

Figure 10, Fig. 10, Robotic Prosthesis, Source: https://biomech.media.mit.edu/portfolio_page/powered-ankle-foot-prostheses/

Figure 11, Robotic Orthosis, Source: https://www.pinterest.at/pin/91549804897690618/

Finally, the term exoskeleton is used in zoology as a hard outer layer that covers, supports, and protects the body of an animal. The purpose of a robotic exoskeleton is to augment, reinforce or restore human performance, working together with its user.

Figure 12, Exoskeleton, Source: https://www.nbcnews.com/mach/innovation/robotic-exoskeletons-are-changing-lives-surprising-ways-n722676

The problems that are arising from the implementation of the liability rules are that the robotic prostheses are used in the unrestrained environments and in the number of different activities, that cannot be foreseen. A real life example can help us to understand this better. Christian Kandlbauer, a first man in Europe who had his two arms replaced with a mind controlled bionic arms, died in a car crash, in a vehicle especially designed for his needs. The cause of the crash remained unclear, since it was hard to identify whether the accident occurred due to a malfunctioning of the prosthesis.(https://www.theguardian.com/world/2010/oct/22/christian-kandlbauer-arm-dies-crash)

It seems that the accidents connected with robotic prostheses is hard to put under the standard rules of liability. The Article 1 of the Defective Products Directive says: "The producer shall be liable for damage caused by a defect in his product." (Council Directive 85/374/EEC of 25 July 1985) This implies strict liability regime, where the existence of a damage is enough, and there is no mention of fault. However, the producer may be liberated by proving that the defect that caused the damage did not exist in the time of putting product into circulation, or it appeared after the product was put into circulation (Council Directive 85/374/EEC of 25 July 1985). This approach is criticized, while it excludes liability in those cases where it is harder to foresee the risks, and the risks with robotic prosthesis is significantly harder to foresee (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014).

Taking all this into consideration, if a robotic prosthesis cause any damage to the wearer or third party, the producer could be held strictly liable for the defectiveness of the product. The development risk could be opposed to state that the defect was undetectable even if the highest level of scientific and technical knowledge at the time when the product was put into circulation were applied. (Karanikić, 2006) However, this kind of litigation would be extremely complex, extremely expensive and it could also lead to different outcomes in different jurisdictions. Therefore, the producer could try to prevent the possibility to be held liable by limiting the way a prosthesis is used, delay the development of technologies to minimize potential unforeseen consequences or try to transfer the part of the costs to the resale price, and thus to the final user.

It is clear that none of these solutions goes in favor to the wearer of the prosthesis or the injured party. Since the robotic prostheses have such a great role in providing a better quality of life to people with disabilities, they require the adoption of a regulatory framework favorable to the development of robotic prostheses and maybe even including alternative liability criteria.

In order to support the research and development of new technologies, an exemption of the application of the current liability rules could be conceived. Moreover, alternative liability compensation schemes could be considered, such as a no-fault plan. Special found could be created, financed both by a producer (i.e. through a percentage in the resale price) and the wearer of the prosthesis (i.e. by paying a fee) that could provide sufficient compensation for the injured parties. The purpose of a no-fault plan is to compensate victims without having to establish causation and fault. Compensation would be available for all the parties, who suffered any kind of accident which involved the use of a prosthesis.

This no-fault scheme could significantly reduce the costs of litigation and eliminate any uncertainty of unforeseeable risks. Moreover, the producer could control the risk by determining a higher resale price to a product (for the amount that they would contribute to the fund. Also, the injured parties would get the compensation for the damage much easier and faster.

This kind of solution could bring more safety und certainty, and thus support the further development of the robotic prostheses, which would help the people with disabilities lead a much better and functional life.

3.4 CARE ROBOTS

The European Comission in the Strategic Implementation Plan of the European Innovation Partnership on Active and Healthy Ageing (2011) defined demographic aging as a “global trend”. It is assumed that in Europe the number of people aged 65+ will almost double over the next 50 years. (Strategic Implementation Plan For the European Innovation Partnership on Active and Healthy Aging Steering Group Working Document, 2011) To experience a long life is a privilege; however, it is also a challenge to find a way of taking care of older people. Care robots could help solving this problem. They could assist the elderly and disabled in everyday activities, as well as caregivers and family members. Care robots could bring them medications, remind them when to take which medication, measure the blood pressure, and so many other things.

The United Nations Economic Commission for Europe (UNECE) and International Federation of Robotics (IFR) engaged in working out a first service robot definition which has been absorbed by the current ISO Technical Committee 184 / Subcommittee 2, resulting in a novel ISO-Standard 8373 which had become effective in 2012. According to this definition, a service robot is “robot that performs useful tasks for humans or equipment excluding industrial automation application. Note: The classification of a robot into industrial robot or service robot is done according to its intended application”, and a personal service robot is “a robot that performs useful tasks for humans or equipment excluding industrial automation application. Note: The classification of a robot into industrial robot or service robot is done according to its intended application”.(https://www.ifr.org/service-robots/)

Care robots are just one part of the service robots and they can be defined as “robots designed for use in home, hospital, or other settings to assist in, support, or provide care for sick, disabled, young, elderly, or otherwise vulnerable persons” (Vallor, 2011: 252). In not so far past robots were able to perform just precise tasks, in defined environments, with a minimal interaction with human. The currently raising society challenges called for development of robots that would help human and interact with him in a variety of tasks. The environments that care robots would be able to perform could vary enormously, from hospitals or nursing homes, to the homes of the elderly or disabled. (Villarogna, 2017) The kind of support they could provide could also vary widely, like providing assistance in caregiving tasks, monitor the health or providing companionship. (Vallor, 2011)

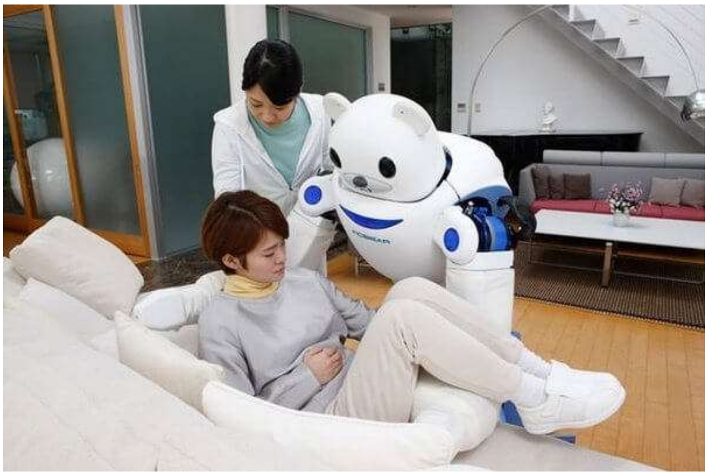

Figure 13, Care robot, Source: https://internetofbusiness.com/robots-japan-social-care/

The nature of a care robot develops a higher risk of making a mistake and hurting a human. However, in the case of malfunctioning it is impossible to attribute them liability in a relation to a harmful event. It is also hard to identify the person liable in such a situation, while the liability could fall on several different people, such as producer, programmer or the owner. This confusion could lead into uncertainty and present a big problem for the patient in need of the robot. The people that need services from a care robot are usually older people or people with disabilities, and such a stress would make their lives even more complicated, instead of making them feel better. Therefore, it is important to identify who would be responsible in the case of a malfunctioning of a robot.

a) The liability of a producer

A robot is composed of a software and hardware, which makes a distinction between responsibility of a producer and a programmer. This distinction is not important for the injured party. However, there is a difference, considering a fact that a user can be a programmer sometimes. (Zornoza et alia, 2017: 64) In the case when the producer is held liable the Directive 85/374/EEC would generally be applicable. The producer would be held liable for a defective product. The injured party would just have to prove the existence of a damage and that the damage is caused by a defect in the product, without having to prove the negligence or fault of a producer. This could lead to a limited ability to foresee and prevent damage. However, the law should not put elderly or disabled people in a situation where they would have to go through a long and stressful litigation. Instead, it should guarantee them a compensation.

b) Liability of a user

If a user should be held liable, sometimes his assets would not be enough for a full compensation. Therefore, creating of a fund for those that are harmed by the use of such products would be a good idea. Moreover, more data regarding risks of the robots would be collected and it help estimate future risks much easier.

4. CURRENT PRACTICE IN EUROPEAN CIVIL LAW RULES ON ROBOTICS

The Committee on Legal Affairs set up a working group in 2015. with the primary aim of drawing up "European" civil law rules in the area of legal and ethical issues raised by new technologies. The group delivered the "Report with recommendations to the Commission on Civil Law Rules on Robotics from the Committee on Legal Affairs of the European Parliament of January 27 2017".

Conventionally, damage caused by an autonomous robot is a consequence of a machine defect and therefore Council Directive 85/374/EEC of 25 July 1985 could be applied. In the paragraph AD of EP report the Directive cover the cases where the cause of the damage caused by a robot can be traced back to a specific human. That could be a manufacturer, operator, owner or the user. Moreover, it should be in cases when the human could have foreseen and avoided the mistake. (European Parliament resolution of 16 February 2017) In such cases, the mentioned parties would be held strictly liable. However, if the conditions needed for the application of Directive 85/374/EEC of 25 July 1985 are not met, the victim may find other responsible parties.

The EP report opposed strict liability and risk management approach and advised that an in-depth evaluation should be conducted by the Commission, in order to decide whether the strict liability or the risk management approach should be applied. (European Parliament resolution of 16 February 2017) Strict liability requires only the proof that the damage occurred, and the causal link between the harmful event and the damaged caused to an injured party. On the other hand, the risk management approach does not held individually liable a person who acted negligently, but it focuses on a person that could under certain circumstances, minimize risks and deal with negative effects.

The regime of strict liability or negligence is linked too much with the human behavior, and the autonomy of a robot is purely technical, which makes them take decisions based on algorithms. However, the strict liability or negligence regime can be applied to the user of a robot. (Van Rossum, 2017-18) The EP Report suggests a solution how to assess the liability of each party involved in dealing with a robot. It says that "liability should be proportional to the actual level of instructions given to the robot and of its degree of autonomy, so that the greater a robot's learning capability or autonomy, and the longer a robot's training, the greater the responsibility of its trainer should be". (European Parliament resolution of 16 February 2017) Moreover, this Article makes the difference between skills learned through a training and skills that a robot learned by itself, with its self-learning abilities. It also says that at the present stage the responsible party must be human, not robot. We can conclude several things from this Article:

- The sole responsibility of a robot is still impossible, there must be a person behind it, who could be held liable. However, we can also make a conclusion that the possibility of having a robot liable for his acts is not completely discarded, since it is said: “at least *at the present stage* the responsibility must lie with a human and not a robot”.

- If a robot has an open source software, the person who should be held liable is the person who programmed the application, which led to the robot causing damage.
- There is a difference between skills learned through a training and skills that robot developed using his self-learning abilities. The person who trained the robot cannot be held liable for something that a robot did by using his self-learning abilities.
- If a robot cause any damage while still learning, its owner or user should be held liable.
- If a damage is a consequence of a defect in design, the designer or producer should be held liable.

4.1 INSURANCE FUND

One of the possible solutions is to create a fund that would be financed by many different sources, from which the damages made by a robot would be covered. The EP Report suggests an obligatory insurance scheme as a possible solution, as it is already case with cars. However, the insurance for road traffic covers only human acts and failiures, and the insurance system for robotics should take into account. (European Parliament resolution of 16 February 2017) This solution would cover every gap in liability, it would also eliminate the costs and duration of long and expensive litigations. It would no longer be necessary to prove the requirements needed to establish liability. Moreover, it would bring certainty and safety in the human interactions with a robot, which would lead to faster development of technology.

The paragraph 59 c) points out that that a person who contributes to a compensation fund can benefit from limited liability. Therefore, it can be concluded that this article supports the creation of a fund, and any person contributing to a fund would be rewarded.

The question stays wheather there should be one general fund for all smart autonomous robots, or wheather there should be an individual fund for each robot catagory. However, it is suggested to make a specific Register of all the robots, which would be assigned with an individual registration number. That way, anyone could see characteristics of a robot, nature of a fund, limits of its liability etc. (European Parliament resolution of 16 February 2017)

4.2 GIVING A LEGAL PERSONHOOD TO ROBOTS

The most innovative alternative is suggested by Article 59 - giving a legal personhood to robots. It says that “at least the most sophisticated autonomous robots could be established as having the status of electronic persons responsible for making good any damage they may cause, and possibly applying electronic personality to cases where robots make autonomous decisions or otherwise interact with third parties independently”. It would mean that robots would have assets from which the compensation could be paid. This theory is strongly criticized, since this recognition of personhood would mainly serve as a liability capping method (Bertolini, 2013). If a robot cannot have some income by itself, then it means that a human, or a corporation should stand behind him and bear the consequences of his acts. Therefore, it does not make any sense to grant a robot a legal personhood if in the end the person, who would bear the burden, would be human. (Bertolini, 2013) Moreover, if we assign duties to a robot, we should also provide it with rights. The question is which rights would that be? This would also raise many ethical questions and call into question Europe’s humanist foundations. By doing so the humankind would likely be demoted to the rank of a machine. (Directorate-General for Internal Policies , 2016) Therefore, the idea of assigning a legal personality to a machine is completely inappropriate.

4.3 SUMMARY

The Committee on Legal Affairs set up a working group in 2015. with the aim of drawing up “European” civil law rules in the area of robotics. The group delivered the “Report with recommendations to the Commission on Civil Law Rules on Robotics from the Committee on Legal Affairs of the European Parliament of January 27 2017”.

Firstly, it is stated that the Council Directive 85/374/EEC of 25 July 1985 is applied always when a damage occurs, which is a consequence of a machine defect, and it can be traced to a specific human. Further on, if the conditions needed for the application of Directive are not met, other responsible parties should be found. There is suggestion for the European Commission to evaluate strict liability regime and risk management approach. The important difference is that the risk management approach does not hold individually liable a person who acted negligently, but also takes into account a person that would be able to minimize the risk and deal with negative effects.

The Report makes a difference between skills that a robot learned from a programmer, and skills that robot learned by itself, and suggests that the liability should be proportional to the level of the given instructions to a robot. Moreover, it can be concluded from the Report that the sole responsibility of a robot is not possible at the moment.

Another solution is to create a compensation fund, which different parties would participate in, such as producer, user or owner. Moreover, if they contribute to a fund, they would benefit from limited liability.

Finally, the most controversial solution is to grant a legal personhood to robots. It is suggested that at least the most sophisticated ones should have a status of electronic persons. However, this suggestion is strongly criticized. The robots are clearly not advanced enough to be capable of having a legal personhood. Also, if a robot is granted by duties, it should be granted also rights, which would then make them equal to humans. This situation would then raise many new questions and problems. Therefore, a solution should be found without creating a new type of personhood.

5. INFLUENCE OF LAW REGULATION ON ROBOTICS

The law regulation in the field of technology influence innovation to a large degree. Liability rules play a big role in the decision making process of a manufacturer, when he produces certain products. If the risks of liability are too high it could make the manufacturer wait with the releasing of a product, which can make a chilling effect on development of new technology. This is certainly not desirable. However, if the field of robotics is not well regulated, it would bring uncertainty, both to the manufacturer and the user. On the other hand, controlling a technology in the early stages is hard, because not everything is known and investigated, but also, the ex post intervention, when the technology is well developed, is far more expensive than in early stages. Therefore, at least some ground rules should be set in the early stages, to serve as a principle. (Leenes et alia, 2017)

In order to understand the problem more clearly, we should look at the following example. In the case of fully automated cars the risk of the liability is completely transferred to a manufacturer. The driver is just a mere passenger in the car, with no obligation to act. Therefore, if an accident occurs, it is very unlikely that the driver could be held liable. In such cases the reason of an accident is usually the malfunctioning of the machine, so all the responsibility falls onto manufacturer. In the case of a partially automated car, the human driver has the final responsibility. However, it is not the same as driving a regular car. When driving a non-automated car, the human driver is involved in driving the whole time, and he is not counting that a machine will do something instead of him. Driving a partially automated car, however, makes a driver more relaxed, and not well prepared to react in every dangerous situation. Therefore, the risk of a manufacturer's liability is again higher than in the cases of regular cars.

Car manufacturers are well aware of these risks. These risks make them delay the introduction of automated technologies, trying to make them at least a little bit safer. This delay is not always a bad thing, as long as it does not turn into stagnation of innovation. (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014)

5.1 IMPLEMENTING A SOFT LAW APPROACH

One of the important questions is should the regulatory dilemmas be resolved with a strong framework of rights and values or a soft law approach should be used. Soft law appears first time in international law in the mid-seventies of the 20^{th} century, and reaches its full expansion in the last decade of the 20^{th} century with the adoption of the Principles of European Contract Law in the 1995. and the UNIDROIT Principles for international trade agreements in the year of 1994. Although soft law sources exist and are applied in international relations, it remains controversial what is legal in their content, which can determine them as a source of law. (Đurđev, 2013) Soft law norms come in a form of recommendations and opinions, and have a non-binding character, which makes them different from hard law. Although soft law has a non-binding character, it is brought in good faith and belief that the non-binding rules will be respected. They are brought with the expectation that, through a national legislation, they will get a binding character and that they will serve as the basis for the emergence of domestic legal rules. Warnings, recommendations, expectations are all pressure instruments that affect the application of soft law in national law. Hence, in the legal theory, it is talked about strengthening the law by transferring soft law from international to national level, when soft law becomes part of hard law. (Đurđev, 2013)

The difference between hard and soft law could be easily explained as the lack of at least one component of legal norm. (Terpan, 2015) The legal norm has three main components: obligation, precision and delegation. (Abott et alia, 2000) Obligation means that the norm requires to act in a certain way. Precision means that the rules unambiguously describe the behavior they require, and the delegation refers to the granting of authority to third parties in order to implement these rules. If any of these components are missing, a norm cannot be considered as a hard law.

The character of the soft law and its flexibility makes it easier to capture the constantly changing technology, which is often a result of a cooperation of research teams from different jurisdictions. (Leenes et alia, 2017) For better understanding, the advantages and disadvantages of implementing a soft law in the field of technological innovation are shown in the table below.

ADVANTAGES AND DISADVANTAGES OF IMPLEMENTING A SOFT LAW	
Advantages	Disadvantages
• The flexibility to adapt to the dynamics in technology development; • The recommendations and standards ensure the continuous adaptation of rules, without the need for statutory intervention; • The norms can be adopted on a voluntary basis in the member states; • They help building the legal environment for robotic technologies;	• Too general character of soft law norms could not cover all the aspects of technological innovation in detailed; • The harmonization depends on a voluntary compliance, which makes the whole system uncertain; • The involvement of more stakeholders makes the process much more complicated and favors the needs of the more powerful ones;

• They involve more stakeholders in the decision making process.	• Implementing soft law norms undermines procedural values, such as due process, accountability and transparency.

Table 4, *Advantages and disadvantages of soft law implementation, Source: Ronald Leenes et alia, „Regulatory challenges of robotics: some guidelines for addressing legal and ethical issues", Law, Innovation and Technology, 2017*

Using a soft law approach on technological innovation helps to adapt on an extremely fast technological development. It also helps in slowly building the desirable environment for robotic development, with giving the guidelines for responsible development. The interests of the large number of stakeholders can be taken into account, than when implementing a hard law. It is also easier to implement the norms of soft law, since its implementation is on voluntary basis.

However, there are also downsides that need to be taken into consideration. The general character of the norms may not be sufficient for covering all the aspects of robotic development. Since the harmonization depend on voluntary basis, it is always a risk whether the rules will be implemented or not. Moreover, involving independent agencies, international organizations and other non-state actors can lead to lack of accountability and effectiveness. Also, the interests of more powerful stakeholder could be put in front of the interests of the less powerful ones. (Leenes et alia, 2017) Although a soft law has the potential to address the need for transnational and flexible solutions, it cannot be used alone, without a strong framework of rights and values.

5.2 IMPLEMENTING A STRONG FRAMEWORK OF RIGHTS AND VALUES

A strong legal framework is certainly more reliable, and people find much more certainty in it. However, it also has some down sides. The advantages and disadvantages of implementing a of strong framework of rights and values are shown in the table below.

ADVANTAGES AND DISADVANTAGES OF IMPLEMENTING A STRONG FRAMEWORK OF RIGHTS AND VALUES	
Advantages	Disadvantages
• The strong rules could ensure the higher level of safety in innovations; • They can determine more precisely the limits in the use of technology; • It could encourage innovation with implementing the rules that favor the technological development; • It brings more certainty to the legal system.	• It is not easily adapt to the fast changing character of technological innovation; • Strong framework could have a chilling effect on technology; • It is expensive to implement new norms with every progress in the field of technology;

Table 5, Advantages and disadvantages of implementing a strong framework of rights and values, Source: Ronald Leenes et alia, „Regulatory challenges of robotics: some guidelines for addressing legal and ethical issues“, Law, Innovation and Technology, 2017

A strong legal framework definitely brings more certainty to legal system, both for innovators and customers. People will not be eager to use new technology if they are not sure who will be responsible in the case of malfunctioning. Therefore, a strong framework would eliminate that problem. Moreover, it would bring more certainty also for the developer of new technologies and encourage him to continue with his research. This is especially important in the field of robotic surgery and robotic prostheses, since these products help people with disabilities have a better quality of life and give them new possibilities. Therefore, the constant innovation and progress is of a great importance.

However, the technology is changing constantly and the legal framework should be able to follow this progress. When the technology is well developed, it is too expensive to intervene. The implementation of new rules takes a lot of time and it can certainly not follow fast developments in technology. These strong rules, can also have a chilling effect on innovators, if they feel too limited with the rules. For instance, it is expected that a self-driving vehicle is safer than a regular car. But what is the safety level that is good enough? Does it mean that it just needs to be safer than a regular car, or should it be safer than the best human driver. If the latter is expected, then we would definitely get a chilling effect on technology. The manufacturer would delay the introduction of automated cars until they are certain that they are safer than a best human driver. This delay would prevent all the population in moving forward. (RoboLaw Project, Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics, 2014)

5.3 SUMMARY

Law regulation can influence technology in a number of ways. Therefore, it is important to find a way to implement regulation, but still leave the space for technology to keep advancing. The manufacturer would not risk with releasing a product if the liability risks are too high. This can make a chilling effect on the technology, which is definitely not recommended. However, regulation technology in its early stages can be very difficult, since not a lot is known, but the later intervention, when the technology is already developed is also very expensive.

One of the dilemmas is whether a soft law approach or a strong framework of rights and values should be implemented. A soft law approach is easily adaptable, which is very convenient for the extremely fast developing field of robotics. It is voluntary based, so it helps in slowly building the desirable environment for robotic development, with giving the guidelines for responsible development. However, these same advantages could also be downsides. The soft law norms are too general, and there is not guarantee that the norms will be implemented.

On the other hand, strong framework brings much more certainty into legal system. It can encourage the developers to continue with their research, by making them feel safe. On the other hand, the strong rules can also make innovators feel limited and restricted, which can lead to a chilling effect on the technology. A strong legal framework is hard to change, and the field of robotics is constantly changing, making it hard for the legal system to catch up.

The technology development should definitely go hand in hand with adequate legal framework. This framework should be ready for fast adjustment with the progress of technology. It should also bring legal certainty, both for innovators and users of the technology. However, it should not make a chilling effect on the technology, yet it should develop standards that would encourage the progress.

6. CASE STUDIES

In the following chapters three different case studies about the application of autonomous mobile robots will be presented and discussed.

6.1 SIASUN DUCO COBOT SCR5

Siasun SCR5 collaborative robot is the first domestic robot with 7 degree-of-freedom with rapid configuration, traction teaching, visual guidance and collision detection. It is able to perform tasks with a high level of flexibility, precision and safety, which makes him suitable to conduct precision assembly, product packaging, polishing, testing, machine loading and unloading and other industrial operations. It has the ability to detect collision, avoid obstacles easiliy. Moreover, it is easily programed, convenient to disassembly and has an optional visual guidance system.

Figure 14, SIASUN Duco Cobot SCR5, Source: http://www.siasun-in.com/plus/view.php?aid=289

One of the implementation of the Siasun SCR5 is at Chinese automotive manufacturer CSVW, where a robot is in charge of tightening the screws of automobile engine assembly line, while a worker performs other tasks on the engine. While performing a task, the robot holds the tightening gun to tighten 5 screws of 2 types and then it can change the tightening gun automatically by equipping a changing gun plate at the end. In the meantime, the operator completes the operation of lubricating and other parts assembling. In the automotive industry, the processes of pressing, welding, painting and final assembly are alreday highly automated. However, the engine and final assembly plants are unable to use traditional automation because of the complex and flexible assembly processes of the engine and the whole vehicle and the compact workspace, but because of its unique characteristics collaborative robots can help automobile manufacturers to achieve that goal.

As said before, this robot is able to detect collision, so there is no need of installing protective fencing. Moreover, it is light weighted, so it is more flexible and it can adapt easily. Finally, it can be programed by manual dragging, which helps in reducing the time of instructions.

The execution of the task is as following:

1. After the engine is in place, the signal is given to the robot. Then, the robot holds 1 tightening gun to complete the tightening task of 3 screws on the engine. The tightening torque is controlled by tightening gun.
2. The robot puts down the first gun and takes the second gun to tighten the other two screws.
3. The cooperative robot and the on-site workers share the same workspace, while the screws are being tightened. The on-site workers install the back oil seal to the cylinder block and then pre-tight 8 bolts combined with oil seal and cylinder block.
4. The robot after that puts down the tightening gun and returns to the beginning position.
5. After the robot finishes the task and is in place, the completed signal is given to the work station,and the production line is released into the next process. (https://ifr.org/case-studies/collaborative-robots/siasun-collaborative-robot-helps-the-automobile-industry-to-chan)

The robot and the human worker are working closely together in this process. As much as the robots precise are, it cannot be expected that no accident will ever happen. This kind of close collaboration raises number of ethical and legal questions. Who would be responsible for the malfunctioning of the robot? Who would be responsible for the mistake made by a robot? What would happen if the worker gets hurt by a robot? Should a robot be treated as a coworker, since it is doing part of the job? In order to keep the technology developing, it is important to find the answers to this questions, either in the current legal framework, or new legal categories should be created.

6.2 PEPPER ROBOT

Pepper robot, developed by SoftBank Robotics, is the world's first social humanoid robot, who is able to recognize faces and basic human emotions, but also can act accordingly. Pepper is designed for interaction with humans, and is able to make a conversation. Its characteristics include 20 degrees of freedom for movements, speech recognition of 15 different languages. It can recognize and interact with the person talking to him. It possess touch sensors, LEDs, microphones, infrared sensors, bumpers, an inertial unit, 2D and 3D cameras, and sonars.

Pepper can be used for all sort of applications. It is able to welcome and assist customers when they first visit something. It offers a really outstanding customer experience, providing them an unusual entertainment. It can guide towards locations, services or products, and help people find things they were searching for. In this way, it is possible to attract more customers, or at least keep their attention and make them listen a little bit longer about the services and products that are being offered.

Pepper is able to offer recommendations about products and services, based on the data it has about them, but also based on the customer data, such as age, gender or mood, that it is able to refine.

Thanks to its sensors, it is able to detect when someone is looking at it, and then it can start a conversation. Moreover, it can adapt its voice and its body language to the conversation. Its ability to express itself in many different languages just improves the quality of the services that it is providing. Also, it has a tablet attached to its body, which is helping during the communication.

Figure 15, Pepper robot, Source: https://www.generationrobots.com/en/402912-pepper-follow-me-application-1-robot-perpetual-license.html

It can work without internet connection. However, its ability to recognize changes in voice and emotional changes is improved when connected to the internet.

Pepper’s task is to to make people happy and entertained, enhance their lives, facilitate relationships, have fun with people and connect people with the outside world. It is intended that independent developers create new content and uses for Pepper.

Looking at all its functions, it can easily be concluded that nowadays there is a very thin line between humans and robots. We can only imagine what could come in the future.

6.3 ASIMO

ASIMO, a humanoid robot developed by Honda in 2000, stands for Advanced Step in Innovative Mobility. The main concept was to create a robot that could be more mobile and that could help and interact with humans in their daily tasks. In order to operate in everyday tasks, it should be able to move as humans do, so two-legged robot was optimal. With its currently 57 degrees of freedom, it is able to move and perform all sort of different tasks. It has multiple sensors that are equivalent to visual auditory, and tactile senses of a human being. These sensors help them estimate surroundings and adapt more easily to the environment. It is able to respond to the movement of other people and the surrounding. Therefore, ASIMO can stop its current action in order to change its behavior and focus its attention on the current situation. Moreover, it is capable of recognizing voices of different people, which is even hard for a human.

Figure 16, ASIMO robot, Source: https://twitter.com/asimo

Due to his strengthened legs, wide range of leg movement and newly developed control technology, ASIMO is able to change landing positions in the middle of the motion. It is also able to walk over uneven surfaces and still maintain stable position. Based on information from pre-set space sensors, it is capable to predict the direction a person will walk in the next few second and act accordingly.

With its multi-fingered hand and object recognition technology, ASIMO can also make sign language expressions, pick up a glass bottle and open it or hold a paper cup without squishing it.

ASIMO has a height of 130cm and 50kg. It is considered that the ideal height for a mobility assistant robot would be around 120 cm and the height of an average adult.

6.4 SUMMARY

These case studies showed autonomous mobile robots, which are being used in different kind of areas, but always in collaboration with humans. They are working hand to hand with them, communicating, giving recommendations, participating in their everyday life. Some of them are working at the productions lines, in the same workspace as humans, some are participating in our decision making processes and helping us get information needed, and some of them even have humanoid shape. So question is what makes them different from humans? Will they make same mistakes as humans do? If yes, how often, and would they be tolerated, who would take the blame in that case?

However, these developments raise also some ethical questions, such as can human be attached to these robots, is it acceptable that people start communicating with robots and accept their recommendations and advices? Would they relay too much on them? In addition, what if something happens to a robot in this situation, how would a human react?

If there was not a need for these kind of technologies in our lives, these robots would certainly never be developed. Therefore, if there is a need for them, we need to find solutions to make them part of our lives, without jeopardizing anyone involved.

7. SUMMARY AND OUTLOOK

As seen in the paper, robotic is the most innovative field in the last couple of decades. It is hard to keep up with all the advancement that is happening, and especially it is difficult for the stiff law regulations to follow the fast progress of technology. It is clear that current legal framework will not be enough and that definitely new legal forms should be considered in order to bring safety in the robotic field and support further development of technology.

The application of robots are numerous, and they interfere with humans daily. In the paper different field of robotic application was discussed, such as, self-driving vehicles, computer integrated surgical systems, robotic prostheses and care robots. All these fields have their own specific characteristics and different circumstances need to be taken into considerations when it comes to liability.

For instance, when it comes to self-driving vehicles, it is recommended to separate compensation function from prevention function of liability. Hence, victims would be compensated by insurers and insurers would decide whether to claim product liability based on the assessment of all given circumstances. It is very important to reduce the chilling effect on technology and support further development in this field.

On the other hand, when it comes to computer integrated surgical systems, situation is much more complicated. Professionals, who need to be trained for the use of a robot, are using surgical robots. Besides that, these robots are used on patients, whose lives depend on their every movement. Therefore, strict liability regime would be certainly unfair in this situation. It is recommended that negligence rule should be adopted. By doing that, judge would be obligated to asses every circumstance that led to the damage. Moreover, liability should be excluded for the surgeons who are participating in the operation, but not using the master console. Due to a specific design of computer integrated surgical system, only one person can direct the robot. Therefore, it would be unfair that the other participants of the surgery take responsibility, since they were not part of the decision making process.

Robotic prostheses are relatively specific case. They become part of the human and are being used in very different ways and environments, which a producer can certainly not predict. Product liability rules are definitely not completely applicable, since the producer would be put in an impossible situation to predict ahead all possible situations in which a prosthesis could be used. The development of the robotic prostheses is most certainly supported, since it plays an important role in lives of the people that are disabled. Therefore, a strict liability regime would just slow the progress in this field, which is certainly needed. In order to support innovation, an exemption from the application of existing liability may be considered, without lowering the level of safety of such devices. To ensure compensation to injured parties, different alternatives could be considered, such as a no-fault plan. A no-fault plan requires creation of a fund, partially publicly and partially privately financed, from which injured parties could be compensated. This could assure the fast compensation to injured parties, and lower administrative costs, which would all help further research in the field of robotic prostheses.

In the case of care robots, the Directive 85/374/CE on product liability should generally be applicable. In the cases of damage that can be attributed to users, a first party insurance could be considered.

The certainly most controversial solution was suggested in the European Report on civil law rules on robotics, which suggests assigning a status of electronic person at least to the most sophisticated robots. This suggestion was strongly criticized, since it would delete any boundary between men and robots. By assigning them duties, they would need to get some rights, and what rights would that be? Could a robot refuse to do something that he was designed to do? Could a robot also sue a human if a human harms it in some extent? No producer would want to develop a robot who could end up suing him eventually. Moreover, from which fund would injured parties be compensated if a robot would have a legal personhood? In the end the responsibility would fall back on human, because a robot is not capable of earning money by itself.

It is evident, that in the basis of all these recommended solutions stands the need to support further technological development and leave space for the innovators to be creative. If the developers of new technologies become too restricted by law regulations, we would not be able to continue finding new technological solutions in the same speed as before, and some of these solutions could even save our lives.

There is always a question should a field as specific as robotic be regulated by using mild soft law approach or it requires strong legal framework. If using a soft approach it is not guaranteed that it will be implemented by every country, but it helps in slowly developing a desired legal framework. Since it is not obligatory, people accept it easier and with a certain period of time begin to get used to the regulations given. Moreover, it is easily adaptable to every future change.

On the other side, strong legal framework deals with the problems immediately and implement the regulations quickly. It brings more certainty into a legal system, which has both its up and downsides. The developer of the new technology would feel safe with a strong legal system, because he would know what to expect from it, but also could feel tied with the rules and would not try to get out of the framework that is given. But what do we have if we always follow the rules and never take risks? Certainly not any kind of improvement.

For instance, the discovery of Minimal Invasive Surgery changed the path of surgery completely. First type of minimal invasive surgery was laparoscopic surgery, which allowed surgeons to perform a surgery with minimal incisions and far less complications. Another, newer, type of a minimal invasive surgery is robotic surgery, which provides a magnified, 3-D view of the surgical site and helps the surgeon operate with precision, flexibility and control. Minimal invasive surgery causes less pain, it requires shorter hospital stay and of course, is associated with a fewer risks. These characteristic make surgery available for a wide range of people, who would usually, not be suitable for the regular, old-fashioned surgery, due to their conditions.

Moreover, in the earlier times people with disabilities could never imagine that one day they would be able to walk, run, work, and even feel as nothing has happened to them. The possibility that was given to them is something that we should all strive for. That is something that we should bare in our minds when thinking of finding new legal solutions for the field of technology. Whatever the new solutions may be, they should always support further development of technology.

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