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REGULATION ON SAFETY AND CIVIL LIABILITY OF INTELLIGENT AUTONOMOUS ROBOTS: THE CASE OF SMART CARS.

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ABSTRACT

Nowadays science and technology offer us artificial intelligence (AI) “embodied” in robots. They are able to self-learn, self-organize and self-reproduce, thanks to genetic algorithms, artificial neural networks and other tools. The focus of this research includes results from the diffusion of a social phenomenon consisting in the application of robots in the most disparate realities (industrial and domestic). Robotics is the AI branch whose aim is to build machines that are able “to feel, to think and to act”. A robot is a complex system that integrates many AI results: such as vision, natural language, study of the movement, communication, machine learning, and knowledge representation and planning. Robotics presents a fascinating and unexpected scenario. Everything we have seen until now - cars, computers, mobile phones and internet - is an AI product and robots in a near future will be used in factories, in yards, in offices, and they will work as nurses in hospitals and in households. The development of robots raises new ethical, legal and social issues, such as the allocation of civil liability when a robot harms a human being. If software agents can process and take decisions autonomously who will be held liable in case of harmful consequences of these decisions? The manufacturer, the programmer, the owner, or other subjects? The answer requires an analysis on both *ex ante* and *ex post* tortious event.

* * *

Aujourd’hui science et technologie nous offrent l’intelligence artificielle (AI) «incarnés» dans les robots. Ils sont capables d’apprendre, de s’organiser et de se reproduire, grâce à des algorithmes génétiques, réseaux de neurones artificiels et d’autres outils. L’objectif de cette recherche comprend les résultats de la diffusion d’un phénomène social consistant dans l’application de robots dans les réalités les plus divers (domestiques et industriels). Robotique est le secteur du AI dont le but est de construire des machines qui sont en mesure de «sentir, penser et agir». Un robot est un système complexe qui intègre de nombreux résultats du AI: tels que la vision, la langue naturelle, l’étude du mouvement, la communication, l’apprentissage machine, et la représentation de la connaissance et de la planification. Robotique présente un scénario fascinant et inattendu. Tout ce que nous avons vu jusqu’à présent - les voitures, les ordinateurs, les téléphones mobiles et Internet - est un produit du AI et les robots dans un proche avenir seront utilisés dans les usines, les gares, les bureaux et ils vont travailler comme infirmières dans les hôpitaux et dans les ménages. Le développement de robots soulève de nouvelles questions éthiques, juridiques et sociales, telles que l’attribution de la responsabilité civile quand un robot nuit un être humain. Si des agents logiciels peuvent traiter et prendre des décisions de manière autonome qui sera tenu responsable en cas de conséquences néfastes de ces décisions? Le fabricant, le programmateur, le propriétaire, ou d’autres sujets? La réponse exige une analyse relative *ex ante* et *ex post* le fait générateur.

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CHAPTER I
AUTOMATION AND CIVIL LIABILITY: A LAW & TECHNOLOGY APPROACH.

1. Introduction.

Nowadays a new product of science and technology is artificial intelligence (AI). It is «embodied» in robots[1]. Robots are able to self-learn, self-organize and self-reproduce, thanks to genetic algorithms, artificial neural networks and other tools. The focus of this research includes results from the diffusion of a social phenomenon consisting in the employment of robots in the most disparate realities (industrial and domestic).

Robotics is the AI branch that aims to build machines able «to feel, to think and to act». A robot is a complex system that integrates many AI technology results such as vision, natural language, study of the movement, communication, machine learning, and knowledge representation and planning. Robotics presents a fascinating and unexpected scenario. To a closer look, everything we have seen until now - cars, computers, mobile phones and internet - is at least in part - an AI product. Robots in a very near future will be used everywhere, and they will take care of humans in hospitals and households.

The development of robots raises new ethical, legal and social issues, such as the allocation of civil liability when a robot harms a human being. If software agents can process and make decisions autonomously who will be held liable in case of harmful consequences of these decisions? The manufacturer, the programmer, the owner, or other subjects?

Three levels of automation – automated, semiautonomous and fully autonomous - will be considered for evaluating the technological impact on legal categories of the different degrees of autonomy possessed by robots. This new technologies have a tech-scientific uncertainty which requires a study analysing two time points, *ex ante* and *ex*

[1] CALO R., *Robots and Privacy*, Robot Ethics: The Ethical and Social Implications of Robotics, LIN P., BEKEY G., ABNEY K. (eds.), Cambridge. MIT Press, 2010.

post tortious event. This approach aims to ensure both consumer safety and technological innovation. Safety regulation and civil liability are interrelated because their balance enables to find a suitable proposal to regulate robots in order to protect consumers against derived risks.

Let me start by saying that automated, semi and fully autonomous categorization is specifically restrictive compared to the one carried out by American Agencies. This reduction aims to simplify the complex technology realities.

AUTOMATED ROBOTS are programmed for responding to a set projects built by their manufacturer or designer. These latter constructs a sort of parallel environment in a robot's brain that may be consider a minimal representation of reality. Simple examples of automated tools are elevators or automatic gates are automated tools. They are mere objects/products/goods. They are efficiently regulated with regards to both civil liability and safety current regulation because they do not pose particular problems to these conventional legal notions.

The diverse levels of intelligence imply a categorization of robots, such as SEMIAUTONOMOUS ROBOTS - those that still require human intervention to work in an environment - and FULLY AUTONOMOUS ROBOTS.

The first type is autonomous in the sense that it has motor skills that do not require human intervention. It still has a limited degree of intelligence which does not enable a higher decision-making comparable with the human one. The second type possesses this higher decision making skills and human intervention is not required for their functioning. Some semiautonomous robots are already available on the market or still undergoing testing, such as shuttles without drivers, robot-assistants, cars and self-driving industrial vehicles.

Semiautonomous systems present several questions related, for instance, to the verification of liability in case of malfunctioning. They were created with the collaboration of several subjects, whose roles are different but complementary. In these cases it is important to understand if the liability has to be allocated on people building the background knowledge, or on people who designed the inferential engine, or on the final user, or on the functioning system. Semiautonomous robot is also the hybrid liability system characterized by the coexistence between human and electronic components (i.e. semiautonomous cars).

In general, these new technological innovations give rise to the issues of creation and management. They are able to move, react to certain circumstances and reprogram themselves for responding to certain stimuli and solving certain situations. These new abilities generate uncertainty about the application of the traditional categories.

The aim of the present research is to verify the impact of technology on the traditional categories of law (limiting however the field to the used remedies). The study assesses if these categories can be used to regulate the robot's activities and whether they are suitable or not. Finally, we try to propose legal solutions that may play an important role before the introduction and wide diffusion of such devices on the market.

In this regard, the impact of this technology on traditional legal concepts may be investigated in order to evaluate the dichotomy of solutions and concepts elaborated by the Anglo-American and the Continental European systems - in particular by Italy and France -. A comparison with other legal orders - that adopt other legislative and regulatory solutions about this issue - may be proven helpful. In fact, the comparison can determine the exact limits of automated artefacts. Then, it allows the management of the issues related to the safety rules suitable for these intelligent systems, along a spectrum that considers both the regulation *ex ante* and the rules of liability *ex post* that will be applied to these devices.

Robotic research is, indeed, a continuously evolving field and technological solutions may have an impact on the legal field. Such solutions can affect not only the contents and the proportions of the traditional categories (of the private sector in this case), but can also offer legal-friendly tools to solve specific legal issues raised by the introduction of these devises in the everyday life.

Apart from the above-mentioned purposes, this research comes within the framework of the relationship between Law and Technology. This relation represents the *fil rouge* of this work given that: «esiste una relazione simbiotica tra il diritto e le attività umane che, sfruttando le acquisizioni della scienza, creano nuovi mezzi, strumenti, congegni, apparati atti a migliorare le condizioni di vita dell'uomo».[2]

[2] RODOTA' S., *Tecnologie e diritti*, Bologna, 1995. A. says that a symbiotic relationship exists between the right and the human activities that, exploiting the acquisitions of the science, create new means, tools, devices, fit apparatuses to improve the conditions of life of the man.

1.1. Overview of chapters.

The research starts with a general draft of the reasons which led to begin an analysis on robots and law implications within the LAW&TECH studies.

The chapters are summarized (The work is structured) as follows:

a) Chapter II examines the main fields of application of autonomous robots, from a technological point of view. The chapter is structured into two *sub-chapters* which provide some basic notions that will be helpful for the further development of the work.

This chapter studies robotics. *Sub-chapter I* will be carried out with the aim of gauging the full scale of the problem leading to legal assessment. *Sub-chapter II* carries out a short history of autonomous vehicles (AV), needed to understand how technology and law influence each other. The development of robot cars is supported by the following arguments: efficiency, safety, comfort, mobility and accessibly which are the substrates to its development.

b) Chapter III presents an overview on safety regulation of intelligent autonomous systems. This chapter analyses the existing safety regulation. In particular it studies the suitability of this regulation for autonomous robots. Advanced technological products whose safety is not adequately guaranteed could violate consumers' health. Therefore, we are going to explore the safety regulation on robots in general and safety regulation on autonomous vehicles specifically. This research brings us to an important aspect related to LAW&TECH: the interaction between regulation on safety and civil liability, in terms of the compliance with the former, could or could not lead to the exemption of civil liability.

The safety regulation is already significant with regard to robot building. The attention is focused on human-robot relationships that will help designers to developed interfaces ensuring a safe approach by humans. Higher attention paid to robot safety could reduce the tortious events.

c) Chapter IV focuses on the civil liability on intelligent autonomous systems. This chapter is split into two *sub-chapters*: the first analyses general issues raised by robotics, while in the second it is attempted a more detailed analysis of the conventional categories of civil liability.

This chapter studies some issues related to robots, in particular scientific evidence, insurance and compensation found and the right to be informed. It follows at first a structural method, and then a functional approach will be developed in order to find a possible solution could solve the seeming normative vacuum, such as the (reasonable) precautionary method.

European Commission describes some of the problems addressed by the Precautionary Principle with this statement: «even if scientific advice is supported only by a minority fraction of the scientific community, due account should be taken of their views, provided the credibility and reputation of this fraction are recognized»[3]. This approach implies the involvement of precautionary at first the assessment of risk, that plays a central role both in safety regulation and thus in civil liability judgment in respect of causation.

d) Chapter V further examines the civil liability issues in relation to one of the many fields of robotic application that of the so-called smart cars.

2. The legal relevance of automation: science, law and technology.

Before going deeper into our topic, we want to clarify why the law deals with science. The idea of exploring the relationship between law and technologies originates from the belief that for a deeper understanding of a given technological phenomenon, a strictly legal analysis is not sufficient. The «legal analysis represents only one factor for the comprehension of the "technological fact", and this analysis must be combined with the results of the studies conducted by other disciplines to understand the phenomenon. Therefore, a multidisciplinary approach is an "imperative" and the main issue is to find a method and a language that can be used in communicating with the different sciences involved»[4].

Nowadays, technology grows fast and the understanding of the technology becomes complex. The scientific progress may be unpredictable and so it may be out of control but progress allows carrying out proper studies on this issue with the aim to maximise social benefits derived from science[5].

[3] COMMUNICATION FROM THE EUROPEAN COMMISSION of 2 February 2000 on the precautionary principle [COM(2000)], 1 final, Brussels, 2000.
[4] IZZO U., MACILOTTI M., PASCUZZI G., *Comparative Issues in the Governance of Research Biobanks*, Trento, 2013, p. 1.
[5] The relationship between law, science and technology is discussed in an extensive body of literature, such as GOLDBERG S., *Culture Clash Law and Science in America*. New York and London. New York

Innovations usually improve safety and living conditions, therefore people do not accept the uncertainty that could affect their certainty[6].

In particular, in the second half of the 19th century the Industrial Revolution and the development of Capitalism led to a new symbolism of science and knowledge which was characterised by technical exhibitions. Therefore, trades and industries created new societies. In this scenario, research methods changed as well and pragmatic research became a priority. The interest in innovation developed and new scientific and technical knowledge influenced society causing the birth of the society of risk[7].

In this new scenario, science and technology run at two different: the first - known as knowledge - changes the rules because i.e. scientific progress causes an «increased strict liability»; «the appearance of new type of injury»; the «recourse serious, precise, concordant factual presumptions» as an alternative to causality[8]. The second – known as ability to do – allows overcoming the conventional definition of risk[9].

Scientific and technological progress develops faster than law. However it is useful to interpret this transition period for studying technology and understanding its implications on society. This also reproduces with respect to well-established technology considered that technology changes constantly. Obviously an adequate regulation on technology requires specific features, such as flexibility and the avoidance of strict provisions. For example, in EU, in 1995, the General Directive on product safety n. 2001/95 was enacted in place of control procedure *ex ante*. General principles, standards dictated by technical and scientific bodies and certification procedures developed and they helped to avoid a continuous updating of law in parallel with scientific and technological improvement.

In response to this evolution, law become soft law at international level where the principals of good behaviour (precautionary principle) are provided. Soft law is not

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University Press, 1994; HERMITTE M.A et al., *La liberté de la recherché et ses limites*: approches juridiques Paris, 2001.

[6] JASANOFF S., *Science at the Bar*. Law, Science, and Technology in America. Cambridge MA: Harvard University Press, 1995.

[7] BECK U., *La società del rischio: verso una seconda modernità*, ed. italiana a cura di PRIVITERA W., Roma, 2000.

[8] VERGES E., *Risk and uncertainties of scientific innovations in French liability law: between radical departure and continuity*, in Technological Innovation and Civil Responsibility 6, n. 4, vol. 59, 2014.

[9] COMANDÈ G., *Gli strumenti della precauzione: nuovi rischi, assicurazione e responsabilità*, Milano, 2006.

binding tools (such as communication, guidelines, and opinions, action plans) are in line with the regulation activity of agencies or standard-setting bodies.

The scientific and technical nature of law shows the interdependence between these poles within economic and social transformations of private law. In order to understand the relationship between law and technology, we found out the following conditions:

> «esiste un rapporto stretto tra diritto e tecnologie; il diritto è chiamato a disciplinare le tecnologie, ma al tempo stesso si serve di tecnologie per perseguire fini suoi propri; oggi l'attenzione è attirata dalle tecnologie digitali, ma occorre prestare attenzione al fatto che hardware, software e reti telematiche non sono "più tecnologia" di quanto lo siano la carta, la penna o lo stesso linguaggio […]; - le regole giuridiche, in quanto perseguono obiettivi servendosi delle tecnologie disponibili nel momento in cui vengono create, sono legate a filo doppio alle tecnologie che ne hanno propiziato e favorito la creazione; - nel momento in cui il progresso mette a disposizione dell'uomo nuove tecnologie è verosimile che queste ultime possano essere usate dal diritto per perseguire propri obiettivi, con la conseguenza che l'avvento di nuove tecnologie può portare alla creazione di nuove regole»[10].

Hence as follows:

1) Even before the advent of robots, other legal matters raised problems concerning the impact of science on law, such as the assisted fertilization, the patentability of new animal breeds and plants varieties, or the nanotechnology. These new technological products raise questions about the suitability of conventional legal categories in order to respond to scientific/technological threats. We should bear in mind that three scenarios can arise: *status quo* may be maintained; current regulations should be adapted or a new legal framework should be adopted[11].

2) Law, science and technology influence each other. Law deals with the regulation of scientific activity, its products and scientific knowledge penetrates legal categories. In particular, science and technology are used for both safety regulation and

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[10] PASCUZZI G., *Il diritto dell'era digitale,* Bologna, 2010, p. 7 ss.. A. says a narrow relationship exists between law and technologies; the law disciplines the technologies, but at the same time it uses technologies with the aim of pursue its proper scopes; today the attention is attracted by the digital technologies, but it needs understand that hardware, software and telematics nets are not "more technology" than the paper, the pen or the language […]; the relationship between law and technologies is a symbiotic one, considering legal rules pursue objective using available technologies when they are created; when progress makes new technologies, it is likely that these last ones can be used by the law with the aim to prosecute own objectives and so the new technologies advent might lead to creation of new rules (translation of the sentence).

[11] VERGES E., *La responsabilité du fait de nanotechnologies: entre droit positif, droit prospectif et science-fiction*, Cahiers Droit, Sciences et Technologies, CNRS éd., 2008, p. 85 (A. concludes that «*le système juridique est suffisamment armé, au susceptible de l'être*»).

regulatory tools considering their integration into law. This inclusion allows creating a presumption of conformity in case of compliance with technical provisions[12].

3) The complexity of technology requires the constant support of experts in the specific field involved. «The necessary recourse to the experts implies the risk of increasing the fragmentation of the knowledge», but «the complexity of "technological phenomena" highlights the needs for the jurists to acquire the fundamental technical notions of the phenomenon that they intend to study»[13].

4) It is necessary therefore to get the right balance between technology/science and law[14]. The first elements have a specific nature that is different than the one of the law. Their development is unpredictable and hard law could slow down the scientific and technological progress.

To achieve these scopes, the infringement of fundamental values of people is an impassable limit for scientific development. An appropriate example is the technological impact on the environment. Environment Law took inspiration from precautionary principle and the aim of it is the protection of people's health and safety[15].

In line with Habermas' observations: science improvement is not autonomous because it depends on public investment. Technology and democracy are in symbiosis: it is necessary a peer dialogue between science and politics, which shall be open to all[16].

Finally, in all fields of technological innovations the role of lawyers depends on their ability to defend the values of humanity, and developing the right of expertise and a right risk - in terms of prevention, precaution, vigilance anticipatory management, governance, information and communication, measurement, calculation of thresholds and risk specifications - accessible and intelligible to citizens[17].

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[12] TALLACCHINI M., *La costruzione giuridica dei rischi e la partecipazione del pubblico alle decisioni science-based*, in COMANDÉ G., PONZANELLI G. (eds.), n. 10, 2004, pp. 339- 355.

[13] IZZO U., MACILOTTI M., PASCUZZI G., *Comparative Issues in the Governance of Research Biobanks* op. cit., 2013, p. 2.

[14] PALMERINI E., *The interplay between law and technology, or the RoboLaw project in context*, Law and Technology. The Challenge of Regulating Technological Development, Pisa University Press, 2013, p.15: «*regulatory opportunity that should be seized, and technology as a regulatory temptation, that ends up marginalizing other forms of regulation and threatens values such as autonomy and human dignity*».

[15] COCKFIELD A.J., PRIDMORE J., *A Synthetic Theory of Law and Technology*, Minnesota Journal of Law, Science & Technology, 8, 2007, pp. 475-513; BROWNSWORD R., GOODWIN M., *Law and the Technologies of the Twenty-First Century*. Texts and Materials. Cambridge-New York. Cambridge University Press, 2012.

[16] HABERMAS J., *La technique et la science comme «idéologie»*, éd. Tel Gallimard, Paris, 1973.

[17] LASSERRE KIESOW V., *Droit et technique*, JCP G n. 4, doctr. 93, 2011, p. 7.

3. Research subject.

The aim of this paper consists in examining the impact robotic technology has on the European[18] - in particular Italian, French - and American current legal system. We are going to evaluate if the current legal categories are apt to be used to regulate the robot, and, in such case, to find out how they could be applied or adjusted on robotics.

The United States is one of the few countries to enact robot-specific laws and regulations; while European Union financed RoboLaw, a European Commission-funded project designed to prepare the way for the creation of legal and ethical guidelines[19].

[18] About harmonization of civil liability, it has been published *Principles of European Tort Law* (PETL). Drafted by European Group on Tort Law, Principles of European Tort Law: text & commentary in 2005 and *Principles. Definition and Model Rules of European Private Law – Draft Common Frame of Reference* (DCFR) in 2007. For a perspective on the European juridical system ROPPO V., *Sul diritto europeo dei contratti: per un approccio costruttivamente critico,* in Europa e diritto privato, 2004, p. 441-442; ID, *Prospettive del diritto contrattuale europeo. Dal contratto del consumatore al contratto asimmetrico?* Corr. giur., 2009, p. 277; ID, *Contratto di diritto comune, del consumatore, contratto con asimmetria di potere contrattuale: genesi e sviluppi di un nuovo paradigma*, in Il contratto e le tutele Prospettive di diritto europeo, a cura di S. MAZZAMUTO, Torino, 2002, p. 101 ss. ROPPO V. distinguishes between "diritto comunitario europeo" (European Community Law) and "diritto comune europeo" (European Common Law). The first originates from EU Directives. The second is a body of rules, principles and categories generating through a process where different juridical actors operate. DI MARZIO F., *Verso il nuovo diritto dei contratti (note sulla contrattazione diseguale)*, in Riv. dir. priv., 2002, p. 723-726; AMATO C., *Per un diritto europeo dei contratti con il consumatore*, Milano, 2003; ID., *Riflessioni sulla politica comunitaria tra diritti dei consumatori ed esigenze del mercato*, in SOMMA A. (a cura di), Giustizia sociale e mercato nel diritto europeo dei contratti, Torino, 2007, p. 55 ss.; ANTONIOLLI L., VENEZIANO A., *Principles of European Contract Law and Italian Law. A commentary*, L'Aja, 2005; BENACCHIO G., *Diritto privato della Comunità Europea, Fonti, modelli e regole*, Padova, 2004; BENEDETTI G., *La formazione del contratto e l'inizio dell'esecuzione: dal codice civile ai principi di diritto europeo dei contratti*, in Eur. Dir. Priv., 2005, p. 309 ss.; CAFAGGI F. (a cura di), *Quale armonizzazione per il diritto europeo dei contratti?*, Padova, 2003; CAMARDI C., *Integrazione giuridica europea e regolazione del mercato. La disciplina dei contratti di consumo nel sistema del diritto della concorrenza*, in Eur. Dir. Priv., 2001, p. 703 ss.; CASTRONOVO C., *Savigny, i moderni e la codificazione europea, ibidem*, p. 219-255; ID., *Common Frame of Reference for EC Contract Law: a Common Lawyer's Perspective*, in L'armonizzazione del diritto privato europeo, Il piano d'azione, Milano, 2004; COLOMBI CIACCHI A., *The constitutionalization of European contract law: judicial convergence and social justice*, in *European review of contract law*, 2006, p. 167; COMANDÉ G. (a cura di), *Diritto privato europeo e diritti fondamentali*, Torino, 2004; D'ANGELO A., *Un ordine europeo per il diritto civile*, in Contr. impr. Europa, 2005, p. 1-20; DE POLI M., *Politica del diritto e drafting nell'attuazione delle direttive comunitarie in materia di consumatore*, in G. SICCHIERO, *Autonomia contrattuale e diritto privato europeo*, Padova, 2005; DI MAJO A., *Il regime delle restituzioni contrattuali nel diritto comparato ed europeo*, in MAZZAMUTO S. (a cura di), *Il contratto e le tutele*, op. cit., p. 423 ss.; FALZEA A., *Il diritto europeo dei contratti d'impresa*, in Riv. Dir. Civ., 2005, I, p. 1 ss.; FERRI G.B., *Il Code Europeén des Contracts*, in Contr. impr. Europa, 2002, p. 27 ss.; ID., *Diritto dei contratti e Costituzione europea - Divagazioni di un civilista intorno alla Costituzione europea*, in *Eur. Dir. Priv.*, 2005, p. 1 ss.; GALGANO F., *Lex mercatoria*, Bologna, 2001; ID., GANDOLFI G., *Il progetto pavese di un codice europeo dei contratti*, in Riv. Dir. Civ., 2001, pt. 1, 2001, p. 455-473; ID., *La vendita nel Codice europeo dei contratti*, in Eur. Dir. Priv., 2006, p. 1229-1234; GATT. L., *Sistema normativo e soluzioni innovative nel Code Europeén des Contracts*, *ibidem*, p. 359 ss.

[19] [Online] *Robot: a Global Perspective*, 2012, available at http://www.roboticsbusinessreview.com/article/robot_law_a_global_perspective.

In the 1970s, autonomous systems could plan and implement relatively complex operations with little or no human interaction thanks to increased interest in digital control electronics, automated perception and cognition, within the new field of artificial intelligence[20].

Robotics[21], one of the most interdisciplinary fields, has created robots which present a high degree of autonomy. For the purpose of this paper autonomous robots we shall consider, not those which have motor autonomy, i.e. robots that act alone without the real time control of humans. We consider autonomous robots which select the methods by themselves to achieve the human-generated goals. This kind of robots has an unpredictable behaviour.

The robotic world is attracting major international attention [22] . Robots functioning and their artificial shape are interesting with regard to their influence on increased functions. The types of robot which can achieve the most complex behaviour are humanoid robots.

This varied world finds its representation in the International Robot Exhibitions, such as the ones which took place at Techfest in 2014 and at the International Robot Exhibition in 2013, where new robot species (specimen) were presented: BINA48 (Breakthrough Intelligence via Neural Architecture); MAKI, a 3D printable humanoid robot; FUMANOIDS, Robocup soccer humanoid robots; NAO, a humanoid robot

[20] WATSON D.P, SCHEIDT D.H., *Autonomous systems*. Johns Hopkins APL Technical Digest 26(4), 2005, p. 369.

[21] Robotics is an interdisciplinary field involving artificial intelligence and computer science, cybernetics, physics, mathematics, mechanics, electronics, neuroscience, biology and humanities.

[22] Nowadays European, national and international commentators have previously made conflicting suggestions on this theme. *See* LEROUX C., *EU Robotics coordination action: a green paper on legal issues in robotic*. In Proceeding of international workshop on autonomics and legal implications, Berlin, 2012; CALO R., *Robotics & The Law: Liability For Personal Robots*, 2009 available at http://ftp.documation.com/references/ABA10a/PDfs/2_1.pdf; CITRON D., *Bright ideas: Talking About Robotics With Ryan Calo*, 2010, available at http://www.concurringopinions.com/archives/2010/05/bright-ideas-talking-about-robotics-with-ryan-calo.html; STEVEN J.F., *Tort Adjudication and the Emergence of Artificial Intelligence Software*. 21 Suffolk U. L. Rev., 1987, pp. 623-639; KOOPS B. J. et al., *Bridging the Accountability Gap: Rights for New Entities in the Information Society?* 11 Minn. J.L. Sci. & Tech. 497, 2010, pp. 539-40; KARNOW C.E.A, *Liability for Distributed Artificial Intelligences*, 11 Berkeley Technology Law Journal, 1996, p. 147, reprinted in KARNOW C.E.A., *Future Codes: Essays in Advanced Computer Technology and the law*, 1997; SALVINI P., LASCHI C., *Roboethics and ethical, legal and social challenges. World Robotics, Service Robots*. Frankfurt: IFR Statistical Department, 2012, pp. 195-202; PAGALLO U., *The laws of Robots, Crimes, contracts and Torts Law*, Governance and Technology Series 10, 2013; STRADELLA E. et al., *Subjectivity of Autonomous Agents. Some Philosophical and Legal Remarks*, in BOISSIER O., BONNET G., TESSIER C. (eds), *Rights and Duties of Autonomous Agents*, Proceedings of the 1st Workshop on Rights and Duties of Autonomous Agents, Montpellier, in conjunction with the 20th European Conference on Artificial Intelligence, 2012, pp. 24-31.

capable of emulating human behaviour[23]; JACK & MATILDA, assistive robots expected to improve living conditions of people affected by mild dementia through engagement and sensory enrichment; SOFT ROBOT TECHNOLOGY, a prototype and the product of a new and important trend, that is soft robotics; HOVIS Eco, a home multiplayer robot for different functions with interactive mobile content monitor; CHILDREN'S TECHNOLOGY WORSHOP, a unique environment designed to enable children to explore and enhance their natural creative abilities to achieve excellence in academics and beyond; ASIMO, an advanced humanoid robot; HRP-4C, a feminine-looking humanoid robot with a realistic head especially remarkable for its ability to imitate human facial expressions and movements; GIMBALL, a robot capable of flying in cramped and cluttered environments that has many advantages over their ground-based counterparts; AUTOBIRD, an autonomous flying device; ROBOBEE, an insect-sized robot.

These are just a few examples of an enormous number of robots made by technological progress. However, there is a huge confusion as far as real technological possibilities and their development are concerned. Several theories support the exponential increase in robotics and AI. Some scholars predict technological progress will reach a point in expansion (in the year 2045), called «*technological singularity*», where AI will get over humans' ability[24].

Most of robots do not look like humans. On the contrary they are *pseudo* object. They evoke the object in the form but overall they have different functions and a different structure. Autonomous vehicles (smart cars) are an example of robots that looks like conventional cars, but have different functioning.

These robots present machine learning, genetic algorithms, neural nets and other type of feedback loops which create unpredictable behaviours[25]. These approaches allowed evolutionary robotics developments that try to get robotic control systems through an evolutionary and adaptive process rather than through a process of

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[23] NAO has been presented to public during *Ciné-Droit* entitled *Les robots* en France 20.03.2015 at Université de Paris Sud- Jean Monnet by director of research at Aldebaran.

[24] KURZWEIL R., *The Singularity is Near,* Viking Penguin, 2006 *contra* DAVIES P., *When computers take over*. Nature, 2006, pp. 421–422; MODIS T., *The Singularity Myth*. Technological Forecasting Social *&* Chang, 2006.

[25] These factors are being developed by evolutionary robotic. In recent years, autonomous robots were built by adopting new approaches based on a form of simulated evolution BROOKS R.A., *New approaches to robotics*. Science 253, 1991, pp. 1227-1232; CLIFF D., HARVEY I., HUSBANDS P., *Explorations in Evolutionary Robotics.* Adaptive Behavior 2, 1993, pp. 73-110.

engineering design. These processes of adaptation and learning have been studied and used within the classic Robotics, but only evolutionary robotics considers the processes of learning and evolution as central and fundamental[26].

Robots receive instructions to ultimate goals and establish for themselves the means of accomplishing these goals. It is clear that means are not predictable by either the operator-owner or by the original programmers, because the same software will became “teacher of it”. Robot can learn by running experiments or doing other real or virtual attempts at solutions, it can correct errors, test results and then can perform operations[27].

Finally, robots are a social-tech system. It is a co-evolution system with other social systems, which has an *autopoietico* and holistic approach; then its sense is the result of its co-evolution through others. If we give them a different definition, i.e. of object, there is a risk to reduce the analysis to a conceptual matter, leaving aside its interesting features, such as its functioning. This perspective helps to understand the aspects to regulate.

4. Research objectives.

Calo[28] identifies the implication between robots and civil liability; he sets a distinction between the Internet and robots. Unlike the former, robots have a body used to act in the environment and interact with human beings. They don’t have just a body, but also a brain which allows them to develop some cognitive abilities with different levels of complexity.

Robots raise social, ethical and politic dilemmas, some of them should be tackled by regulation and soft governance, and others have to be provided for by hard law.

The present comparative research aims to recognize the impact of technology - in particular the technology developed in the car sector - on the traditional legal

[26] NOLFI S., FLOREANO D., MIGLINO O., MONDADA F., *Robotica evolutiva: metodologia e prospettive.* Sistemi Intelligenti VII (2), 1993, pp. 203-221; CLIFF D.T., HARVEY I., HUSBANDS P., *op. cit.*, 1993.
[27] KARNOW C.E.A., *The application of traditional Tort Theory to Embodied Machine Intelligence*, 2013 available at http://works.bepress.com/curtis_karnow/9.Karnow, A. says: «*many commentators do not spend much time distinguishing these sorts of robots as they address the difficulty of applying law to their effects; this is a mistake because the interesting legal issues only pertain to a small (but growing) set of them*».
[28] CALO R., *Robotics & The Law,* op. cit., 2009.

categories. We evaluate whether these are suitable and otherwise revealing possible solutions for a proper regulation on their use. This allows adding important information to the juridical scenario of the civil liability.

The present research is interesting not only at a comparative level, but also for the future developments of the field, at a practical level: smart cars. Smart cars are becoming a global phenomenon and apt regulations should be introduced as a starting point before their massive placement in the market. Understanding the legal nature of these smart systems and of the *ex-ante* and *ex-post* remedies of our legal system is unquestionably a preliminary task for the protection of interests of the involved subjects.

Safety of smart cars is the *leitmotiv* guiding the engineers who make these systems. The engineers' intuition is not going to be enough for ensuring robots safety. Because of their technological complexity engineers can't predict robots' behaviour in response to new situations. Bear in mind that many workers build a robot and only the designer and manufacturer of an individual component know how it works. How this component will interact with all the others is not always predictable[29].

Civil liability study takes into account the functions pursued by different legal systems. These functions change over time on the basis of different historical and cultural contexts. They are: the function to react to the damage with the aim to compensate the victim; the function to restore the *status quo ante*; the function to assert the punitive power of the State; the function of deterrence for anyone intending to act in a prejudicial way; distribution of losses and costs allocation (these last two functions fall within the framework of the economic effects of civil liability)[30]. The selection of these functions corresponds to *policy* options and will guide the adoption of various solutions about robots.

5. Methodology.

The research takes into consideration three different legal systems, such as the US and EU (Italian and French[31] systems). This comparison enables us to determine

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[29] NISSENBAUM H., *Accountability in a Computerized Society.* 2 Science and Engineering Ethics, 1996, p. 25.

[30] ALPA G., MARICONDA V., *Commento all'art. 2043 c.c.*, Codice civile commentato, Milano, 2013, p. 2583 ss.

[31] In France in 2013 MONTEBOURG A., *Ministre du Redressement productif*, presented project *France Robots Initiative*, a plan to support the robotic improvement in France *avec pour objectif de placer le pays en position de leader mondial d'ici 2020*. Among action plans there was *la Nuouvelle France industrielle* (12.11.2013), in which among 34 plans there was that robotic one under which SPARC project started

similarities and differences between realities that are addressing these problems.

The comparison allows identifying common or universal principals and it detects the affinity of these principles[32]. According to Zweigert K. and H. Kötz the comparison indicates a method and an investigation field. This method operates following the technique of the comparison. The scopes of comparison change with the historical phases. It aims to overcome national barriers; propose to countries the simplification and the unification of their legal systems; realize the progress of the law in line with the evolution of social relations within a global plan; promote the trade with the aim to overcome the differences of regulatory models; facilitate the movement of goods and services and create business[33]; identify common values and principles on which to build a uniform standardization[34].

The comparison is not only in in texts (laws, judgments, doctrinal). According to Arthur von Mehren the law is law in action. The comparison has to consider that the method and the mentality of civilian and common lawyer are different (For instance, civilian was formed with *Corpus iuris*, beginning with lectures of Irnerio in Bologna in 1095). Rules, principles and theories have to be appreciated in a realistic way and the rules are fixed by the political, economic and social phenomena[35].

For scientific research, comparative law allows a convergence of different perspectives and the rejection of unity and centrality of each legal system. Through the *macrocomparazione* similarities and differences of systems are observed as well as the constitutional structure, the organization of justice and the protection of interests. Instead, through *microcomparazione* it is possible to observe the functioning of individual institutions. Alpa identifies the functions of comparison. «Le funzioni odierne sono molteplici; la conoscenza del diritto comparato: è un serbatoio di soluzioni; è il veicolo di materiali per i legislatori; è strumento di interpretazione; è

(3.06.2014).

32 ALPA G., *Il metodo nel diritto civile*, Contratto e Impr., 2000, 1, p. 357 states: «*non è necessario che si tratti di affinità di struttura, ma è necessario che si tratti di affinità di scopi, cioè di affinità funzionali (cap. XVIII); anche le categorie concettuali possono essere diverse; ciò che rileva è registrare, là dove sia possibile, concezioni identiche occultate dall'eterogeneità delle forme mentali*».

33 These observations are taken from the work of *Ibidem*.

34 ZWEIGERT K., KÖTZ H., *Introduzione al diritto comparato*, vol. I, I princìpi fondamentali, Milano, 1991, vol. III ed., trad. it., Milano, 1998; MATTEI U., *A Theory of Imperial Law: A Study on U.S. Hegemony and the Latin Resistence*, in *Global Jurist Frontiers*, 2003, p. 3; GARDNER J.A., *Legal Imperialism*, Madison Wisc., 1980; HARDT M., NEGRI A., *Empire*, Harvard University Press, 2000.

35 von MEHREN A.T., *The Comparative Study of Law*, in *Essays in Honour of prof. Ferdinand Stone*, Tulane Law School, 1992, p. 43; These observations are taken from the work of ALPA G., *op. cit.*, 2000.

strumento di educazione giuridica; è strumento di unificazione giuridica»[36].

With regard to comparative method, Sacco, says that «*comparazione non ha paura delle differenze*» and in order to detect the differences it is necessary avoid a literal translation. It needs to understand the relation between formal terms and socio-political context and avoid an overlap of the similar concepts belonging to different legal systems[37].

With the establishment of the European Union, the study of comparative law had a considerable relevance. Through this method it is possible understand the EU legal order. This method enables to analyse the current crisis of hierarchical system of sources. Interpreter has to find the sources within network legislation that goes beyond the barriers of local rights[38]. These sources are in the highest levels of supranational regulations of private associations and commercial practice[39]. In this context it is possible to interpret the harmonization projects such as the experience of Draft Common Frame of Reference (DCFR), which should anticipate the adoption of a code for Europe[40].

Nowadays, the adaptation of the traditional research methods to the transformation of the global reality involves also research in comparative law. The "de-territorializzazione" of borders is evident when we understand the action of private corporations in both the preparation of contract models and in solving international arbitration of disputes. «È questa l'influenza egemone di una cultura, anche giuridica, che interroga l'osservatore circa l'opportunità di un modello concorrenziale stimolato da gruppi di potere che mettono in competizione gli ordinamenti statali, nella ricerca di norme disegnate in relazione ai loro interessi. Nello stesso tempo, l'emersione dei nuovi confini segnala il rischio che le opportunità di vita e di ricchezza divengano ancora più

[36] ALPA G., op. cit., 2000.
[37] SACCO R., *Introduzione al diritto comparato*, Torino, 1992, p. 22. ID., *L'enseignement du droit comparé en Italie*, in *Rev. int. dr. comp.*, 1988, p. 723 ss., LARENZ K., *Storia del metodo nella scienza giuridica*, Milano, 1966, trad. it. di VENTURA dell'edizione tedesca del 1960. ASCARELLI T., *Studi di diritto comparato e in tema di interpretazione*, Milano, 1952. SPINOSI C., DAVID R., *I grandi sistemi giuridici contemporanei*, 4[a] ed. a cura di Sacco, Padova, 1994; ALPA G., *op. cit.*, 2000.
[38] GAROFALO A.M., MEZZANOTTE F., PATTI F. P., *L'insegnamento del diritto civile: prospettive metodologiche (a proposito di un recente convegno)*, Riv. dir. civ., 2015, 3, 10643.
[39] VON BAR C., CLIVE E. (eds.), *Principles, Definitions and Model Rules of European Private Law*. Draft Common Frame of Reference (DCFR), Full Edition, Munich, 2009.
[40] JANSEN N., ZIMMERMANN R., *European Civil Code in All But Name: Discussing the Nature and Purposes of the Draft Common Frame of Reference*, in 69 *Cambridge Law Journal*, 2010, p. 98 ss.; HESSELINK M., *The Common Frame of Reference as a Source of European Private Law*, in 83 *Tulane Law Rev.*, 2009, p. 919 ss.

asimmetriche, anche in corrispondenza ad un palese deficit di democraticità dei processi decisionali su scala globale»[41]. In this new scenario, the function of comparison is the harmonization or standardization that are «un'arma di auto-legittimazione, non dissimile in questo dalla funzione che fu propria dei codici ottocenteschi, oltre che di colonizzazione giuridica di realtà estranee alla tradizione dominante. È evidente, allora, come la stessa idea di promozione di un diritto uniforme nasconda la convinzione evoluzionista che il diritto armonizzato traduca nel linguaggio giuridico il progresso sociale dei popoli, ed in questa prospettiva la comparazione altro non sarebbe che uno strumento maneggiato in maniera del tutto priva di scientificità a scopo politico»[42].

The robotic revolution assumed a remarkable echo within the United States of America. Many scholars are studying the legal implications of robots, which is a linguistic tool that contains the futuristic development of law caused by a futuristic technological wave. Some US States led the way on AVs policy and at the end of 2013, four states and the District of Columbia enacted at least seven ACT dealing with AVs regulation. Others have a pending legislation on AVs, while in others AVs legislation failed during previous legislative sessions. So far, all the state bills (including those that have failed to pass) acknowledge the importance of AVs and their potential impact on society.

EU is still hesitant in passing a legislation directly addressing AVs-related issues. This may be explained by the fact that almost all EU Member countries (with the exception of Spain and the United Kingdom) have signed and ratified the Convention on Road Traffic, also known as Vienna Convention. However several countries in EU have expressed interest in developing legal frameworks for testing and implementing AVs.

Besides, the comparative method is a fundamental tool because it creates a bridge between two research poles (technology and law). It puts together two realities occupying a different temporal and spatial position. Technology is temporally and geographically universal, while law assumes a spatial dimension within different views.

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[41] VIGLIONE F., *I «confini» nel diritto privato comparato*, Nuova Giur. Civ., 2011, 3, 20162: «*In un panorama simile, è evidente come gli spazi lasciati vuoti dalla sovranità statale possano in larga misura venire occupati dalla privatizzazione delle fonti normative, che si manifesta in modo palese nella funzione regolamentare del contratto*».

[42] SOMMA A., *Tanto per cambiare....Mutazione del diritto e mondializzazione nella riflessione comparatistica*, in Global Law v. Local Law. Problemi della globalizzazione giuridica, a cura di AMATO-PONZANELLI, Torino, 2006, 139 ss.

Moreover the comparative method avoids the simple juxtaposition of legal solutions and allows explaining the analogies and the differences among the compared systems analysing the implied conceptual models as well.

Finally, the research will be carried out with a bi-dimensional research method. From a technological point of view the analysis will focus on three elements – automatic systems, semiautonomous and fully autonomous robots. From a juridical point of view the analysis will be developed on two elements – safety regulation (for an *ex-ante* regulation of the smart cars) and liability rules (for an *ex-post* regulation). For what concerns the chosen method of analysis, concerning the practical applications of the technological evolution and the related issues on the suitability of the present legal categories, the case study of the smart cars will be structured and analysed in a comparative fashion.

For this purpose it will be considered the combined reading of different sources as academic articles, government and business white papers, green papers issued by the European Union and other research data. An accurate analysis of the legislative and regulatory actions in the United States and in Europe will follow, highlighting possible similarities and differences in the approach that characterize this stage of the decisional process on the Autonomous Vehicles in the jurisdictions taken in consideration.

Finally, the comparative method enables to predict the future development of robots in our system.

* * *

To sum up, our work presents a structure which should make understanding of this study much easier:

1. Conceptual organisation of technological tools:
   - automation, semi-autonomy and full autonomy;
   - throughout our study it will be bear in mind the difference between close and open robotic in relation to the different types of embodied software.
2. Study of the regulations aimed at ensuring and enhancing the safety of robots;
3. Study of the civil liability scenarios following the event of damages determined by robots failures or interactions.

4. The application of the general framework depicted in the first 3 previous sections to the specific field of robot car.

CHAPTER II
EXPLORING ROBOTS AND SMART CARS

SUB-CHAPTER I
INTELLIGENT AUTONOMOUS ROBOT AND AUTONOMOUS VEHICLES

In this chapter, we look into the object of the research, i.e. robots. In particular, we are going to carry on a widespread study of robotics with the aim of gauging the full scale of questions leading to its legal assessment in the fourth chapter. We are going to investigate different aspects related to the improvement of robots.

1. The complexity of robot applications: Intelligent Autonomous Robot (IAR).

In 2006, Gates made the famous statement, announcing «*A robot in every home*» and foreseeing the current state of robotic research and its application[43]. It is an undeniable fact that the time when robots belonged to the world of science fiction in literature and movies is well past us.

Robots[44] became well-known to people thanks to Čapek's drama, Asimov's novels[45] and science fiction movies such as Metropolis (1927), the Star Wars saga (1977); Blade Runner (1982) and Terminator (1984). While Robotics - a new scientific discipline – has begun to unfold since the second half of the 1970s.

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[43] GATES B., *A robot in every home*. Scientific American, 2007, p. 58: «*although a few of the domestic robots of tomorrow may resemble the anthropomorphic machines of science fiction, a greater number are likely to be mobile peripheral devices that perform specific household tasks*».

[44] DA VINCI L., who designed a humanoid robot in 1495, developed the first robot project. A mechanical knight represented this robot and this project was based on research of Vitruvius's man. Before the above-mentioned novels, in 1738 VAUCANSON J. built an android, such as a recorder and a mechanical ducks. In 1817, HOFFMANN E.T.A described a mechanical woman with a doll form in *The sandman* novel; in 1817 IPPOLITO N. referred to robots in *Storia filosofica dei secoli futuri*. In 1865, ELLIS E. S. wrote on robots in *Steam Man of the Prairies*; in 1885, SENARENS L. wrote *Electric Man*. However, fear for robots took place in *Frankenstein* (1818).

[45] ČAPEK K., *R.U.R. Rossum's Universal Robots,* Prague, 1920; ASIMOV I. *Liar!* Astounding science-fiction, New York, 1941.

Robotics, a branch of cybernetics, is a multidisciplinary field were Electronics, Information technology; Physics, Mechanics and Mathematics, Linguistics, Psychology, Biology and Physiology interact.

Through 80s, industrial robots were developed into industries thanks to several technological achievements: the growing technical abilities of machine tools' manufacturers - where numerical control procedure were settled (Computer Numerical Control - CNC); the knowledge derived from remote control manipulative arms technology, used to move materials which contain hazardous substances (for example, MASCOT built in 1961 by the Italian Nuclear Energy Committee); the improvements of electronics, information technology, automation, carried out in the military field. In 1954 Devol G. Ch. invented the first programmable robot and, in 1961, Township E. designed the first industrial robot prototype that worked in General Motors factory.

Robots born from this state of art have three fundamental features: they are able to manipulate their physical environment; they are computer-controlled and they operate in industrial settings[46]. However, they are not planned to interact with people directly, in fact they are placed in cages in order to protect workers.

Following the rapid increase of the industrial field, robotics was seen as a discipline applicable to every object able to act autonomously[47].

In the late 1980s some researchers understood that even if a robot was able to solve complex computing problems, it would never have the same abilities of a child. This new perspective is known as «Moravec paradox» by its author Moravec H. According to this paradox, a computer has difficulties in taking over primordial human abilities.

On this basis, Brooks R. presented a new paradigm, *Nouvelle* AI, which enabled to create robots that thought and sensed as little as possible. In order to achieve "strong

[46] THRUN S., *Towards a framework for human-robot interaction*. Human Computer Interaction, vol. 19, n. 1&2, 2004, pp. 9-24.
[47] NICOSIA S., *Robotica*, http://www.treccani.it/enciclopedia/robotica_ (XXI-Secolo)/, 2010.

AI” [48] machines shall be equipped with sensory and motor abilities and a body connected with the environment[49].

Since the beginning of the 21st century, while the robotic industry reached a high level of development, new robots became able to fulfil people’s needs[50]. «During the early age of this century, various applications of robots, ranging from manufacturing processes to non-manufacturing processes and from professional uses to personal or domestic uses, are changing our society. To do this robots are becoming more powerful, with more sensors, intelligence and cheaper components»[51].

Nowadays robotic industry products can be divided into two different categories according to their tasks and market purposes: industrial and service robots[52].

According to the International Federation of Robotics[53], a service robot is a robot operating autonomously in order to provide services to humans. This category distinguishes professional and personal care robots[54]: the former ones manipulate and navigate through their physical environments, but also help people in the pursuit of their professional goals. On the other hand, personal care robots, known as domestic robots, are capable of successfully taking over routine tasks in the household environment where people live.

1.1. The current evolution process of robotic: «robotic species».

Even before the current process of robotic evolution, the digital age – as every

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48 “Strong AI” refers to a theory based on AI distinction, such as strong and weak AI. SEARLE J. coined the first theory, under which same AI forms can truly reason up to self-aware and thought. They have a wide range of human level cognitive capabilities. Unlike strong AI, weak AI theory affirms software is mere specific reasoning objects, unable to think like humans.

49 BROOKS A.R., *Cambrian Intelligence: The Early History of the New AI.* MIT Press (Bradford), Cambridge, 1999.

50 The automation and modernization of manufacturing processes depend on the industrial robots. Service robots are enriching innovation or products development in different applications, such as professional or personal.

51 SHUKLA M., SHUKLA A.N., *Growth of Robotics Industry Early in 21st Century*. International Journal of Computational Engineering Research (IJCER), 2(5), 2012, pp. 1554-1558, analyze the growth of robotics industry in the early age of 21st century for both industrial robots and service robots, by considering sales between 2000 and 2011 years.

52 KUMAR V., BEKEY G., ZHENG Y., *Industrial, personal, and service robots*, in BEKEY G., AMBROSE R., KUMAR V., SANDERSON A., WILCOX B., ZHENG Y. (eds), WTEC Panel Report on International Assessment of Research and Development in Robotics. World Technology Evaluation Center, Baltimore, Maryland, 2006, pp. 55-62.

53 The International Federation of Robotics was established in 1987 in connection with the 17th International Symposium on Robotics, in particular it promotes and strengthens the robotics industry worldwide

54 ISO 8373:2012, Robots and robotic devices - Vocabulary.

other innovation – attracted the attention of legal scholars[55]. The digital age has been on the rise in recent years, especially to households where consumers interact with the digital.

The development of the World Wide Web, in the 1990s and the development of browsers with a graphic interface in 1993[56], opened new perspectives for research on intelligent agents. Now, the Internet allows robots to collect data and to communicate among themselves as shown by the Italian project *Robo Ex Novo-Robots Learning about objects from externalized knowledge sources* from the University of Rome. Here researchers have developed algorithms able to build robots' knowledge through the Web, and then robot self-learning[57]. (See chap. II)

To describe robotic evolution, we have to consider both form and function of robots (or better) the ability of robots to act within the environment.

Form refers to robots' physique aspect. There are three different features: moveable arms – which work in industrial assembly lines; movable robots, able to move in the environment; humanoids, which have sensory and motor abilities that emulate the human ones.

Examples of movable robots are ROOMBA and AIBO. The former is a robot vacuum cleaner, produced by the American company iRobot. ROOMBA has multiple sensors to detect the objects, which could block its path and the edge of the floor in order to avoid falling down. It can also automatically adjust to different kinds of floor and choose the most suitable cleaning program. «The self-charging function can lead ROOMBA to the self-charging base between each cleaning session. It can design a cleaning schedule by its own to intensely clean the dirty parts»[58].

AIBO is a dog robot, produced by the Japanese multinational Sony. It is a «pet-type robot that combines hardware and software in order to move naturally and expressively, think and depict feelings, training, intentions, instincts (love, search, movement, recharge, sleep), development and physiological characteristics. This

[55] PASCUZZI G., *Il diritto dell'era digitale*, 3nd ed., Bologna, 2010.
[56] BERNERS-LEE T., CAILLIAU R., LUOTONEN A., NIELSEN F. H., SECRET A., *The World- Wide Web, Communications of the ACM*, vol. 37, N. 8, 1994, pp.76-82.
[57] [Online] *Barbara Caputo, la mamma-fisico che insegna ai robot l'uso di Internet*, http://roma.corriere.it/notizie/cronaca/15_aprile_06/barbara-caputo-mamma-fisico-che-insegna-robot-l-uso-internet-61b8bf42-dc26-11e4-83c6-bcc83638beb8.shtml.
[58] CHEN H., DAVID M., GLIGORESCU A., *The influence of robots on the human society*, 3nd semester project, Basic Studies in Natural Sciences, R.U.C., 2011, p. 33.

inanimate technological system supports communication with user by expressing different moods and predefined behaviors based on learning from adaptation to user preferences. It is equipped with a variety of sensors, face lights, musical tones, camera, a stereo microphone for sound analysis and a loudspeaker and uses integrated control over the operation of the 20 joints and 20 degrees of freedom»[59].

Examples of humanoid robots interacting with humans[60] are: H7 - designed by LabJSK at University of Tokyo - and HRP-2P - carried out under the Japanese Humanoid Robotics Project. Both are used as an experimental platform to study ambulant on rough terrain and to research every situation related to Human-robots interaction. The most advanced android is ASIMO (Advanced Step in Innovative Mobility) designed by Honda's Research & Development Wako Fundamental Technical Research Center in Japan. It is as multi-function mobile assistant and it can walk, run, dance, go up and down the stairs, stand on its leg, and play soccer. It can also recognize people, greet and call people by their name, follow moving objects and follow given directions.

The second criterion of robotic evolution is their functions, which give us an idea about their degree of intelligence.

The technological artefacts were born as automated articles and now they are developing as semiautonomous products. In the future they will probably become fully autonomous[61].

Automated artefacts are programmed to respond to a set of actions developed by their manufacturer or designer, who build a sort of parallel environment into the robot's brain that may be considered a minimal representation of reality. «Normally, a pre-programmed machine is a computer-controlled and it does is work with very little variation. This means that such machines have no or little capacity to vary from the original instructions or from pre-programmed movements»[62].

At first, automation market had settled in the industrial field. Later, the

[59] SPYRIDON M.G., ELEFTHERIA M, *Classification of domestic robots,* Proceedings in ARSA-Advanced Research in Scientific Areas 1(7), 2012, p. 1693; PRANSKY J., *AIBO - the No. 1 selling service robot.* Industrial Robot, 28(1), 2001, pp. 24–26.

[60] [Online] *The Honda Humanoid Robot- Asimo,* Technical Information (2007) http://asimo.honda.com/downloads/pdf/asimo-technical-information.pdf.

[61] KRISHNAN D.A., *Killer robots: Legality and Ethicality of Autonomous Weapon*, Farnham (UK) and Burlington (USA), Ashgate, 2009, p. 43 ss. proposed a distinction between: pre-programmed; limited or supervised autonomy and complete autonomy.

[62] *Idem,* p. 43.

automated artefacts have been introduced into households, for instance as household appliances, automatic gates, elevators. Their behaviour is programmed, thus their actions are predictable and when robots are in a different environment than the originally planned one, they seize up.

Semiautonomous products are available at this historical moment. To understand this type of robots we are going to study both intelligence and autonomy which are two different terms.

A robot could be autonomous because it has motor skills and it doesn't require human intervention, but its degree of intelligence is low because it acts on the basis of the user or designer's instructions. This illustrates that (artificial) intelligence – rather than autonomy – provides specific social, ethical and legal issues.

«The possible variance in behaviours is greater than in the case of pre-programmed autonomy, which allows the robot to find its own way and to do any other things without the need of continuous human intervention. […] Robots with limited autonomy are less capable of dealing well with situation not foreseen by their programmers and therefore need some human supervision»[63].

Semiautonomous robots have a mean degree of intelligence because they are not able to think as a human being. Their condition of limited brainpower requires human supervision as an integral parts of the robot's action.

Fully autonomous robots are the last categories of this functioning evolution. They do not require human intervention, «they are often able to learn themselves and to modify their behaviour accordingly»[64]. Nowadays they exist as experimental robots and are built for research scopes. Some scholars think a small number of robots can be considered as genuinely autonomous[65].

However this scenario will eventually disappear in the next years since semi-autonomous robots are a temporary stage which prevents the advent of robots with a high level of autonomy. Recently some researchers of Hasegawa at Tokyo Institute of Technology have created a new model of self-thinking, self-learning and self-acting

[63] *Idem*, p. 44.
[64] *Ibidem.*
[65] HEUDIN J.C., *Les 3 lois de la robotique: Faut-il avoir peur des robots?*, Paris, 2015 (suggests of seeing market with the aim to assess that really autonomous robots do not exist); KARNOW C.E.A., *The application of traditional Tort Theory to Embodied Machine Intelligence*, op. cit., 2013.

robot thanks to SOINN (Self-Organizing Incremental Neural Network)[66].

Finally, another classification of robots could be done according to the level of cognitive or reactive abilities.

The approach used for cognitive robots is a symbolic-deliberative one, founded on a reasoning-planning paradigm[67]. A cognitive robot is able to respond to external stimulus on the basis of pre-programmed situations carried out by its designer. Thus it has a formal representation of the environment that includes its knowledge, its scope and its actions, which will be exploited within the environment in order to achieve goals. Each of these robots is characterised by both preconditions and effects.

Instead, reactive robots are able to adapt to not planned situations thanks to a cognitive process that simulates human intelligence. Robots choose actions in accordance with their perception and to input corresponding to a related action. That is possible because they have a sub-symbolic knowledge that is conventionally defined as Brooks' Subsumption Architecture. It is organised with a series of structured behaviours[68].

To eliminate the specific concerns of these two approaches, researchers combined them, so that robots can have both reactive and cognitive behaviour[69].

2. Defining IARs.

«I can't define a robot, but I know one when I see one»[70].

This sentence captures the multiplicity of definitions of the word "robot" and their general nature. The definition of robot is not a unique one.

The term robot derives from the Czech word "robota" meaning "hard work" in Czerny and slave generally. The term came into being with the play *Rossum's Universal Robotics* written by K. Čapek in 1921.

[66] SOINN technology allows the adaptation of robots to new situations and then it can pick up information on the Internet or other robots.
[67] RAO A.S., GEORGEFF M.P., *Modeling rational agents within a BDI-architecture*, in Proceedings of KR-91, Morgan Kaufmann, 1991, pp. 473-484.
[68] BROOKS R.A., *A robust layered control system for a mobile robot*, IEEE Journal of Robotics and Automation, 2 (1), 1986, pp. 14–23.
[69] GOY A., TORRE I., *Agenti artificiali e agenti intelligenti: paradigmi, applicazioni e prospettive*, in Lexia, volume monografico Attanti, Attori, Agenti, a cura di M. LEONE, Aracne, n. 3-4, 2009, pp. 299-315.
[70] ENGELBERGER J., *Robotics in service*. Cambridge, MA: MIT Press, 1989.

In 1942 the term robot became popular thanks to I. Asimov's novel. Asimov wrote the three well-known robotic laws and the positronic brain[71]. He imagined a world where robots were an integral part of society.

The EU so-called "Machinery" Directive[72] 2009/127/EC adopted by the Parliament and Council of the European Union, portraits the following definition of industrial robots:

> «'machinery' means: - an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application, - an assembly referred to in the first indent, missing only the components to connect it on site or to sources of energy and motion, - an assembly referred to in the first and second indents, ready to be installed and able to function as it stands only if mounted on a means of transport, or installed in a building or a structure, - assemblies of machinery referred to in the first, second and third indents or partly completed machinery referred to in point (g) which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole, - an assembly of linked parts or components, at least one of which moves and which are joined together, intended for lifting loads and whose only power source is directly applied human effort» (art.2).

In parallel with the development of industrial robots, new definitions were created, in particular in 2012 by the International Organization for Standardization (ISO) with ISO 8323:2012 that defines a robot:

> «an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention».

Then, it makes a distinction between industrial robots:

> «automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications»;

and service robot:

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[71] ASIMOV I., *Runaround,* Astounding Science Fiction, New York. 1942. The laws are «*A robot may not injure a human being or, through inaction, allow a human being to come to harm. A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law*».

[72] DIRECTIVE 2009/127/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 21.10.2009 amending DIRECTIVE 2006/42/EC with regard to machinery for pesticide application.

«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».

Then, the the ISO standard makes a distinction between personal service robot and service robot for personal use. Accordingly, a personal service robot:

«is a service robot used for a non-commercial task, usually by lay persons. Examples are domestic servant robot, automated wheelchair, personal mobility assist robot, and pet exercising robot»;

A professional service robot or service robot for professional use, which:

«is a service robot used for a commercial task, usually operated by a properly trained operator. Examples are cleaning robot for public places, delivery robot in offices or hospitals, fire-fighting robot, rehabilitation robot and surgery robot in hospitals. In this context an operator is a person designated to start, monitor and stop the intended operation of a robot or a robot system»[73].

These ISO definitions are only functional and are set forth as technical standards. No legislative definition taking into account different robotic applications, such as social robots can be detected as of today.

CERNA (Commission de réflexion sur l'Éthique de la Recherche en sciences et technologies du Numérique d'Allistene) defines robot as:

«une machine mettant en œuvre et intégrant: des capacités d'acquisition de données avec des capteurs à même de détecter et d'enregistrer des signaux physiques; des capacités d'interprétation des données acquises permettant de produire des connaissances; des capacités de décision qui, partant des données ou des connaissances, déterminent et planifient des actions. Ces actions sont destinées à réaliser des objectifs fournis le plus souvent par un être humain, mais qui peuvent aussi être déterminés par le robot lui-même, éventuellement en réaction à des événements; des capacités d'exécution d'actions dans le monde physique à travers des actionneurs, ou à travers des interfaces. Le robot peut également présenter: des capacités de communication et d'interaction avec des opérateurs ou des utilisateurs humains, avec d'autres robots ou des ressources via un réseau comme l'Internet. Une capacité transversale aux précédentes, l'apprentissage, qui permet au robot de modifier son fonctionnement à partir de son expérience passée»[74].

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[73] ISO 8373:2012 was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 2, *Robots and robotic devices*.

[74] CERNA, *Éthique de la recherche en robotique*, 2014 available at http://cerna-ethicsallistene.org/digitalAssets/38/38704_Avis_robotique_livret.pdf.

Social robots are also defined in Oxford English Dictionary (OED), in which a robot is «a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer». At the same time, robots are also associated with humanoid machines that take over all kinds of functions from humans. The OED continues its description saying that a robot is also «a machine resembling a human being and able to replicate certain human movements and functions automatically».

Webster’s Dictionary describes a robot as: «a physical entity embodied in a complex, dynamic, and social environment sufficiently empowered to behave in a manner conducive to its own goals and those of its community»[75].

This is only a tiny part of the many existing definitions, hence the concept of robot has not a unique definition and there is still a normative provision on that.

Under a structural approach, robot is a programmable, self-controlled device consisting in electronic, electrical, or mechanical units. More generally, it is a machine that functions in substitution of a living agent. It may include any of the following components: effectors (arms, legs, hands, and feet); sensors (acting like senses and converting the information into symbols); computer (the brain containing algorithms to control the robot); equipment (including tools and mechanical fixtures)[76].

However this approach gives a definition characterised by a set of electronic elements which does not serve to understand the true difference between robots and other technological objects. This description points out the structural complexity of a robot without drawing attention about legal questions which could arise.

On the contrary, the structural variety may be relevant bearing in mind that robots’ functions make them a world apart different from other technologies; they generally have the following functions: sense - «receiving information from various sensors»; plan «taking in information» and «producing one or more tasks»; act - «producing output commands to motor actuators»[77]. The different degree of intelligence

[75] DUFFY, B. *The Social Robot*. Ph.D. Thesis, Department of Computer Science, University College Dublin, 2000.

[76] [Online] *The definition of robot – Inventors*, http://inventors.about.com/od/roboticsrobots/a/RobotDefinition.htm.

[77] SHARKEY N., *The Ethical Frontiers of Robotics*, 322 Science, 2008, pp. 1800-1801.

enable carried out a classification on different levels. Each of them raises specific ethical, social and legal issues.

The robot's abilities allow employing them in «4D tasks», such as dangerous, dirty, dull, and dumb[78]. In other words the features of robots enable employing them in activities that are dangerous, dirty, dull and dumb. These situations are implemented in the following fields[79]: industrial[80]; medical[81]; military[82]; educational[83]; entertainment[84];

[78] TAKAYAMA L. et al., *Beyond Dirty, Dangerous and Dull: What everyday people think robots should do*. HRI '08, Proceedings of the 3th ACM/IEEE International Conference on Human Robot Interaction. New York, NY, USA, ACM, 2008, pp. 25-32. «*Robots are frequently envisioned as fulfilling jobs that have the three Ds: dirty, dangerous and dull. In this model, the archetypical robot job is repetitive physical labor on a steaming hot factory floor involving heavy machinery that threatens life and limb*».

[79] STRUIJK B., *Robots in human societies and industry*. International Journal in Academic and Applied Research in Military Science AARMS, Vol. 10, Issue 1, 2011, pp. 183-195 presents a table providing an exhaustive overview of the various categories of modern robots.

[80] They are machines that move autonomously on the ground, in the water, in the sky and on the road (several manufacturers are currently developing vehicles that drive themselves, requiring little-or no-human input: [Online] HACHMAN M., *Volkswagen Develops Self-Driving Car, Almost*, 2011 available at PCmag.com,http://www.pcmag.com/article2/0,2817,2387524,00.asp#fbid=cbDEXQGVzSY; WOJDYLA B., *Ford Developing System To Tell Future, Predict Crashes Before They Happen*, Jalopnik, 2009, available at http://jalopnik.com/5377690/ford-developing-system-to-tell-future-predict-crashes-before-they-happen; SQUATRIGLIA C., *GM Says Driverless Cars Could Be on the Road by 2018*, Wired.com Autopia, 2008 available at http://www.wired.com/autopia/2008/01/gm-says-driverl; GOLDBERG D., *Self-Driving Robot Cars About to Hit Nevada Highways.* Las Vegas Sun, 2011 available at http://www.lasvegassun.com/news/2011/jun/26/self-driving-robot-cars-about-hit-nevada-highways.

[81] Robots are used in rehabilitative healthcare therapy (HUSSEIN A.A. et al., *Results of clinicians using a therapeutic robotic system in an inpatient stroke rehabilitation unit.* Journal of neuro-engineering and rehabilitation, 2011; ESCHWEILER J. et al., *A survey on robotic devices for upper limb rehabilitation*. Journal of neuro-engineering and rehabilitation, 11.1, 2014; to administrate adequate medication to the patients (Van den BEMT P.M.L.A., IDZINGA J.C., ROBERTZ H., KORMELINK D.G., PELS N., *Medication Administration Errors in Nursing Homes Using an Automated Medication Dispensing System.* Journal of the American Medical Informatics Association, 16(4), 2009, pp. 486-492; in surgical procedures PEÑA GONZÁLEZ J.A. et al., *Evolution of open versus laparoscopic/robotic surgery: ten years of changes in urology*. Actas Urológicas Españolas (English Edition) 34.3, 2010, pp. 223-231; in therapeutic option for several disorders and illnesses SALE P. et al., *Robot-assisted walking training for individuals with Parkinson's disease: a pilot randomized controlled trial.* BMC neurology 13(1), 2013, p. 50; HESSE S. et al., *Robot-assisted practice of gait and stair climbing in non-ambulatory stroke patients.* Journal of Rehabilitation Research & Development, 2012, 49.4; SHAMSUDDIN S. et al., *Initial response of autistic children in human-robot interaction therapy with humanoid robot NAO.* Signal Processing and its Applications (CSPA), IEEE 8th International Colloquium, 2012, pp. 188 -193.

[82] Among others *see* generally LUCAS G., *Industrial Challenges of Military Robotics.* Journal of Military Ethics 10(4), 2011, pp. 274-295; NASKAR S. et al., *Application of Radio Frequency Controlled Intelligent Military Robot in Defense.* Proceedings of International Conference on Communication Systems and Network Technologies (CSNT), Katra, India, 2011, pp. 396–340; SHARKEY N., *The automation and proliferation of military drones and the protection of civilians.* Law, Innovation and Technology 3.2, 2011, pp. 229-240; ARJOMANDI M. et al., *Classification of Unmanned Aerial Vehicles.* The University of Adelaide. Australia, 2007.

[83] Among others *see* SANSING C., *Build Better Robots with LEGO* Mindstorms Education EV3 SLJ Review, 2014, available at http://www.thedigitalshift.com/2014/02/k-12/highly-intelligent-brick-build-better-robots-legos; HUNG H.K., CHONG-JI KE, *Integrating computer games with mathematics instruction in elementary school-An analysis of motivation, achievement, and pupil-teacher interactions.* World Academy of Science, Engineering and Technology 60, 2009, pp. 992-994.

personal; agricultural[85] and assistive[86].

Hence, a definition of robot should mainly involve its functions. Instead its structure should be considered with regard to its abilities. The structure increases the functions of robots.

The effort on defining robots becomes relevant with respect to robot's qualification. A working definition could implement an idea about robots which could influence the application of current legal categories on tortious events involving robots, too (*see* chap. IV).

Taxonomy of robot's qualification, based on several scholars' theories, could structure as follows:

(a) *Robot as a product/good/object*. Many current robots, used in different fields, are automated or remote-controlled by humans. They process and perform the pre-programmed tasks and act by making decisions apparently «self-made». Indeed, their decisions are based on the internal system of the software, which will often be unknown to users.

(b) *Robot as an animal*. Some scholarship has advocated the utility to compare autonomous robots to animals. However this comparison gives rise to some doubts (*see* chap. IV).

(c) *Robot as legal person*. Some scholars support the view that fully autonomous robots should be acknowledged with legal personality. This theory gives rise to greater reservations among those who consider them to be unable of discerning the best reaction to situations - given that they act on basis of program made by their manufacturers[87] - those who argue that such recognition will be «*dangereuse et*

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[84]ALVES S. et al., *A friendly mobile entertainment robot for disabled children*. Biosignals and Biorobotics Conference (BRC), ISSNIP. Rio de Janerio, 2013; YAMAMOTO S., KIMURA R., *Investigation of playing with entertainment robotic pet of pre-school aged child in nursery school by video observation.* SICE, Annual Conference. IEEE, 2007.

[85] YAGHOUBI S., et al., *Autonomous Robots for Agricultural Tasks and Farm Assignment and Future Trends in Agro Robots*. International Journal of Mechanical & Mechatronics Engineering 13.3, 2013; HELLSTRÖM T., RINGDAHL O., *A software framework for agricultural and forestry robots*, Industrial Robot. An International Journal, Vol. 40, Issue: 1, 2013, pp. 20-26.

[86] TORTA E. et al., *Attitudes towards socially assistive robots in intelligent homes: results from laboratory studies and field trials.* Journal of Human-Robot Interaction 1(2), 2012, pp. 76-99; EDELMAYER G. et al., *Prototyping a LED projector module carried by a humanoid NAO robot to assist human robot communication by an additional visual output channel*. Proc. IASTED, 2012.

[87] BENSOUSSAN A., *Les droit des robots. De l'éthique au droit: Planète Robots*, n. 24, 2013, p. 24; VEBER PH., *Droit&Robotique: Le choix du pragmatisme et du réalisme*, 2014 available at http://www.veberavocats.com/blog/droit-robotique-le-choix-du-pragmatisme-et-du-realisme_a388/.

hasardeuse»[88], and those who - instead of reframing robot into a conventional legal categories, argue for the need of recognizing new concept encapsulating the idea of - suggest an artificial awareness («*une forme de coscience artificielle*»[89]).

(d) *Robot as a system.* Robot is not a collection of elements; on the contrary it is a functional unitary taking into account. The system is not the result of the «thing itself», it is the outcome of a number of relationships, replicating into subsystems of incessant self-reproductive activity. This interpretation drifts from traditional categories and enables to bear in mind these sophisticated technological objects with regard to their abilities and their plausible social behaviours. This point attracts law scholars' interest[90].

2.1. The difference between autonomy and intelligence and artificial intelligence (AI)

To explain the functioning of these particular «machines», that are changing our life, we should focus on different features that are at their core: robot (embodied)[91], autonomy and intelligence software architecture.

Further technical descriptions wouldn't be of any use for the purpose of this research. It is more interesting to analyse the possibilities and experiences the architecture creates and prevents, because robots capacity to act physically upon the world translates, in turn, into potential physical harm to people or property.

So, when we project a robot we should start by saying that it has a physical presence and it is able to sense, plan and act upon the world. This point of view will help us to consider not only their pre-programmed actions but also their possibility to have an unpredictable behaviour[92].

[88] LOISEAU G., BOURGEOIS M., *Du robot en droit à un droit des robots*, JCP G., 2014, p. 2162. They consider the recognition of personhood to robots is *dangereuse* because «*il serait désastreux de singer les personnes humaines pour faire une place à des personnes robots avec lesquelles elles interagissent» et hasardeuse* because *«il ne répond pas à aucun besoin social*».

[89] *Ibidem.* Authors consider *la charte éthique* «*ensemble des règles constituant une forme de conscience artificielle qui pourrait être programmée dans les machines*».

[90] ASARO P., *Robot and responsibility from a legal Perspective*. Proceedings of IEEE Conference on robotics and automation: workshop on Roboethics, Roma, 3, 2007.

[91] Robot embodied is a decription used by CALO R., *Robotics and the new cyberlaw*, op. cit., 2014. Its sense is that software is embodied in a robot, in other words this definition describes the inclusion of a brain in a body.

[92] *Ibidem*. A. says «*embodiment, emergence, and social meaning are three features - alone, and especially in combination - turn out to be relevant to an extraordinarily wide variety of legal contexts: criminal law and procedure, tort, intellectual property, speech, privacy, contract, tax, maritime law, to name but a few*».

This great possibility can be carried out through *artificial intelligence*[93]. Based on computer science, engineering and computational understanding, AI creates artefacts and gets them to behave or think intelligently, to solve problems and reach goals in the kinds of complex situations in which humans require intelligence to achieve goals[94]. So an intelligent robot has the ability to determine behaviour that will maximize the probability of purpose satisfaction in a dynamic and uncertain environment[95].

Intelligence is not synonymous of capability and, in particular, autonomy. First, a remote control robot might be incapable of developing any intelligent solution; however when a remote control robot it is given a solution, it could execute task corresponding into that solution with minor failures than an intelligent system. It might correctly determine a valid course of action to achieve a goal, but it may also be incapable of executing it[96].

Second, autonomy[97] allows robots to decide their own behaviour - choosing among many options - and to execute the chosen options. It is clear that a system cannot be considered autonomous if it is not able to generate options for behaviours or to select among several options, but the execution of the option is controlled by an external agency.

Both intelligence and capability settle the maximum level of autonomy that a system reaches. Within this range, the system can have as many variable levels of

[93] AI is «*the intelligence exhibited by machines or software, and the branch of computer science that develops machines and software with intelligence*», *Artificial Intelligence* in Wikipedia; McCARTHY J. *Basic Questions, What is Artificial Intelligence?,* 2007 available at https://web.archive.org/web/20131011010206/http://www.formal.stanford.edu/jmc/whatisai/whatisai.html defines AI as «*the science and engineering of making intelligent machines*». It is interesting that in a recent bill on autonomous vehicles adopted by the state of Nevada in the USA, artificial intelligence is defined as the use of intelligence by computers and similar devices, allowing the machines to imitate and reproduce human behavior. ASSEMBLY BILL N. 511 – COMMITTEE ON TRANSPORTATION, (2011).

[94] FETZER J.H., *Artificial intelligence: its scope and its Limits,* Dordrecht, The Netherlands: Kluver Academic Publishers, 1990.

[95] ALBUS J.S., MEYSTEL A.M., *Engineering of Mind, – An Introduction to the Science of Intelligent Systems,* John Wiley & Sons Inc., Chichester, 1, 2001, pp. 6-7.

[96] GUNDERSON J.P, GUNDERSON L.F., *Intelligence ≠ Autonomy ≠ Capability*. Performance Metrics for Intelligent Systems, PERMIS: Gaithersburg, Maryland, USA, 2004. To demonstrate the interdependence between intelligence and capacity authors elaborate this function: «*g = f (c, i,) (where g = goal satisfaction, c = capability, and i = intelligence)* » based on example of four vacuum cleaning robots.

[97] The term autonomy means: 1) the condition or quality of being self-governing; 2) self-government, or the right of self-government; self-determination, independence; 3) a self-governing state, community, or group *see* AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE, New York: American Heritage Publishing Co., 1969.

autonomy as the designer allows. In other words, as intelligence and capability increase, the range of available options increases[98], as well.

Therefore we can understand the difference between an autonomous system and an automated system in this way: the latter cannot choose for itself; it just follows a script, that could also be complex, one in which the programmer could have already elaborated all possible courses of action. By contrast, an autonomous system is able to act without human intervention. As a consequence, only an intelligent autonomous robot could take unpredictable behaviours in unpredictable environments in which it can interact with us humans[99] when pursuing the tasks that it is assigned with[100].

So, only a high level of intelligence allows the robot to have an unpredictable behaviour, as it can collect pieces of information without an express instruction to do so, choose information from available data without direction, make calculations without being told to do so and implement decisions without authorization[101].

To reach this stage, robots are programmed with hybrid architecture with algorithm using that use particular methods[102], such as genetic algorithms, fuzzy logic, learning e artificial neural network.

The basic idea is to emulate human brain cells with the aim to reproduce human intelligence.

A specific discipline ALIFE (Artificial Life) intended to simulate living organisms' behaviour on computer[103] by using DARWIN's evolution theory in order to understand how evolution processes are developing trough simulation on computer. In ALIFE, automaton cells are self-guided software that lives in two-dimensional simulated environments. These cells have some simple behaviours, for instance life

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[98] Intelligence and capability act as upper bounds on the autonomy of a system as shown by a graph in GUNDERSON J.P, GUNDERSON L.F., *op. cit*., 2004, p. 4.

[99] FROST C.R., *Challenges and Opportunities for Autonomous Systems in Space Frontiers of Engineering*: Reports on Leading-Edge Engineering from the 2010 Symposium, 2010, pp. 89-90.

[100] For example, a ROOMBA floor cleaner may not be humanly guided in real time and it operates from previously fixed code. That means that it has marginal autonomy, where it cannot deal with by itself numerous situations.

[101] In order to have ideas about the possibilities of intelligent software see MCAUDILL C., BUTLER C., *Naturally intelligent systems*, 1990, pp. 152-153.

[102] These methods allow to make control system different from planning- and behavior- on basis of robotics. In the first, only the programmer knows the environment and plans robot actions in case it finds obstacles; in the second, the planning of the environment can be decomposed in reactive behaviors (i.e. to avoid obstacles and follow walls).

[103] ALIFE discipline was born in 1987 with a conference at Oppenheimer Study Center of Los Alamos (New Mexico) organized by biologist LANGTON C.

processes, and they can self-reproduce by combining elements (that are within the environment) based on guideless rules. Mutations simulating variations of real organism may occur during reproduction[104].

A self-reproducing structure is a genetic algorithm[105]. Their reproduction is based on natural selection, where some parents/algorithms reproduce themselves causally. They have a digital genetic heritage expressed in terms of sequences of bits. Two types of evolutionary processes are applied on these algorithms, such as casual mutation of one or more bits of the original genetic heritage. The crossing over, i.e. the creation of an individual child whose genetic heritage is composed by two parents/algorithms ones. Then, the most suitable individuals will be submitted to new mutations, while others will be removed. The process goes on until the evolution is achieved and it does not create algorithms which are able to solve problems[106].

Genetic algorithms allow the acquisition of the learning process by working on a modified process of primary learning, through a corrective modification of the available options[107].

On the other hand, neural networks emulate neural cells. They are computational examples that emulate the human brain, in particular the connections among neurons communicating and enabling processes through electrical impulses. Network models are structures composed by a certain number of units linked to each other. A unit affects other units through connections. They allow learning specific functions in a specific environment. There are two types of models simulating learning: «supervised» artificial neural networks - that simulate learning «for try and bug» on the basis of goals established by a tutor - and «unsupervised» - that are considered inside criteria of classification[108].

Each method has been adopted in different projects in order to developed potential solutions for the improvement of robots' intelligence. Among them: neuron-

[104] CONWAY J.H. knows an example of this research method as «game of life» invented in 1960. A two-dimensional chessboard composes the game's environment and, here, there are some bodies represented by one or more full jail cells; on the contrary, those ones empty die. These bodies evolve because of simples rules. In this way, system evolves itself and creates complex life forms.

[105] HOLLAND J.H., early to mid '70, invented a method to identify and optimize algorithms used in calculating some functions.

[106] CIOTTI F., *Introduzione all'intelligenza artificiale. Un nuovo paradigma: reti neurale e vita artificiale,* http://www.mediamente.rai.it/mediamentetv/learning/corsi/9912c2_4.asp.

[107] Genetic algorithms *see* HOLLAND J.H., *Adaption in natural and artificial systems*. Ann Arbor: University of Michigan Press. Second edition 1992, Cambridge MA: The MIT Press.

[108] PARISI D., *Mente. I nuovi modelli della vita artificiale,* Bologna, 1993, p. 80.

evolutionary navigation systems that allow a better behaviour than rule-based navigation[109]; adaptive robot which are able of adapting to their environment[110] by realizing and exploiting precise coordination between produced outputs and self-generated internal inputs[111]; the combination of multiple and simple behaviours in order to create a particular intelligent response that is superior to the sum of its parts[112].

In this last case, robots create the modules needed from smaller units; also they can also separate and reconfigure them in order to make new arrangements in response to the constraints of the physical environment. The applied method used to carry out this dynamic is called kind of operations is swarm robotic. This is an open-source agent-based modeling simulation package, useful for simulating the interaction of agents and their emergent collective behavior.

An open source is inserted into hardware by developers and it is different than closed software. The latter is sold with a license of use by the manufacturer and – unlike other open software - the code is not accessible[113].

This technology leads some researchers to develop Self-Organizing Incremental Neural Network (SOINN) that is especially effective for real-world data processing, and it can be effectively used for the learning and recognition of patterns such image and sound data, or intelligent robots that run online and in real time in a real environment. The neurons in the network are self-organized, so it is not necessary to

[109] BROOKS A.R., *A Robot that Walks; Emergent Behaviors from a Carefully Evolved Network,* in IEEE International Conference on Robotics and Automation, Scottsdale, AZ, May 1989, pp. 292-296.

[110] FLOREANO D., KELLER L., *Evolution of Adaptive Behaviour in Robots by Means of Darwinian selection*, in Robots by Means of Darwinian Selection. PLoS Biol 8(1), 2010.

[111] MATHEWS N., CHRISTENSEN A.L., O'GRADY R., DORIGO M., *Spatially Targeted Communication and Self-Assembly*. Proceedings of the 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS, 2012. Vilamoura, Algarve, Portugal; MENG Y., ZHANG Y., JIN Y. (2011). *Autonomous Self-Reconfiguration of Modular Robots by Evolving a Hierarchical Mechanochemical Model*, IEEE Computational Intelligence Magazine, vol. 6, Issue: 1, pp. 43-54.

[112] DORIGO M. et al., *Swarmanoid: A Novel Concept For The Study Of Heterogeneous Robotic Swarms*. IEEE Robotics & Automation Magazine, IEEE Vol. 20, Issue: 4, 2013.

[113] On open software see CASO R., *Digital rights management: il commercio delle informazioni digitali tra contratto e diritto d'autore*, Trento, 2006, LEMLEY M.A, MENELL P.S., MERGES R.P., SAMUELSON P., *Software and Internet Law*, II ed., New York, 2003, 919; NADAN C.H., *Open Source Licensing: Virus or Virtue?*, 10 Tex. Intell. Prop. L. J., 2002, 349; MCGOWAN D., *Legal Implications of Open Source Software*, 2001 U. Ill. Rev., 2001, 241,; MCJOHN S., *The Paradoxes of Free Software,* 9 Geo. Mason L. Rev. 9 (25), 2000; LESSIG L., *The limits in Open Code: Regulatory Standards and the Future of the Net,* 14 Berkeley Tech. L. J., 1999, 759; GOMULKIEWCZ R., *How Copyleft Uses License Rights to Succeed in the Open Software Revolution and the Implications for Article 2B*, 36 Hous. L. Rev., 1999, 179; HEFFAN I.V., *Copy left: Licensing Collaborative Works in the Digital Age*, 49 Stan. L. Rev., 1487 (1997).

define the network structure and size in advance [114]. EU project, entitled Evolvingrobot[115], is an experiment of little robots that are able to copy collective behaviours of humans.

In these cases the robot itself and alone (or in collaboration with others) develops - starting from a sort of *tabula rasa* - a set of strategies and behaviours as a result of the adaptation to the environment and to its own body[116]. It is hard to control and make predictions about and expect the robot's behaviour because connections exploited for optimal robot functioning are not linear.

Some researchers have described the service robots as "underspecified" because «the tasks of a service robot are frequently underspecified, i.e., not predefined completely, because users usually provide underspecified descriptions about their intentions (e.g., tasks) and the environments are typically unpredictable and dynamic. Of course, one can choose to develop service robots of which the tasks are defined completely in advance. But this choice means that the robots have no sufficient [sic] capability to response/adapt to their unpredictable and dynamic environments, as well as the users»[117].

These concerns involve in particular the new trend of cooperation among multi-agents or swarm robotics. Several agents interact in an attempt to jointly solve in a collaborative way tasks or maximise utility through cooperation[118]. These systems are

[114] SHEN F., HASEGAWA O., *An incremental network for on-line unsupervised classification and topology learning*. Neural Networks, vol. 19, No.1, 2006, pp. 90-106; YAMASAKI K., MAKIBUCHI N., SHEN F., HASEGAWA O., *How to use the SOINN Software: User's Guide* (Version 1.0), Artificial Neural Network – ICANN, Lecture notes in Computer Science, 6354, 2010, pp. 521-527.

[115] EVOLVINGROBOT is «*a European Union (EU) funded research project which has developed an artificial intelligence system to control tiny robots, enabling them to replicate the 'swarming' behavior seen in insects such as bees or ants, or even in birds and fish. It is an innovation which could have far-reaching implications for a range of human activities, from medical to industrial, military and disaster relief*», available at http://ec.europa.eu/programmes/horizon2020/en/news/way-future-%E2%80%98swarming%E2%80%99-robots.

[116] FLOREANO D., MONDADA F., *Automatic creation of an autonomous agent: genetic evolution of a neural-network driven robot*. Proceedings of the third International Conference on simulation of adaptive behavior: from animals to animats3. Cambridge: MIT Press, 1994, pp. 421-430. Authors describe the results of the evolutionary development of a real, neural network driven mobile robot; the completely evolutionary process takes places entirely on a real robot without human intervention. They show a number of emergent phenomena that are characteristic of autonomous agents.

[117] CHEN X., JI J., JANG J., JIN G., WANG F., XIE J., *Developing High-Level Cognitive Functions for Service Robots*, In: Proc. of 9th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS 2010), Toronto, Canada, 2010.

[118] PANAIT L., LUKE S., *Cooperative Multiagent Learning: The State of The Art*. Autonomous Agents and MultiAgent Systems 11(3), 2005, pp. 387-434.

composed of several robots equipped with various devices, such as arms and grippers to carry out activities and a host computer to coordinate them[119].

2.2. The misleading anthropomorphic conception of robots.

> «The total number of professional service robots sold in 2013 rose by a relatively low 4% compared to 2012 to 21,000 units up from 20,200 in 2012. The sales value slightly decreased by 1.9% to US$3.57 billion. […]. In 2013, about 4 million service robots for personal and domestic use were sold, 28% more than in 2012. The value of sales increased to US$1.7 billion. […]. It is projected that sales of all types of robots for domestic tasks (vacuum cleaning, lawn-mowing, window cleaning and other types) could reach almost 23.9 million units in the period 2014-2017, with an estimated value of US$6.5 billion. The size of the market for toy robots and hobby systems is forecast at about 4.5 million units, most of which for obvious reasons are very low-priced. About 3 million robots for education and research are expected to be sold in the period 2014-2017. […] Sales of all types of entertainment and leisure robots are projected at about 7.5 million units, with a value of about US$4.5 billion. […] Sales of robots for elderly and handicap assistance will be about 12,400 units in the period of 2014-2017. This market is expected to increase substantially within the next 20 years»[120].

The International Federation of Robotics has produced this information on service robots; it shows that the market of robots is different from how collective imagination depicts it.

Public opinion is convinced that robots are only the artefacts that look like humans, since most people know robots as characters of movie or novels where they have human qualities and characteristics.

This belief is incorrect, since, considered under Darwin’s-evolution theory, humanoid are only the last product of the evolution of robotic species. Now, humanoids represent sophisticate evolved organism: an “apparent object” with a human skeleton, a torso, two arms, two legs and a head with a face, eyes resembling those of the animals, and a mouth, all these elements put together become an entity that is reminiscent a living organism. The quality of their voice - in synthetic speech output - is improving and becoming more natural.

In addition, their design enables robots to receive instructions for carrying out tasks by using multi-modal interfaces, which combine i.e. speech, gestures, and faces. However, the complexity of this design represented an obstacle for the development of

[119] KIM K.H., RELKIN N.R., LEE K.M., HIRSCH J., *Distinct cortical areas associated with native and second languages.* Nature, 388 (6638), 1997, pp. 171-174.
[120] http://www.ifr.org/industrial-robots/statistics/

humanoid, which in fact are way fewer than other type of robots.

Nonetheless humanoids are usually preferred to other ones by manufacturers and it is developing on the basis of some HRI theories better used in this field[121]. The preference is justified because it achieves a greater social acceptance by consumers: they are more prone to interact with metal and technological tools that look like them[122]. This seems to be the best model of solving interaction problems between robots, and environment[123], and increasing social acceptance[124].

Also, humanoids bring important benefits with regard to the implementation of functions: they combine both advanced abilities in manipulating and cognitive processes similar to human ones; they are anthropomorphic, thus they are able to operate in an unmodified environment suitable for humans; they resort to tools and equipment usually used by humans.

However, the advent of service robotics had a major impact on the social representation of robots. This robot category consists of a large number of robots that are far from looking like humans, such as drones, surgical robots or robot cars.

3. The consequence of human-robot interaction.

Robotic do it yourself is a practical aspect that gives to huge curiosity. Anyone could build a To use a robot in a real environment, where there are human beings, robots have to sense, to move, to plan their tasks, to take decisions and to reason. These different features are not complete because of the lack of suitable interfaces that ensure a human-friendly communication. These interfaces are essential in order to plan robot efficiently.

[121] HERSH M., *Ethical Engineering for International Development and Environmental Sustainability* , Glasgow, 2015, p. 73 sets out several studies that show that the desirability of robots to a person is inconclusive.

[122] For design of technological artifacts, see WEIN L.E., *Maladjusted contrivances and clumsy automation: a jurisprudential investigation*, 9 Harv. J. Law & Tec., 1996, p. 375.

[123] BREAZEAL C., *Social Interactions in HRI: The Robot* View. MURPHY R. and ROGERS E. (eds.), Systems, Man and Cybernetics Part C: Applications and Reviews. IEEE Transactions vol. 34, n. 2, 2004.

[124] Several projects are realized to identify how humans interact with robots, evaluating the influence of their interfaces on social acceptance, such as European projects GIRAFFPlus12 (http://www.giraffplus.eu/) and MOBISERV (http://www.mobiserv.info/); in France ROMEO project (http://projetromeo.com/). In relation to this latter «*vise à mettre au point un robot social humanoïde assistant à domicile. De façon à interagir le plus naturellement possible avec l'utilisateur, le système robotique effectue un traitement des indices paralinguistiques (non sémantiques) extraits du signal de parole*» DELABORDE A., DEVILLERS L., *Impact du Comportement Social d'un Robot sur les Émotions de l'Utilisateur: une Expérience Perceptive.* In proc. Des Journées d'études sur la Parole (JEP). Grenoble, France, 2012.

(a) *Factual implications*. As seen above, robots can take real time decisions in unpredictable environments.

It is clear that when robots became able to interact with the environment, proactive and reactive issues arose. Some of them are: is it prudent to produce robots, whose behaviours cannot be controlled? Who can assure, that in war a robot soldier would observe an ethically acceptable behaviour? Who is responsible for their behaviour? If a robot provokes personal or property injures, will the machine or its designer be considered liable? When and how should we limit the intelligent autonomous robots?

These are the kinds of questions arising when robots are involved in accidents. Already in 1979 a worker in a Ford plant became the first person ever to be killed by a robot[125]. The worker was harmed by the robot with its arm while working in the same luggage compartment[126]. In 2007, a malfunctioning, remote control robotic cannon gun killed nine African soldiers and wounded 14 others[127]; in 2010 a helicopter drone drifted towards Washington DC, violated airspace restrictions[128]; in 2011, after the accident that involved Google's vehicles[129] (capable of navigating public roads and interacting with traffic, entirely without human input[130]) somebody put into question the legality of autonomous vehicle usage in public roads[131]; the further development of the surgical robot DA VINCI was stopped by civil lawsuits against its manufacturers[132]; the risk that

[125] Williams died instantly in 1979 when the robot's arm slammed him as he was gathering parts in a storage facility, where the robot also retrieved parts. Williams' family was later awarded $10 million in damages. The jury agreed the robot struck him in the head because of a lack of safety measures, including one that would sound an alarm if robots were near.

[126] We consider a number of claims against manufacturers by workers injured on the job *see* Payne v. ABB Flexible Automation, Inc., 116 F.3d 480 (8th Cir. 1997) (affirming summary judgment in favor of defendant on claim of design defect); Hills v. Fanuc Robotics Am., Inc., 2010 WL 890223 (E.D. La.) (suit by employee against manufacturers/sellers).

[127] SCHACTMAN N., *Robot cannon kills 9, wounds 14*, Weird.com, 2007 available at http://blog.wired.com/defense/2007/10/robot-cannon-ki.html.

[128] BUMILLER E., *Navy Drone Violated Washington Airspace*. New York Times, 2010.

[129] HYDE J., *This Is Google's First Self-Driving Car Crash.*, Jalopnik, 2011 available at http://jalopnik.com/5828101/this-is-googles-first-self+driving-car-crash.

[130] THRUN S., *What We're Driving at*, 2010, available at http://googleblog.blogspot.com/2010/10/what-were-driving-at.html.

[131] MATYSZCZYK C.: *Google's Self-Driving Wreck: Really Human Error?*. Cnet News, http://news.cnet.com/8301-17852_3-20088751-71/googles-self-driving-wreck-really-human-error.

[132] *See* O'Brien v. Intuitive Surgical, Inc., 2011 WL 3040479 (N.D. Ill.) (Granting summary judgment to manufacturer of "Da Vinci" surgical robot); Mracek v. Bryn Mawr Hosp., 610 F.Supp.2d 401 (E.D. Pa. 2009) (granting summary judgment to manufacturer of "da Vinci" surgical robot); Mohler v. St. Luke's Med. Ctr., 2008 WL 5384214 (Ariz. App. Div.) (Finding that issue of proper credentialing of surgeon to use robot existed and reversing grant of summary judgment to defendant hospital); Silvestrini v. Intuitive Surgical, Inc., 2012 U.S. Dist. LEXIS 13801 (E.D. La. Feb. 6, 2012); PIERCY H.M., *Note, Cybersurgery:*

warrior and sword robots could be capable to identify and kill enemy in Iraq, Afghanistan and also in the «automatic kill zone» between Israelis and Palestine[133]; in 2015 a robot crushed a worker at a Volkswagen production plant in Germany[134].

(b) ***Legal implications*.** Legal scholars are currently studying how injurious actions of robots should be considered with the lens of civil liability, and particularly how robotic manoeuvres can be evaluated using the traditional legal concepts of civil liability.

Apart from particular purposes, these studies should not underestimate the economic implications of the use of robots: the allocation of the risk of injuries from robots will influence innovation, encouraging or hampering according to the path taken the production and purchase of robot.

To evaluate the legal implication of robots' behaviour, the starting point is stressing the difference between robots and difference from personal computers; «like the computer, it runs on software, but it can touch you. It doesn't have a particular purpose like a lawn mower or a toaster; it's more like a platform that you can program to do all kinds of different things. And it can act on the world, so it has legal repercussions. It might be very difficult to ascertain where the liability lies when a robot causes some physical harm»[135].

Some robots can be qualified as products[136]; therefore they do not pose novel questions: it is out of question the need to envisage a liability falling on the robot itself, as it is clear that this liability should rest on the robot's owner or on its producer and programmer. The former one could complain against the seller and the latter could retrace the marketing chain up to the designers, all according to the applicable legislation. Despite everything the current legislation presents some issues about its application on this type of robots (*see* chap. IV).

Why the United States Should Embrace This Emerging Technology, 7 J. High Tech. L. 203, n.11, 2007, pp. 205-06.

[133] MANZONI A., PAGALLO U., *Ermeneuti, visionari, circospetti: la quarta via alla robotica tra diritto e letteratura*, in Diritto e narrazioni, temi di diritto letteratura e altri, atti del secondo convegno nazionale, Bologna (3)(4), 2010, pp. 157-174.

[134] DOCKTERMAN E., *Robot Kills Man at Volkswagen Plant.* TechRobotics, 2015, available at http://time.com/3944181/robot-kills-man-volkswagen-plant/

[135] CALO R. *Robotics & The Law, op. cit.*, 2010.

[136] Robots are «products» or «goods» based on characteristic expect by law applying on robot involving in an accident.

Truly intelligent autonomous robots cannot be qualified as products, considered that their harmful acts are unpredictable for two reasons: firstly, they are capable of self-learning as a way to achieve a goal, and of interaction with the outer world. Imagine a complex program whose components interact in an unexpected and uncontrolled way among them. We can understand where the difficulty to provide instructions comes from. Secondly[137], the collaborative and coordinate communication among these robots raises troubles to determine which robot caused the injury[138].

4. Robotic DIY (Do It Yourself).

Robotic do it yourself is a practical aspect that generate huge curiosity. Anyone could build a robot with instructions contained in suitable manual available on line (where we can find tutorials regarding their construction).

It seems that it is sufficient to buy electronic components of unused devices in order to build remote control robot commanded via WI-FI, computers or tablets and through open software, such as Arduino Starter[139] an undeveloped robotic platform.

Building robots seems to be comparable with building toys even if a robot is not a toy. For example in Europe a toy, built by a manufacturers, is placed on the market if it responds to harmonised standards, an European technical approval or to a non-harmonised technical specification recognised at Community level.

The maker of a robot for the personal use of the maker is not a producer; anybody could make and use sophisticated unsafe robots. Internet makes freely available detailed information that could enable the in house production of a robot to everyone with rudimentary notions of electronics. Clearly this phenomenon raises concern and call for safety regulation.

In case of tortious event caused by the robot, the producer of a robot DIY is not responsible, considering that under art. 7 of the 85/374/EEC Directive, the liability of manufacturers is excluded if this latter «proves: [...] that the product was neither

[137] BROOKS A.R., *Flesh and machines: how robots will change*. US 19-21 Pantheon Books, New York, N.Y, 2002, pp.19-23.

[138] HUBBARD P., *Sophisticated Robots. Balancing Liability, Regulation and Innovation.* 66 Fla. L. Rev. 1803, 2014, p. 14 ss.

[139] http://arduino.cc/en/Main/ArduinoStarterKit.This is «*an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control the physical world. The project is based on a family of microcontroller board designs manufactured primarily by Smart Projects in Italy, and also by several other vendors, using various 8-bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors*» in https://en.wikipedia.org/wiki/Arduino.

manufactured by him for sale or any form of distribution for economic purpose nor manufactured or distributed by him in the course of his business». Therefore, this provision should apply if there is no sale related to license.

To ensure its development «lawgivers should take a position on the topic in a specific regulation or leave to courts the task to set up solid case law and play an active role when establishing the boundaries to the industry. Consequently, lawgivers should take a position on the topic in a specific regulation or leave to courts the task to set up solid case law and play an active role when establishing the boundaries to the industry. That is, open robotics industry needs protection in order to generate shared information and access to robots without assuming the risks of creating potential semiconscious beings that could negatively affect society depending on the abilities that the end-user has coded on its product without having any control on the end-user»[140].

However, a high degree of intelligence of IARs gives rise to questions on the applicability of conventional law; in fact until these robots are not fully autonomous current legal categories should be suitable.

[140] GUERRA J. M., *European robots: an umbrella under the rain.* La stratégie juridique au coeur de l'innovation numérique, Revues des Juristes de Sciences Po n. 10, 2015, p. 117.

SUB-CHAPTER 2
INTELLIGENT TRANSPORTATION SYSTEM (ITS): SMART CARS FEATURES

This chapter carries out a short history of autonomous vehicles (AVs) that is needed to understand how technology and law influence each other. The development of robot car is supported by the following arguments: efficient, safety, comfort, mobility and accessibly.

First, AV will improve social benefits. One of these utilities consists in improving the **efficiency** of transport system, in term of reduction of traffic. Therefore, AV will help to decrease the energy consumption and emissions of vehicles[141].

Second, AV will ensure **safety** that reduces the risk, efficiently. In particular, the cooperation system among robot cars will allow to coordinate flow traffic, thus collision could be avoided. It's obvious that this cooperative communication will lead to privacy problems[142].

Third, AV will ensure **mobility** for all, including elderly and impaired users.

Finally, AV will enable **user's freedom** for other activities while driving and it is **accessible** to all, even by people who has disability or have not a full ability.

1. Autonomous vehicles: smart cars as artefacts included in the definition of «auto-mobile».

The semantic sense of auto-mobile definition – in other words car self-driving – includes the current robot car evolution. The car history is characterised by a particular purpose, such as create self-driving cars.

Car history began when the wheel was invented in 3500 BC. by Sumerian, this innovation allowed the spread of road transport. The essential development of car took

[141] BISHOP R., *Intelligent Vehicle Technology and Trends.* Boston, MA: Artech House, 2005, p. 98 ss.
[142] On interaction between safety and civil liability, *see* CALABRESI G., *The Cost of Accidents. A legal and Economic-Analysis*, New Haven, 1970, trad. it. Di DE VITA, VARANO, VIGORITI, *Costo degli incidenti e responsabilità civile. Analisi economico-giuridica*, Milano, 1975.

place as of 1780 with the invention of combustion engine by J. Watt.

However, even before of this above mentioned invention, a French military engineer J. N. Cugnot invented the forerunner of car, such as «Cugnot's wagon».

The Italian officer V. Bordino (1804), on basis of steam engine, created a wagon. The wagon had a boiler and four containers that produced the steam. However the application of steam engine disappointed the expectation of a self-driving car because steam engine was suitable to rail transport.

In Italy I. Manzetti built the first steam wagon that was driven on public road (1864). A few years back (1853), the first piston engines – single-cylinder and 2-cylinder engines – were produced and their ignition was created by electrical spark (in Italy Barsanti E. and Matteucci F., in France J.-J. Lenoir).

In 1876 N. A. Otto invented four-stroke spark engine. This invention is part of the work of De Cristofaris, K. Benz e G. Daimler. The first built a combustion engine prototype. In 1886 the second developed De Cristofaris's idea on a tricycle and he created a vehicle with an endothermic engine. Daimler - a car manufacturer specialised in the production of engine - installed Benz's patented engine on a four-wheel vehicle.

Then, in 1926, K. Benz and G. Daimler created a car manufacturer called Daimler Mercedes Benz[143].

In 20th century, mass production of car took place thanks to petrol engine development, electrical starting and new ways of working[144].

The new logic - that is the car is accessible to everyone - was the subject of propaganda under dictatorial rule which used it by promising an increase of both employment and collective welfare. However the massive spread of cars took place during the economic boom in the aftermath of World War II.

Although mass media are only speaking about autonomous vehicles a few years, autonomous car projects have been numerous since the second half of the 20th century[145].

The first government that demonstrated interest in developing of AVs was Japan

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[143] For a complete analysis on automobile history SCALERA I., *I grandi imprenditori del XIX secolo*, Milano, 2011.

[144] New worker method was introduced in factories. In 1913, Ford Henry introduced assembly line and conveyor belt instead *taylorismo* developed new productivity criteria.

[145] For an analysis on autonomous car history *see* BARFIELD W., DINGUS T.A., *Human Factors in Intelligent Transportation System*. New Jersey: Lawrence Erlbaum Associates, Inc., 1998.

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with a project realized in 1977 by Tsukuba Mechanical Engineering Laboratory[146].

From 1987 to 1995, European Commission financed the European Traffic with Highest efficiency and Unprecedented Safety (PROMETHEUS) Project[147] as part of EUREKA program.

In 1997, a demonstration of autonomous driving - AHS's Demo'97 - took place on California highway[148]. In 2000, AHSRA (Advanced Cruise-Assist Highway System Research Association) settled cooperative communication among vehicles[149]. AHS (Automated Highway System) program defines a new relationship between vehicles and the highway infrastructure, through both control technologies and communications technologies. These technological tools aim to recognize and react to the external infrastructure's real-time traffic conditions[150].

The fundamental event to growth of AVs was the international demonstration organised by DARPA[151] Challenge. From 2003 until 2007[152], it organised three "Grand Challenges" where various teams were challenging each other to build self-driving cars. The first two were held in rural environments, while the third event took place in an urban environment[153]. These projects contributed considerably to the improvement of autonomous cars[154].

The challenges of DARPA are complicated because these vehicles had to sense environment through a set of sensors that detect all images of reality without an order[155].

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[146] SCHMIDHUBER J., *Highlights of Robot Car History*, 2005 available at http://www.idsia.ch/~juergen/robotcars.html.
[147] EUREKA – PROMETHEUS, http://www.eurekanetwork.org/project/-/id/45.
[148] USA Bureau of Labor Statistics, *Employment and wage data from the Occupational Employment Statistics survey, by occupation*, Boston metropolitan area, 2004 available at http://www.bls.gov/ro1/oesbos.pdf.
[149] HOSAKA A., *Future Intelligent Transportation, AA (Advanced Cruise-Assist Highway System Research Association (AHSRA).* IEEJ Transactions on Sensors and Micromachines, vol. 123, Issue 3, 2003, pp. 63-68.
[150] CHEON S., *An Overview of Automated Highway Systems (AHS) and the Social and Institutional Challenges They Face.* University of California Transportation Centre, University of California, 2003.
[151] The U.S. Defense Advanced Research Projects Agency (DARPA), http://www.darpa.mil/.
[152] BURDICK J.W., DU TOIT N.E., HOWARD A., LOOMAN C., MA J., MURRAY R.M., WONGPIROMSARN T., *Sensing, navigation and reasoning technologies for the DARPA Urban Challenge*, tech. rep., DARPA Urban Challenge Final Report, 2007.
[153] DARPA Grand Challenge 2005 was won by University of Stanford with Stanley car developed under Volkswagen Touareg. In 2007, SUV BOSS (created by Carnegie Mellon University with Caterpillar and General Motors) won the challenge.
[154] MOHAMMED M., *Junior' on Track for Urban Race*, The Stanford Daily, Stanford University, 2007, p. 26; URMSON C. et al., *Autonomous Driving in Traffic: Boss and the Urban Challenge*, Artificial Intelligence Magazine, Association for the Advancement of Artificial Intelligence, vol. 11, Issue 2, 2009.
[155] Vehicles completed a series of driving missions, without human intervention, respecting traffic rules in front of others semi and fully autonomous vehicles.

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In the period between February 2004 and January 2008, European Commission funded a PReVENT Integrated Project (IP)[156] in order to improve an awareness development of Advanced Driver Assistance Systems (ADAS).

From 2009 until 2012, EU financed SARTRE Project (Safe Road Trains for the Environment)[157] in order to encourage the use of road-trains (platoons) for personal transport. Its scope is to create robot truck platoon consisting in a set of cars piloted by the first car that is driven by human[158].

In 2014, French government presented a plan containing different innovation fields with the aim to develop a new industrial France[159]. Robots are one of these fields. Then, France proposed the first demonstration of autonomous vehicles in Bordeaux, Isère, Île-de-France[160] in 2015.

These projects have been financed by government primarily. By contrary nowadays the most projects are also financed by corporate, for instance Google[161] and others car manufacturers such as Audi, Volkswagen[162], Ford and Volvo that are testing autonomous vehicles[163]. In Italy, Artificial Vision and Intelligent Systems Laboratory (VisLab) at University of Parma realized BRAIVE and DEEVA cars that have a particular aesthetic. In France Renault presented its concept of Next Two car[164].

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[156] PReVENT, http://prevent-ip.org/.

[157] SARTRE, http://www.sartre-project.eu.

[158] For a deepen study of European project on AVs developed over the years, *see* EPoSS Roadmap, *Smart systems for automated driving,* 2015, p. 9 ss. edited and published by European Technology Platform on Smart Systems Integration EPoSS. This is a research about development roadmap on smart systems technologies for automated driving, in http://www.smart-systems-integration.org/, where researches organize the European project in four different categories: «*a) Networking and Challenges, b) Connectivity and Communication, c) Driver Assistance Systems and d) Robot car*».

[159] [Online] *La Nouvelle France industrielle, Présentation des feuilles de route des 34 plans de la nouvelle France industrielle,* available at http://www.economie.gouv.fr/nouvellefrance-industrielle.

[160] [Online] *Le véhicule autonome tracera sa route dès 2015 en France,* available at http://www.usine-digitale.fr/article/le-vehicule-autonome-tracera-sa-route-des-2015-en-france.N272918.

[161] MARKOFF J., *Google Cars Drive Themselves, in Traffic*, The New York Times, 2, 2010 available at available at http://www.nytimes.com/2011/05/11/science/11drive.html?_r=0. SIEGLER M. G., *Google Has a Secret Fleet of Automated Toyota Priuses; 140,000 Miles Logged So Far,* 2010, available at http://techcrunch.com/2010/10/09/google-automated-cars/.

[162] [Online] *Audi, In-Car Technology, and the Autonomous Car,* available at http://blogs.motortrend.com/1312_audi_in_car_technology_and_the_autonomous.html.

[163] On autonomous vehicles *see*: GURNEY J.K., *Sue Me Not my car: product liability and accidents involving autonomous vehicles,* U. ILL. J. L. TECH. & Pol'y, 2013, n. 6, pp. 247-249; FUNKHOUSER K., *Paving the way ahead: autonomous vehicles, products liability and the need for a new approach*, in UTAH L. REV., 2013, 437-38; GARZA A.P., *Look Ma No Hands!*: Wrinkles and age wrecks autonomous vehicles, 46 New Eng. L. REV., 2012, pp. 581, 587.

[164] *See* https://group.renault.com/en/passion-2/innovation/renault-a-born-innovator/autonomous-and-connected-car/

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Let us explore Google project, because it was one the first to have a media resonance. Google is advancing its project by applying their innovative technology on existing vehicles, such as Toyota Priuses, Audi and Lexus.

There is a structure on the roof of the car which points out traffic and environment through radar, laser telemeters, cameras, positioning system (GPSS) and maps. This information is sent to the data centre of Google and these date need to update maps of all Google vehicles. The inside of vehicle has an interface to assist drivers for driving. In fact, this car must have a human driver who assumes its control. Driver has to move the wheel or touch the brake; or use the switch - that toggles vehicle on self-driving way -; or listen a voice that informs driver to take control of car[165].

2. Mass production of cars and its implications on civil liability.

Technological progress – started with industrial revolution – gave rise to a revision process of civil liability[166]. This progress leads to pass from a fault-based liability system to no-fault liability system (strict liability)[167].

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[165] GURNEY J.K., *op. cit*., 2013.

[166] For a study on proposal of new civil liability systems: TRIMARCHI P. (1961). *Rischio e responsabilità oggettiva*, Milano; SCOGNMIGLIO R., Voce «Illecito», in Noviss. Dig.it, VII, Torino, 1962, p. 164 e ss.; BUSNELLI F.D., *La lesione del credito da parte di terzi*, Milano, 1964, pp. 32 ss.

[167] «The general principle of our law is that loss from accident must lie where it falls, and this principle is not affected by the fact that a human being is the instrument of misfortune. But relatively to a given human being anything is accident which he could not fairly have been expected to contemplate as possible, and therefore to avoid. In the language of the late Chief Justice Nelson of New York: No case or principle can be found, or if found can be maintained, subjecting an individual to liability for an act done without fault on his part […] All the cases allow that an injury arising from inevitable accident, or, which in law or reason is the same thing, from an act that ordinary human care and foresight are unable to guard against, is but the misfortune of the sufferer, and lays no foundation for legal responsibility. If this were not so, any act would be sufficient, however remote, which set in motion or opened the door for a series of physical sequences ending in damage; such as riding the horse, in the case of the runaway, or even coming to a place where one is seized with a fit and strikes the plaintiff in an unconscious spasm. Nay, why need the defendant have acted at all, and why is it not enough that his existence has been at the expense of the plaintiff? The requirement of an act is the requirement that the defendant should have made a choice. But the only possible purpose of introducing this moral element is to make the power of avoiding the evil complained of a condition of liability. There is no such power where the evil cannot be foreseen. Here we reach the argument from policy, and I shall accordingly postpone for a moment the discussion of trespasses upon land, and of conversions, and will take up the liability for cattle separately at a later stage. A man need not, it is true, do this or that act, the term act implies a choice,—but he must act somehow. Furthermore, the public generally profits by individual activity. As action cannot be avoided, and tends to the public good, there is obviously no policy in throwing the hazard of what is at once desirable and inevitable upon the actor. The state might conceivably make itself a mutual insurance company against accidents, and distribute the burden of its citizens' mishaps among all its members. There might be a pension for paralytics and state aid for those who suffered in person or estate from tempest or wild beasts. As between individuals it might adopt the mutual insurance principle *pro tanto*, and divide damages when both were in fault, as in the *rusticum judicium* of the admiralty, or it might throw all loss upon the actor irrespective of fault. The state does none of these things, however, and the prevailing view is that its cumbrous and expensive machinery ought not to be set in motion unless some

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In parallel with progress, civil liability presents an evolution in two-stages.

The development of enterprise was encouraged because it was considered as a phenomenon that would ensure collective welfare. The improvement of enterprises had to be incurred, thus a fault-based liability system was perfect at that moment because it was hard to held liable entrepreneurs. The injured person would demonstrate intentional fault or negligent of manufacturers, but this burden of proof is complicated for victim. So, if injured did not prove the subjective element, the damages were in his wake[168].

By contrary, the improvement of compensation would sacrifice interests and strategies of the new industrial society against collective interests. A fault-based criterion ensured the compensation of avoidable damages at a reasonable cost. The other injuries - expressions of a risk that could not reasonably have been foreseeable - should be paid by injured.

At the beginning of our century, the development of enterprises caused a reduction in natural resources, a destruction of raw material and the emergence of social alarm, such as pollution caused by productive activities. The productive activities became dangerous for people, thus there was the passage towards strict liability system where victim shall prove causation between harmful event and damage. The function of strict liability «consiste principalmente nella regolazione delle attività rischiose che sono consentite dall'ordinamento in considerazione della loro utilità sociale».[169]

In this scenario, the focus moved to manufacturer who organizes a dangerous activity. The economic analysis of cost-benefits allowed establishing that enterprises could sustain the costs associated with damages - caused by uncertain risks -. Thus, enterprises shall compensate victims[170]. In addition, Calabresi considered that a civil

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clear benefit is to be derived from disturbing the status quo. State interference is an evil, where it cannot be shown to be a good. Universal insurance, if desired, can be better and more cheaply accomplished by private enterprise. The undertaking to redistribute losses simply on the ground that they resulted from the defendant's act would not only be open to these objections, but as it is hoped the preceding discussion has shown, to the still graver one of offending the sense of justice. Unless my act is of a nature to threaten others, unless under the circumstances a prudent man would have foreseen the possibility of harm, it is no more justifiable to make me indemnify my neighbor against the consequences, than to make me do the same thing if I had fallen upon him in a fit, or to compel me to insure him against lightning». HOLMES O. W., *The Common Law*, Boston: Little Brown, 1881, pp. 94-95.

[168] A leading case of the above mentioned behavior is described in Loose v. Buchanan, N.Y. 576, 1871 where court denies compensation to victim of burst of a kettle, given that individual damage become a social duty whether a collective well-being could be obtained.

[169] TRIMARCHI P., *Rischio e responsabilità oggettiva*, 1961, p. 91.

[170] Among authors of economic analysis: CALABRESI G., *The Cost of Accidents. A legal and Economic-Analysis*, op. cit., 1970; POSNER R.A., *Economic Analysis of Law*, 2nd ed., Boston-Toronto, 1977;

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liability system should seek to reduce the costs caused by harmful event through the prevention of accidents. Then, civil liability should reduce hazardous activities whose usefulness is not higher than the destruction of the resources[171]. For this purpose, who is in a better position to do cost-benefit analysis can avoid the damages through the comparison of both preventive and remedial costs of injuries[172].

The effects of these above interpretation are the following. Strict liability system facilitates the victim to obtain compensation. Manufacturers are encouraged to take some additional precautions for risks. This behaviour leads to an increase in costs of product that involves a changing of the product's price. Consequently, production and consumption of goods will not go up. However, manufacturers and sellers can allocate the costs of damages caused by their products. They ensure their products and distribute the costs of insurance through an increase of costs.

Now, we apply the above arguments on strict liability on road liability.

The spread of vehicle – goods of mass - leads to the improvement of road traffic accidents. This scenario turned the focus from drivers' diligent behaviour to causation between road accidents and damages[173]. The compensation interest eroded the central role of fault [174], so mandatory insurance was introduced and new methods of compensation were created[175]. (*See* chap. V)

The introduction of compulsory insurance leads drivers to adopt additional precautions in order to reduce their liability and consequently their costs of insurance premiums. In fact, «la responsabilità oggettiva fa sì che il premio assicurativo rifletta tutto il rischio introdotto nella società dalla circolazione automobilistica. La responsabilità per colpa, infatti, inciderebbe in misura minore sui premi assicurativi e questi rifletterebbero la sola parte del rischio che poteva essere eliminata a costi

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SHAVELL S., *Foundations of Economic Analysis of Law*, Cambridge Mass., Belknap Press of Harvard University Press, 2004. The premise of economic analysis is that in a perfect market, the marginal social cost - which coincides with the supply function - meets the marginal social benefit that coincides with the function of demand.

[171] CALABRESI G. *The Cost of Accident*, op. cit., 1970, p. 102.

[172] *Idem*, 183.

[173] VISINTINI G., *Trattato breve della responsabilità civile: fatti illeciti, inadempimento, danno risarcibile*, 2 ed., Padova, 1999, p. 722.

[174] RODOTÀ S., *Il ruolo della colpa nell'attuale sistema della responsabilità civile*, in RC, 1978, p. 6 ss.

[175] FANELLI G., *I problemi fondamentali dell'assicurazione obbligatoria della responsabilità civile per i rischi della strada con particolare riferimento al progetto governativo*, in ASS., 1966, p. 347 ss. CASTRONOVO C. *La nuova responsabilità civile*, Milano, 1977, p. 477.

ragionevoli».[176]. The combination of strict liability/insurance allows using insurance premiums with the aim to control the number of cars in circulation[177].

3. Intelligent Transportation System (ITS): Autonomous Vehicles (AVs) in context.

Intelligent transportation system (ITS) is related to use of automation, informatics and communication technologies. These systems aim to improve efficient and safety of cars. ITS is a system in which information and communication technologies are applied in the field of road transport and it involves infrastructures, vehicles and users, traffic and mobility management. Its aim is to «provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated and 'smarter' use of transport networks»[178].

It is composed by Intelligent Infrastructure and Intelligent Vehicle (IV). This latter refers both to systems of driver assistance and to systems of autonomous driving - which do not require the intervention of driver-.

The IV systems assist driver through the information on driving. These systems can alert driver on hazards; or correct maneuvers of driver; or replace driver partially, or intervene to avoid collision. Instead, a fully autonomous car has a system that replaces the driver in all driving activities.

Through IV systems, robotic vehicles are different than those conventional. Driving system takes decisions about guide-way. It evaluates the driving of other driving systems, the traffic signs, the pedestrians' behaviour and viability. It also decides the driving movement, its speed and it is responsible to alert other driving systems or pedestrians in case of danger. Driver has a marginal role because vehicle performs the most of above-mentioned actions.

Thus, cars interact with the environment and driver supervisions it - at least until robot cars will be fully autonomous -. Car is able to interact with environment thanks to the ability of driving system of collecting data. These data refer to car - i.e., its speed, its

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[176] TRAMONTANO L., ROSSI S., BORDON R., *La nuova responsabilità civile. Causalità - Responsabilità oggettiva. Lavoro,* Torino, 2010, p. 429.

[177] AFFERNI G, *La riparazione del danno non patrimoniale nella responsabilità oggettiva,* in RC, 2004, p. 862.

[178] DIRECTIVE 2010/40/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7.07.2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport.

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pneumatic conditions -; to other vehicles – i.e., other drivers' behaviour -; to environment features – i.e., road traffic and weather -[179].

The ability of collect data depends on the level of intelligence of driving system. Its intelligence depends on the type of technology involved. For instance, an individual sensor has a limited capacity to detect data; on the contrary a combination of sensors ensures an increase of data collected. In this last situation vehicle has more confidence.

However, many sensors collect the largest variety of data and this action leads to any practical problem. Vehicle should select date and organize a functional framework for driving. Consequently it should be able to process data quickly and understand what are useful information - not all date are relevant -. Finally it should remove the contradictory data that could create confusing[180].

To create a coherent framework, vehicle has to get data based on a plan. The planning is relevant when something is changing. For instance, another vehicle brakes suddenly and it is necessary to plan an adequate action, in a short time.

The complexity of the planning depends on its intelligence. In fact, the plan could be pre-programmed by designer or it could be carried out while driving. In the first case, car is automated because it knows how to act in different scenarios in advance. It has a programmed representation of reality. An example is a pre-crash brake. In the second case, car creates its representation of reality and it acts in accordance to this representation. For instance an autonomous car will change lane departure, it will turn right, and at the roundabout it will take the second exit.

There are different technological proposals to increase the intelligence and driving quality of AVs, such as the PCB algorithm. This algorithm operates in order «to coordinate the ACC controller and lateral controller of the vehicle to perform high-quality distance keeping, lane changing and obstacle avoidance behaviours»[181].

The level of intelligence of AVs is the criterion of their classification. The Automotive Engineers Society (SAE) provides a common taxonomy where AVs are

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[179] KALRA N., ANDERSON J., WACHS M., *Liability and Regulation of Autonomous Vehicle,* Technologies UCB-ITS-PRR-28, PATH Research Report RAND Corporation, California, 2008.

[180] To deepen some aspects on functions of an AV, *see* COX I. J., WILFONG G.T., *Autonomous Robot Vehicles*, New York, 1990; KALRA N., ANDERSON J., WACHS M., *op. cit.*, 2008.

[181] WEI J., SNIDER J.M., GU T., DOLAN J.M., LITKOUHI B., *A Behavioral Planning Framework for Autonomous Driving,* Intelligent Vehicles Symposium Proceedings, IEEE, 2014, pp. 458-464 «[…]*For path planning, the behavioral planner does not need to use polynomial paths, as do spatio-temporal sample-based planners. Therefore, it generates much smoother paths in some complicated cases* […] ».

classified into six different levels, such as Level 0- No Automation; Level 1- Driver Assistance; Level 2 - Partial Automation; Level 3 - Conditional Automation; Level 4 - High Automation; Level 5 - Full Automation. The difference among the first three levels and the last levels is the presence of supervisor who monitors during driving[182].

Also, National Highway Traffic Safety Administration (NHTSA) has set out a sensible framework on intelligence of robot car in which we can see four levels, such as Level 0 – No Automation (Development and testing of Human-in-the-loop (HITL) Connected Driving Assistance); Level 1 - Function-specific Automation and Level 2 - Combined Function Automation; Level 3 - Limited Self-Driving Automation (Conditional Automation Safety Assurance); Level 4 - Full Self-Driving Automation (Limited Driverless Vehicle Operations)[183].

3.1. The "body" and "mind" of AVs.

An AV is a car able: **a)** to sense the environment; **b)** to plan; **c)** to carry out the actions; **d)** to control itself - i.e. its power and its pneumatics -[184].

When car engineers design an autonomous vehicle, they choose some of common sensors - such as radar, laser, GPS and artificial methods for visual which pick up environment –; computer and actuators.

a) The sensors are used to create the same human senses, in particular both a visual perception and a sense of direction. Sensors «*allow robots to obtain a basic set of observations upon which controllers a higher level decision-making mechanism can act upon, thus forming an indispensable link in the chain of modules that together constitutes an intelligent, autonomous robotic system*»[185].

First, to carry out a visual sensing are used cameras that detect colours and forms of the objects that are on the road. The performance of this sensor depends on lighting

[182] SAE INTERNATIONAL, http://www.sae.org.
[183] US Department of Transportation, National Highway Traffic Safety Administration, PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES, 30 May 2013.
[184] These steps are better indicated by WILLIAMSEN P., *Global Manager of Education and Training for Lexus International*, in an interview carried out by ILIAIFAR A., 2013; LIDAR, [Online] *Lidar, lasers, and logic: Anatomy of an autonomous vehicle*, available at http://www.digitaltrends.com/cars/lidar-lasers-and-beefed-up-computers-the-intricate-anatomy-of-an-autonomous-vehicle/.
[185] GE S.S., LEWIS F.L, *Autonomous mobile robots: sensing, control, decision making and applications*, vol. 22 CRC Press, Boca Raton, Fla, USA, 2006, p.3.

conditions. The cameras combined with stereo improve their performance in fact it is also possible to establish the distances between different objects[186].

Also, ultrasonic sensors allow the development of visual sensing in fact they measure the positions of objects that are close to the vehicle.

Instead, radar and laser establish the distance and the speed of other objects. They make a three-dimensional representation of the environment. The difference between radar and laser is that the former measures distances for all solid objects, but it has a short-range. Laser operates over larger distances, but they are able to detect only metal things on the road.

If vision sensing fails, radars are employed. They forward un-modulate radio waves and these latter are mirrored in any direction when they hit an object. The reradiated signal rears back in the source and create an echo of transmitted signal[187].

Laser is a device able to forward a coherent beam of light that is a straight radius. Light Detection and Ranging (LIDAR) is a remote sensing method that uses the light in order to measure variable distances. For instance, it divides lines, crash barriers and other surrounding objects[188].

Radar and LIDAR are combined as shown by «a real-time efficient radar/LIDAR obstacle fusion approach» (presented by some scholars) for «combining the advantages of both accurate and highly available position estimation with LIDAR and precise velocity estimation with radar»[189].

Robot has a sense of direction through both GPS (Global Positioning System)[190] and INSS (Inertial navigation system). They detect position, speed, and orientation of the vehicle. GPS is an overall system of satellite navigation that provides a mobile terminal through a satellite network of artificial satellites in orbit. GPS pickups

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[186] KALRA N., ANDERSON J., WACHS M., *op. cit.*, 2008.

[187] American Naval coined the term RADAR (radio detection and ranging) in 1940. [Online] *Radar*, http://www.wikipedia.org.

[188] [Online]. http://www.wikipedia.org

[189] «*In experiments we could show that by fusion of LIDAR with radar data we increased the precision compared to the LIDAR velocity and also achieved a good position and velocity estimation whenever radar data were unavailable, thus compensated the narrow field of view of the radar sensor*». GOHRING D., WANG M., SCHNURMACHER M., GANJINEH T., *Radar/Lidar Sensor Fusion for Car-Following on Highways*, in Automation, Robotics and Applications (ICARA), 5th International Conference, Germany, 2011.

[190] A global positioning system GPS (Global Positioning System), abbreviation of NAVSTAR GPS, acronym of Navigation Satellite Timing and Ranging Global Positioning System or Navigation Signal Timing And Ranging Global Position System.

coordinate of geographical information, time, and weather conditions everywhere. The location is possible thanks to both the transmission of a wave signal by each satellite and the development of signals received by receiver. GPS performs its tasks when there is a clear view. INSS uses gyro sensors and accelerometers and it is used when GPS is not available.

b) These information are processed through a processor, or better an ECU (centreline system), that is a sort of AV's mind. Nowadays the most experiments concern this part of robots. In fact different projects are projecting centrelines which ensure a better combination of sensors and a faster elaboration of several data[191].

d) Vehicles shall control their body. This is possible through some systems called ADAS (see *infra* §3.2) including: Anti-lock Braking System (ABS); Electronic Brake-force Distribution (EBD); Anti-Slip Regulation (ASR); Electronic Stability Control (ESC).

3.2. The interplay of Advanced Driver Assistance Systems (ADAS) and In-Vehicle Information Systems (IVIS).

Now, we suppose to build a robot car with those above-mentioned components. The collection of these components creates a system having a set of functions. The vehicle shall carry out three driving tasks, such as: stabilization, navigation and manoeuvring tasks[192].

Manoeuvring is «related with adhering to traffic rules and avoiding collisions»[193] (n. 40). Navigation is «related with finding a route to the driver's destination» (n. 43). Stabilisation is «related to keeping the car under control (lateral and longitudinal) » (n. 61).

To achieve these features, the functions of vehicle shall be automated through Advanced Driver Assistance Systems (ADAS). These systems essentially support driver on the manoeuvring level.

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[191] «*Audi has announced that its zentrale Fahrerassistenzsteuergerät (zFAS –Central Controller Driver Assistance, 'all functions, one unit') system will be developed by Delphi With zFAS, .[…] all the mechanisms are controlled by a single board, combining the sensors, electronics hardware and the software architecture into its central system*» *see* DAVIES A., *Delphi secures Audi's zFAS contract, finishes coast-to-coast autonomous trip*, 2015, available at http://rethinkresearch.biz/articles/delphi-secures-audis-zfas-contract-finishes-coast-to-coast-autonomous-trip/.

[192] These features are described more detail in KNAPP A., NEUMANN M., BROKMANN M. et al., Code of practice for the design and evaluation of ADAS, PReVENT Response 3, 2009.

[193] Code of ADAS, (2009), n. 2.2).

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Article 2.1 of Code of Practice for designs and Evaluation of ADAS [194] establishes:

> « […] Driver Assistance Systems are supporting the driver in their primary driving task. They inform and warn the driver, provide feedback on driver actions, increase comfort and reduce the workload by actively stabilising or manoeuvring the car. They assist the driver and do not take over the driving task completely, thus the responsibility always remains with the driver. ADAS are a subset of the driver assistance systems.
> ADAS are characterised by all of the following properties: support the driver in the primary driving task, provide active support for lateral and/or longitudinal control with or without warnings, detect and evaluate the vehicle environment, use complex signal processing, direct interaction between the driver and the system. […]».

One of the first ADAS is Adaptive Cruise Control (ACC) system. It «allows the subject vehicle to follow a forward vehicle at an appropriate distance by controlling the engine and/or power train and potentially the brake» [195]. If «a vehicle with a lower speed is in front of the vehicle, the ACC will respond with a vehicle deceleration in order to not exceed a pre-set distance to the preceding vehicle»[196].

ACC detects the distance relative to the vehicle immediately in front[197] and whether this vehicle stops, the system acts with an emergency braking[198].

Traditional ACC system lays down the speed but it does not consider the environment. On the contrary, new ACC system considers traffic flow; in fact the speed of car is reduced when other vehicles run more slowly than the desired speed. Instead, it accelerates when it can do it.

However, current ACC system cannot operate in specific weather or visibility conditions. The inability of ACC justifies the driver's supervision. Driver shall intervene when i.e. there are potholes on the road. However drivers – who use a vehicle with ACC - rely on it and their monitoring could go down. Therefore, their reaction and action could be very slow in order to avoid an accident[199].

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[194] A group of experts within the RESPONSE 3 project produced Code of Practice. This project is a subproject of the integrated project PReVENT, a European automotive industry activity, co-funded by the European Commission, to contribute to road safety by developing and demonstrating preventive safety applications and technologies.
[195] ISO 15622:2012.
[196] Code of ADAS, (2009), p. 71.
[197] European project CARSENSE, finished in 2002, had the aim to increase ACC systems.
[198] Volvo presented the emergency braking system, which works as part of an Adaptive Cruise Control, LANXON N., *Volvo Smashes Car in Safety Demo*, Wired Magazine, 2010.
[199] RUDIN-BROWN C.M., PARKER H.A., *Behavioural adaptation to adaptive cruise control (ACC): implications for preventive strategies*. Transportation Research Part F 7(2), 2004, pp. 59-76.

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It is clear that ACC system does not exclude the drivers' liability. They shall be careful while driving and they could be held liable if accident occurs because of their distraction (*See* chap. IV)

Parking Assist system is another ADAS. It assists driver through cameras - located on vehicle's rear-view mirrors -; ultrasound rangefinders – placed on the rear of the machine - that alert the driver with sounds; radar - located at the front and at the back of the vehicle - for sensing non-visible objects.

Night Vision System is an ADAS. It allows detecting objects as infrared images on the screen situated into the machine. This system enables preventing hazardous situations.

Adaptive Front Lighting (AFS) lights up areas on the sides and in front of the vehicle.

Lane Departure Warning Systems (LDWS) warns the driver when the car moves to close to the edge of the lane. Several methods ensure the LDWS functioning, such as magnetic markers in the roadway - that communicate with sensors of vehicle -; digital maps combined with GPS - that communicate to vehicle by indicating its position on driveway[200]-; cameras – that collect information in order to draw up of the data[201]-.

Lane Keeping Assist Systems (LKA) is a co-pilot system that regularises driving by acting on steering control[202].

LDWS and LKA systems form part of Collision Warning/Collision Avoidance (CW/CA) System[203] that acts on the basis of the time. If time is short, the system alerts drivers who can act immediately; otherwise, brakes go on autonomously.

Now, every individual system is only an automated system. The combination of these systems leads to an increase of the car's intelligence. For instance, the combination between ACC and LKA creates a complex system that - up the discretion

[200] In the case of vehicle is not in the lane designated by digital map, driver should receive a feedback to wheel. This feedback allows him acting to wake up car.

[201] BISHOP R., *op. cit.*, 2005, p. 98 ss. indicates the LDWS approaches as: embedded magnetic markers in the roadway; highly accurate GPS and digital maps; image processing.

[202] The difference between LDWS and LKA is: the first «*alerts the driver when the vehicle starts to deviate from its lane with a warning buzzer, alert lamp and the application of a small counter-steering force to the steering wheel*»; the second one «*when the Rader Cruise Control is activated and the system senses the vehicle deviating from its lane, the system helps the car stay on course near the center of the lane by continuously applying a small amount of counter-steering force*». http://www.toyota-global.com/innovation/safety_technology/safety_technology/technology_file/active/lka.html.

[203] SEILER P., SONG B., HEDRICK K., *Development of a collision avoidance system*, 98PC-417, SAE Conference, 1998.

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of drivers - takes full command of vehicle. ACC maintains speed and LKA maintains steering.

These ADASs influence driver indirectly. They do not act on vehicle but assist him. Driving system interprets recommendations originated by ADAS and it takes into account other information (weather conditions, viability and traffic) that could influence the validity of data suggested by ADAS. If there is a contradiction between data, driver shall control and intervene to ensure a suitable use of the car[204].

In-Vehicle Information Systems (IVIS) allow collecting useful information and contributing to comfort driver. They «triggers actuators like a braking or steering system based on environmental sensor information to avoid, e.g. a lane departure or to mitigate a forward collision. Intervening systems usually include a preceding warning phase, therefore showing characteristics of both, ADAS and active safety systems»[205].

The difference between IVIS and ADAS is that ADAS can intervene on driving while IVIS are mostly information systems.

Both IVIS and ADAS effect on drivers, in terms of increasing or decreasing safety. Drivers can have a feeling that they are out of the danger when they have some sophisticated safety system in their car and thus, they drive too fast. These issues depend on elements or sub-elements with which IVIS/ADAS interact with drivers. For instance, all input and output devices (e.g. knobs, switches, levers, displays) shall enable the interaction between driver and one or more vehicle systems.

These elements or sub-element are the interfaces, which are carried out by using the “user centered design” (UCD) methodology. This methodology ensures that a car’s design compliance with user’s perspectives and needs. UCD is a complex procedure composed by different steps, such as the specification of context in which car is used; the specification of the requirements of car; the creation of design solutions and the assessment of design[206].

3.3. Communication system: “Vehicle-to-Vehicle” (V2V) and “Vehicle-to-Infrastructure” (V2I).

Robot car moves within environment through information collected from surroundings. These data could be collected through both advanced sensors and

[204] KALRA N., ANDERSON J., WACHS M., *op. cit.*, 2008.
[205] 2.2). n. 36 Code of ADAS, (2009).
[206] ISO 13407:1999, *Human-centered design process***.**

communication systems, such as vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communication systems. These communication systems should improve safety, efficiency and comfort of cars. Also, they allow getting data from infrastructures, others AVs and both. These data could help cars to prevent hazards, such as curves, traffic congestion, health risks, crossovers that are not recognisable, easily. They can have a perception of environment, in this respect.

These communication systems will be connected to Internet from where they process a massive number of data. So, "Internet of things"[207] integrates the senses of AVs' through digital information of other smart objects that are in environment. These communication systems are combined through sophisticated systems as wireless vehicular networks that operate on the dedicated short-range communications (DSRC). DSRC «can enable a communication network of nodes consisting of mobile vehicles or roadside units, sharing traffic and safety information and coordinating vehicle behaviour»[208].

V2I system[209] connects cars with buildings, traffic lights in smart city network where infrastructures are composed by «several base stations that give signals over a long range, such as cellular networks that are designed for voice data exchange or

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[207] The concept of the «Internet of Things (IoT) refers to an infrastructure in which billions of sensors embedded in common, everyday devices – "things" as such, or things linked to other objects or individuals – are designed to record, process, store and transfer data and, as they are associated with unique identifiers, interact with other devices or systems using networking capabilities» *see* G29, OPINION 8/2014, 16 SEPT. 2014, ON THE RECENT DEVELOPMENTS ON THE INTERNET OF THINGS.

[208] EU DIRECTIVE 2010/40/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 7.07.2010 lays down «1.2. The definition of necessary measures to further progress the development and implementation of cooperative (vehicle-vehicle, vehicle-infrastructure, infrastructure- infrastructure) systems, based on: the facilitation of the exchange of data or information between vehicles, infrastructures and between vehicle and infrastructure, the availability of the relevant data or information to be exchanged to the respective vehicle or road infrastructure parties, the use of a standardized message format for the exchange of data or information between the vehicle and the infrastructure, the definition of a communication infrastructure for data or information exchange between vehicles, infrastructures and between vehicle and infrastructure, the use of standardization processes to adopt the respective architectures».

[209] EU DIRECTIVE 2010/40/EU lays down that «the specifications and standards for linking vehicles with the transport infrastructure shall include the following: 1. Specifications for other actions 1.1. The definition of necessary measures to integrate different ITS applications on an open in vehicle platform, based on: the identification of functional requirements of existing or planned ITS applications, the definition of an open system architecture which defines the functionalities and interfaces necessary for the interoperability/interconnection with infrastructure systems and facilities, the integration of future new or upgraded ITS applications in a 'plug and play' manner into an open in vehicle platform, the use of a standardization process for the adoption of the architecture, and the open in vehicle specifications».

Worldwide Interoperability for Microwave Access (WiMAX) that can provide wireless data (e.g. high-speed Internet) for mobile users»[210].

Vehicle to vehicle (V2V) communication system allows conveying safety messages (such as speed and distance with them) among vehicles in order to avoid future collisions thanks to alarm systems that notify hazards to drivers. This ability to communicate each other is an application of swarm robotic approach (see *supra*§ 2.1, chap. II). V2V systems could be based on indirect communication with vehicle through a communication mediated by third parties. The communication can be direct through wireless access in the vehicular environment (WAVE) for high-speed data transmission, or the communication air interface for long and medium-range (CALM) communication standard.

NHTSA anticipated a legislative proposal on V2V technology in order to facilitate its spread and thus to increase safety and to reduce traffic and fuel consumption[211]. These benefits are possible thanks to an exchange of information[212].

By applying these above-mentioned technologies some projects are making experiments.

In 2012, University of Michigan is testing a project in Detroit. This project is seat of a miniature city created in order to experiment autonomous vehicles on public roads. Cars can communicate with each other, through «dedicated short-range communication» (DSRC) and there are advanced infrastructures. This project is developing intersections where there are not traffic lights or stop signs that are replaced by the cooperation software among cars placed on departure lane[213].

The project CITYMOBIL2 – successor of CITYMOBIL - implements intelligent transportation systems (ITS) with regard to automated transport in protected environments. This initiative uses a model of vehicles based on the Cyber Cars concept

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[210] AL-SULTAN S., AL-DOORI M.M., AL-BAYATTI A.H., ZEDAN H., *A comprehensive survey on vehicular ad hoc network*. Journal of network and computer applications, 37(1), 2014, pp. 380-392. LINDEMANN P., KOELLE M., KRANZ M., *Human Factors for Connected Cars Advances in Embedded Interactive Systems Technical Report*, Series Advances in Embedded Interactive Systems, v. 3(1), 2015.

[211] A legislative package obligates car manufacturer to use V2V systems on vehicles. This will be presented before the end of 2015s. [Online] *How ignition interlock devices can stop drunk drivers in their track,* http://www.techhive.com/article/2362002/how-ignition-interlock-devices-can-stop-drunk-drivers-in-their-tracks.html.

[212] KELLY R.B, JOHNSON M.D., *Defining a Stable, Protected and Secure Spectrum Environment for Autonomous Vehicles*, 52 Santa Clara L. Rev., 2012, p. 1271.

[213] ULI ROSE CENTER, *Detroit Future City The making of Detroit's Long Term Strategic Framework Plan,* available at http://uli.org/wp-content/uploads/ULI-Documents/Detroit_fulldeck_03-28-13.pdf.

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defined and promoted by INRIA in France[214]

However, these communication systems raise some issues, such as i.e. the choices of HMI for communication systems (Centred Human Design for transportation intelligent). This choice is very important in order to increase safety of robot cars.

4. Recapitulation.

This chapter gives an overview (albeit a non-exhaustive one) on IARs and, in particular, on AVs. The resulting observations are the following:

Social awareness. Robots are already in our households but people are unaware of their spread, considering the majority of them are automated (or pre-programmed) and in collective imagination robots are only those with an anthropomorphic appearance.

Degree of intelligence. In relation to semiautonomous robots, they have a mean degree of intelligence which allows them to self-move in the environment and to make decisions although they are far from simulating human thinking and human behaviours. Recently, they have been entering the market and this this process should be supported by guidelines for ensuring consumers' safety. These regulations will thus enable manufacturers' testing of autonomous vehicles in public. Similar legislations are being passed in Nevada, Florida, the District of Columbia and Michigan.

By considering SAE's classification this type of cars correspond to a range from level 1 to level 2 that already hold human drivers liable for driving. Driver assistance systems designed for autonomous longitudinal and/or lateral control of a vehicle, are used for level 1 and 2, while the combination of these systems, such as (ACC) e Lane Departure Warning (LDW) are used for level 2. At the same time, solutions for Level 3 are now on trial, whereas solutions for Level 4 are already being developed. However a fully autonomous vehicle - able to drive on its own from beginning to end - is not yet available on the market.

The challenge of technology. It is to regulate autonomous vehicles, under different points of views. The design of robots follows imposing norms and safety standards for ensuring that robots are non-harmful for users.

In addition, consumers' behavior should follow legal and social norms, as well

[214] CITYMOBIL2, http://www.citymobil2.eu/en/.

as technological choices should follow legal and social norms. The Human-Machine interface options regulate the way consumers will feel and behave, thus regulations designing choices of HMIs are desirable. Some scholars consider that a moral code within IARs[215] would be appropriate. This will have to be embedded into robot's «positronic brain»[216].

Finally, before continuing we have to consider that the AVs spread meets fundamental values under which stakeholders' practices should be improved. European research group states: «automated cars are not good or bad *per se*. Instead, they "switch on" several ethical issues such as safety (in the sense of protection of life and protection of the environment), surveillance and privacy (data protection, ownership of data, confidentiality), freedom (autonomy, mobility, personality), and justice (accessibility) », then « […] an attention to the values at stake needs to accompany current attempts to design appropriate policies, technologies and regulations»[217].

In the next chapter, we are going to study safety – in the sense of protection of consumers' health – by analyzing the interaction between the regulation on safety and civil liability.

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[215] GOODALL N. J., *Ethical Decision Making During Automated Vehicle Crashes*. Transportation Research Record: Journal of the Transportation Research Board, 2014.

[216] LEENS R.E., LUCIVERO F., *Laws on Robots, Laws by Robots*, *Laws in Robots: Regulating Robot Behaviour by Design*. Law, Innovation and Technology, 6(2) LIT, 2014, p. 198, organize the robot regulation on four levels: «*1.Regulating robot design, production through law. 2. Regulating user behavior through the robot's design. 3. Regulating the effects of robot behavior through law. 4. Regulating robot behavior through code*».

[217] RoboLaw , *op. cit*., 2014, p. 49 ss.

CHAPTER III
SAFETY REGULATION ON AUTONOMOUS ROBOTS

TABLE OF CONTENTS:

This chapter analyses the current safety regulation, in particular it studies the suitability between this regulation and autonomous robots. So we are going to research: **1.** safety regulation on robots; **2.** safety regulation on autonomous vehicles and the **3.** Interaction between safety regulation and civil liability.

1. Balancing safety, intelligence and autonomy in the safety regulations on robots.

The discussion on civil liability leads to the development of a product safety law, which allows the greater spread and acceptance of robots. It operates *ex ante* tortious event because it aims to prevent the accidents caused by product. Product safety law also plays a particular role as regards judicial investigation in civil liability.

For safety regulation, we refer 1) in EU, to European Directives (Directive GPSD n. 2001/1995/EC and other particular directives), technical regulation [218], harmonized standards[219], guidelines. 2) In USA, to federal and state law, regulations[220] and standard [221].

[218] A technical regulation «include the relevant administrative provisions, the observance of which is compulsory, *de jure* or *de facto*, in the case of marketing or use in a Member State or a major part thereof, except those laid down by local authorities», art. 1, 83/189/EEC.

[219] A standard is a «technical specification (that is contained in a document which lays down the characteristics required of a product such as levels of quality, performance, safety or dimensions, including the requirements applicable to the product as regards terminology, symbols, testing and test methods, packaging, marking or labelling) approved by a recognized standardizing body for repeated or continuous application, with which compliance is not compulsory». art. 1 Directive n. 83/189/EEC.

[220] Regulations are mandatory requirements developed by Government and these rules are made real and enforceable by the power that Government gives itself under an Act.

[221] Standards are engineering criteria written by tech community and they specify how a product should be designed or carried out. Standards have no authority, but they may be adopted into regulations making them legal requirements. Although standards are not mandatory, they are admissible in a process and manufacturers could demonstrate to fulfil them. Judge or jury will be free to consider this compliance. However, Restatement (Third) of Torts (1998) §4 indicates that failure to comply with a rules – that are

There are similarities between European and American safety regulation. Nowadays the European Directive 83/189/CEE[222] introduced the New Approach for standardization[223] that is getting close to American system[224].

The European legislator harmonizes basic requirements of products and removes technical obstacles of good through both procedure of technical standards and mutual recognition. The first procedure takes place thanks to general regulation - on specific sectors, types of products, types of risks - wrote by European Standards Organizations (ESO), such as CEN (European Committee for Standardization), CENELEC (European Committee for Electro technical Standardization); ETSI (European Telecommunications Standards Institute). When standards are published, Standards Organizations of EU States are obliged to reproduce the harmonized standards. However, harmonized standard are voluntary, thus manufacturers do not have to follow them. They become mandatory when legislative Act transposes them.

In EU, the scope of harmonization is to achieve the uniformity of rules on product safety in all Members States. The same scenario unfolded in the American system, where there is a Consumer product Safety Act (1972), which regulates safety product law in general and others Acts regulating particular sectors. Then, for each sector, the corresponding Agencies promulgate regulations.

This system ensures a general compliance also thanks to preemption theory. It allows the prevalence of federal standards on those ones of States and ensures the safety harmonization in all US States[225]. (See *infra* in this chapter).

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relevant for manufacturers - should lead to liability of manufacturers for design defect or warning failure even if the respect of it does not rule out their liability.

[222] COUNCIL DIRECTIVE of 28 March 1983 laying down a procedure for the provision of information in the field of technical standards and regulations (83/189/EEC). In July 2008, the New Approach was modernized as the New Legislative Framework (NLF). New requirements for accreditation and market surveillance by Member States were included in Regulation (EC) 765/2008.

[223] COUNCIL RESOLUTION of 7 May 1985 on a New Approach to technical harmonization and standards establishes that «standardization goes a long way towards ensuring that industrial products can be marketed freely and also towards creating a standard technical environment for undertakings in all countries, which improves competitiveness not only on the Community market but also on external markets, especially in new technology. It recognizes that the objectives being pursued by the Member States to protect the safety and health of their people as well as the consumer are equally valid in principle, even if different techniques are used to achieve them».

[224] For a complete draft about these similarities, *see* AL MUREDEN E, *La sicurezza dei prodotti e la responsabilità del produttore*, Torino, 2015, p. 8 ss.

[225] OWEN D.G., *Products liability law,* St. Paul, Mn: Hornbook Series, Thomson West, 2005, p. 930 says «*the constitutional issue, under the Supremacy Clause, of when federal law (normally safety regulations of federal agencies) overrides state products liability law (normally standards set by courts in defectiveness adjudications) with which it may conflict*». McGARITY T., *The preemption war: when*

To assess if current safety regulation is sufficient with regard to robots, we consider robots in a unified manner. A robot is not the sum of its components, but it is a system. A different approach leads to different results.

For instance, "Machinery" Directive n. 2006/42/CE deals with robots as artefacts and it lays down a set of safety rules related to use of individual part of a robot. Directive indicates the relevant procedure in order to obtain the presumption of conformity of the product. Now, if we only think to the structure of robot, we would apply this Directive also to service robots. However, this is not possible because the Directive refers to industrial robots. So, the difference between robots is their functioning. Then, these rules are inappropriate to settle service robots. They have other functions. They are not located within industrial areas with barriers of protection, but they interact with human beings in the environment.

Before looking at the following framework on safety autonomous car, it is important to take in exam safety regulation on robots in **(a)** European and (**b)** American systems. Finally, we assess the **(c)** current regulation on protection of privacy through design and data protection against hackers.

(a) By studying European legislation – such as General Product Safety Directive (GPSD) n. 2001/1995/EC[226] and sector specific legislation - only industrial robots have a safety regulation.

Italian legislator transposed the Directive into p. IV, tit. I cod. cons. (art. 102-113). French legislator transposed the GPSD into art. L. 221-1/L221-1-4 code de la consommation[227].

federal bureaucracies trump local juries Yale University Press, 2008; AUSNESS R.C., *Preemption of State Tort Law by Federal Safety Statutes: Supreme Court Preemption Jurisprudence Since* Cipollone, 92 KY. L.J., 2004, p. 913; SHARKEY M., *Products Liability Preemption: An Institutional Approach*, 76 Geo. Wash. L. Rev, 2008, p. 449. As regards this issue there is a debate at international level. American Agencies state that their standards are not minimal requirements GREEVE M.S., *Federal Preemption, States' Powers, National interests*, Washington D.C., XV, 2007, p. 84; DELLACASA M., *Sulle definizioni legislative nel diritto privato*. Tra codice e nuove leggi civili, Torino, 2004, p. 355 ss.; MONATERI P.G, *La responsabilità civile*, Tratt. dir. civ., diretto da SACCO R, Torino, 1998, p. 721; *contra* VLADECK D. C., *The Emerging Threat of Regulatory Preemption*, 33 Pepperdine L. Rev, 2005, p. 8; LUMINOSO A. *Certificazione di qualità dei prodotti e tutela del consumatore-acquirente*, in Europa dir. priv., 2000, p. 52.

[226] The Directive 2001/95/CE applies in the absence of specific European regulation**s** on safety of certain product categories and complements the provisions of sector legislation**,** which do not cover certain matters, for instance in relation to producers' obligations and the authorities' powers and tasks. It lays down product safety requirements for all other non-food consumer products. It provides a generic definition of a safe product and establishes an alert system on dangerous products (RAPEX)

GPSD has a residual nature than specific sector legislation[228]. It complements the provisions of sector legislation, which do not cover certain matters. The General Product Safety Directive 2001/95/EC (GPSD) contains the core safety provisions. It requires the safety of products and it provides for standard setting, imposes obligations on Member States and on surveillance by authorities of national market. In addition, it lays down procedures for the exchange of information among EU States and for a rapid intervention in relation to unsafe products[229]. Under this Directive, a product is safe when it conforms to the safety provisions provided in European legislation or national legislation adopted in accordance with EU law. Otherwise, the product is safe if it complies with other reference documents such as national standards, Commission recommendations and codes of practices.

Then, Directive lays down two mechanisms operating (*ex post*) after the time when the product was put into circulation. These procedures are the recall and the withdrawal. Recall «means any measure aimed at achieving the return of a dangerous product that has already been supplied or made available to consumers by the producer or distributor». Instead, the withdrawal «means any measure aimed at preventing the distribution, display and offer of a product dangerous to the consumer».

The application of GPSD on robots raises some issues. GPSD states that a product is safe when, in the absence of specific Community provisions governing the safety of

[227] These articles were inserted into Code de la consommation with Ordonnance n. 2008-810, 22.08. 2008 «*complétant la transposition de la directive 2001/95/ ce du 3.12.2001 relative à la sécurité générale des produits*».

[228] GUIDANCE DOCUMENT ON THE RELATIONSHIP BETWEEN THE GENERAL PRODUCT SAFETY DIRECTIVE (GPSD) AND CERTAIN SECTOR DIRECTIVES WITH PROVISIONS ON PRODUCT SAFETY. European Commission Directorate General Health and Consumer Protection (DGSACON), November 2003. *See* Art. 1.2.

[229] On this Directive there is a proposal of update *see* (COM/2013/074) COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE MORE PRODUCT SAFETY AND BETTER MARKET SURVEILLANCE IN THE SINGLE MARKET FOR PRODUCTS, Brussels, 13/02/2013 where art. 2 states «As for the remaining provisions of the GPSD, recurrent product safety alerts have clearly signaled the need for more effective, up to date product safety rules. The requirement that consumer products made available in the EU must be safe also remains the key provision of the new Consumer Product Safety Regulation. Its interaction with sector-specific legislation applicable to consumer products, however, is clarified to avoid undue overlaps and increase legal certainty for economic operators. To reflect the challenges of a globalized market, emphasis is put on enhanced product identification and traceability. The obligations for economic operators (manufacturers, importers, distributors) are aligned to the 'New Legislative Framework for the Marketing of Products' adopted in 2008 to ensure consistency with sector-specific rules. Last but not least, the proposed regulation promotes enhanced use of European standards. The procedures to identify or update existing standards or to develop new ones which provide the presumption that a product is “safe”, is significantly simplified and aligned with the recently adopted European Standardization Regulation 1025/2012».

the product in question, the product conforms to the specific rules of national law of the Member State where product is sold. In addition, relevant national standards are concerned when the product conforms to voluntary national standards transposing European standards, the references of which have been published by the Commission in the Official Journal of the European Communities

As regards robots, there are not EU provisions governing their safety. Then, there are not specific rules of national law.

The safety of robots may be assessed based on the state of-art and reasonable consumer expectations concerning safety. The state of art on robots is poor because the current technology knowledge about this matter is still unclear. Instead, the second parameter (reasonable consumer expectations) does not a reliable source of safety. Consumers do not know what to expect from robots. Consumers have an idea based on cars advertising on this unknown product. They cannot yet get a realistic impression.

There are not specific Directives that refer to robots of service.

For instance, "Machinery" Directive [230] refers to industrial robots that are "machines" [231]. Directive identifies a set of minimum standards which should be respected by any parties involved (manufacturers, supplier, user). Perimeter protections are one among all these standards; they represent barriers of distance[232] which reduce robot's motion. It is obvious this Directive refers industrial robots and it is not adequate to others robots. However, it gives some suggestions in order to achieve safety of robots. It suggests to take into account the «design and construction of machinery».

The second preamble establishes:

> «The machinery sector is an important part of the engineering industry and is one of the industrial mainstays of the Community economy. The social cost of the large number of accidents caused directly by the use of machinery can be

[230] The new Machinery Directive comes into effect on the 29/12/2009. The Machinery Directive is known as "Machinery" (2006/42/EC), and replaces the previous Directive "Machinery and other technical apparatus" (98/37/EC). Although both Directives are similar to a certain extent, there is naturally a number of changes that affect you as a machine manufacturer and importer; *See* FRASER I., *Guida all'applicazione della direttiva Macchine* 2006/42/CE, Commissione Europea. Imprese e Industria, 2010.

[231] SANTOSUOSSO A., BOSCARATO C., CAROLEO F., *Robot e diritto. Una prima ricognizione*, in NGCC, 2012, p. 10 (for an exhaustive exposure on European safety law about «machines»).

[232] In order to height of protection *see* EN ISO 13857:2008: Safety of Machine safety - Distance to avoid the achievement of dangerous areas through superior and inferior legs, with the indication that perimeter protections cannot have an inferior height to 1400 mm from the square footage. The identification of distances in which stamped perimeter protections (caused by different areas) is complex and there is still the reference to EN ISO 13857: 2008 and ISO 13854:1996, UNI EN 349: 1994 related to distances to avoid crushing of parts of human being. UNI_EN_ISO_10218-2.

reduced by inherently safe design and construction of machinery and by proper installation and maintenance.

In addition, Directive n. 93/42/EEC[233] lays down the medical devices that are not robots. Directive 2007/46/CEE [234] and Reg. (EC) N. 661/2009 [235] refer to conventional car.

In particular, Directive 2007/46/EC does not ensure the spread of robot cars. It establishes a framework for the approval of motor vehicles. It identifies forty-seven types of testing of passive safety (airbags) and active safety. Article 20 establishes exemptions for new technologies or new concepts:

> «1.Member States may, on application by the manufacturer, grant an EC type-approval in respect of a type of system, component or separate technical unit that incorporates technologies or concepts which are incompatible with one or more regulatory acts listed in Part I of Annex IV, subject to authorization being granted by the Commission in accordance with the procedure referred to in Article 40(3).
> 2. Pending the decision as to whether or not authorization is granted, the Member State may grant a provisional approval, valid only in its territory, in respect of a type of vehicle covered by the exemption sought, provided that it informs the Commission and the other Member States thereof without delay by means of a file containing the following elements:
> (a) the reasons why the technologies or concepts in question make the system, component or separate technical unit incompatible with the requirements;
> (b) a description of the safety and environmental considerations concerned and the measures taken;
> (c) a description of the tests, including their results, demonstrating that, by comparison with the requirements from which exemption is sought, at least an equivalent level of safety and environmental protection is ensured».

Current European safety law should be integrated in order to regulate robots. The current product safety law doesn’t include the evolutionary capabilities of some

[233] DIRECTIVE 93/42/EEC of 14 June 1993 concerning medical devices (OJ L 169 of 12 July 1993), lately modified by DIRECTIVE 2007/47/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 5 September 2007 amending COUNCIL DIRECTIVE 90/385/EEC on the approximation of the laws of the Member States relating to active implantable medical devices, COUNCIL DIRECTIVE 93/42/EEC concerning medical devices and DIRECTIVE 98/8/EC concerning the placing of biocidal products on the market.

[234] DIRECTIVE 2007/46/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 5.09.2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles.

[235] REGULATION (EC) NO 661/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009 concerning type-approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefor.

robotic systems. Intelligent and autonomous robots need a more incisive qualitative control of their consequential risks.

Nowadays safety regulation exists as regards robots which interact with engineer who works to elaborate the same robots[236]. For other types of robots there is not a safety regulation. However, in same specific sector of EU is developing reports in order to evaluate new technologies.

(b) In American law system, product safety law is a regulatory law. The systems of rules established by legislatures and administrative agencies of federal, state and occasionally even municipal governments regulate the safety of the products sold to the public.

Standards play an important role in regulating design, warnings and in tort litigation cases on claims of two above defects. Production rules standardize the mass-production in order to fixed guidelines that should be respected by manufacturers. These standards are always developed by independent private subjects, such as Automotive Engineers Society (SAE); Underwriters Laboratories (UL); American National Standards Institute (ANSI); International Organization for Standardization (ISO); Robotic Industries Association (RIA). These standards can be adopted by government – i.e., the standard adopted by National Institute of Standards Technology (NIST) or National Highway Safety Administration (NHTSA) that promulgated Standards Federal Motor Vehicle Safety (FMVSS)[237].

Various federal Agencies exert considerable control over product safety on national scale. For instance, Consumer Product Safety Commission (CPSC) has jurisdiction to regulate consumer product safety under the Consumer product Safety Act[238]. NHTSA administers The National Traffic and Motor Vehicles safety Act of 1996. Occupational Safety and Health Administration (OSHA) administers the Occupational Safety and Health Act of 1970; FDA administers the Federal Food, Drug, and Cosmetic Act; the Federal Aviation Administration (FAA) administering the safety provisions of the Federal Aviation Act of 1958 and the Environmental Protection

[236] SANTOSUOSSO A., BOSCARATO C., CAROLEO F., *op. cit.*, p.13.

[237] The regulations are published into Federal Register and they are into Code of Federal Regulations (CFR).

[238] But only the Federal Hazardous Substances Act; The Poison Prevention Packing Act, the Flammable Fabrics Act and the Refrigerator Safety Act.

Agency (EPA) administers the Toxic Substances Control Act, the Federal Insecticide, Fungicide, and Rodenticide Act, the Clean Air Act[239].

Federal regulatory Agencies (such as the Consumer product Safety Commissions, The Food and Drug Administration, and the National Highway) churn out a profusion of regulations that governs product safety issues. The federal regulation raises important issues on preemptive effect of federal law on state products liability litigation[240]. (See *infra* §3)

To ensure safe robots, the first step is a prevention policies about the risk associated to the technological innovations. For this purpose, Federal product safety Agency should analysis risks and benefits in regulatory decision-making. This allows creating a clear perspective of the real or supposed risks. It is necessary ensure the balance between risks and benefits that the science and technology provide to the society in general, and to each individual in particular[241].

Nowadays, none of these policies is directly applied to intelligent autonomous robot. Nevertheless, it is possible to find some examples of current practices where they have taken into consideration. For example paradigms like OSHA regulations[242] or federal regulation of automobiles by NHTSA[243].

(c) IARs are able to collect information and this ability ensures them the interactivity and connectivity. One of main issue is the protection of privacy. This scope could be carried out with "Privacy by design" (PbD).

"Privacy by Design" is an approach adopted by the Information and Privacy Commissioner in Ontario, Canada[244] and then it was developed in US and in EU. Ontario' research group developed the concept "Privacy by Design" that is «embedded

[239] HUBBARD P., *Sophisticated Robots. Balancing Liability, Regulation and Innovation,* op. cit., 2014.
[240] In 1998, The American Law Institute provided products liability with its own Restatement (Third) of Torts: Product Liability. OWEN, D.G., MONTGOMERY J.E., DAVIS M. J., *Products Liability and Safety*, New York, VI ed., 2010, p. 1.
[241] GEISTFELD M., *Reconciling Cost-Benefit Analysis with the Principle that Safety Matters More Than Money*, 76N.Y.U. L. Rev. 114, 2011.
[242] Payne v. ABB Flexible Automation, Inc., 116 F. 3d 480 (8th Circ. 1997); Behurst v. Crown Cork & Seal USA, Inc., 2007 U.S. Dist. Ct. Lexis 24922 (D. Or.)
[243] Grier v. Am Honda Motor Co., 529 U.S. 861 (2000). Williamson v. Mazda Motor of Am., Inc., 131 S. Ct. 1131 (2011).
[244] CAVOUKIAN A., *Privacy by design. The 7 Foundational Principles*. Information and & Privacy Commissioner of Ontario, Canada, 2013, available at https://www.ipc.on.ca/images/resources/7foundationalprinciples.pdf.

into the design and architecture of IT systems and business practices»[245]. PbD extends to IT systems and to a physical design and networked infrastructure.

This approach develops on seven foundations principles. PbD approach « […] anticipates and prevents privacy invasive events before they happen». Therefore, PbD « […] comes before-the-fact, not after» (principles n.1). It « […] seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given […] » (principles n. 2). Finally, PbD «requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options […] » (principles n. 7).

Federal Trade Commission (FTC) recognized this approach in 2012 with a report entitled "Protecting Consumer Privacy in an Era of Rapid Change". This report contains the recommendations for business and policymakers, such as Privacy by Design, Simplified Choice, and Greater Transparency[246].

European Commission also adopted PbD. First, G29 states that EU Directive 95/46/EC protects data collected and processed by connected objects. It states a list of recommendations as regards data protection in order to develop the Internet of Things (IoT), including principle of "Privacy by design". In this respect, «every stakeholder in the IoT should apply the principles of Privacy by Design and Privacy by Default» and «Application developers should apply a data minimization principle. When the purpose can be achieved using aggregated data, developers should not access the raw data. More generally, developers should follow Privacy by Design approach and minimize the amount of collected data to that required to provide the service»[247].

In addition, PbD has been included in EU's legislative bodies. EU legislator is preparing an updated and more harmonized data protection law (the "Regulation") to

[245] *Ibidem*, principles n. 3.

[246] PROTECTING CONSUMER PRIVACY IN AN ERA OF RAPID CHANGE: RECOMMENDATIONS FOR BUSINESSES AND POLICYMAKERS, An FTC Report (Mar. 26, 2012), available at http://www.ftc.gov/os/2012/03/120326privacyreport.pdf.

[247] G29, OPINION of 8/2014 ON THE RECENT DEVELOPMENTS ON THE INTERNET OF THINGS, available at http://ec.europa.eu/justice/dataprotection/article29/documentation/opinionrecommendation/files/2014/wp223_en.pdf. This Opinion does not deal specifically with B2B applications and more global issues like "smart cities", "smart transportations", as well as M2M ("machine to machine") developments. But, the principles and recommendations in this Opinion may apply outside its strict scope and cover these other developments in the IoT.

replace the Directive n. 95/46/ECC. The Regulation remains under negotiation[248].

One of the main concerns of IARs is the hacked attacks. The study of another sector in which there is this question could be useful.

In aviation matter there is a comment of Electronic Privacy Information center (EPIC) of the Department of Transportation (2012) to the Federal Aviation Administration. Its concerns are on drone hacking or on the process of remotely intercepting and compromising drone operations, which poses a threat to the security of lawful drone operations.

EPIC recommends that: «the FAA identify testing sites and develop evaluation criteria with consideration for the privacy and civil liberties threats arising from drone deployment. The FAA states that drone test sites will "assist in the effort to safely and efficiently integrate" drones into the national airspace. To "efficiently integrate" drones into the national airspace, and because drones possess unparalleled surveillance capabilities, the FAA should assess and prevent privacy risks before drones are further deployed»[249].

The recommendations given by EPIC are interested related to safety of robots.

> «1. Task local governments, in conjunction with the FAA, with the management of drone test ranges. This will aid in accountability and transparency throughout the drone integration process;
> 2. To the extent that drone surveillance is lawfully permissible, test drone network security, which will inform the FAA on the best methods to prevent drone software from being compromised;
> 3. Limit flight testing to sparsely populated areas and provide notice to the individuals in those areas of all scheduled tests. Limiting drone testing in this fashion can minimize privacy threats caused by drones».

These recommendations could inspire, i.e. the regulation of smart cars against hacker attacks.

2. Building a safety net around smart cars.

Smart cars are able to sense the surrounding environment. They respond to traffic and to sudden movements. Robot cars also monitor their brake, speed and road

[248] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) COM(2012).

[249] COMMENTS OF THE ELECTRONIC PRIVACY INFORMATION CENTER TO THE FEDERAL AVIATION ADMINISTRATION of the DEPARTMENT of Transportation [Docket No. FAA-2012-0252]. Request for Comments on Unmanned Aircraft System Test Sites May 8, 2012.

signs. Smart cars take information (input). Then, this information is developed through their control system. Subsequently, smart cars act, i.e. they navigate on routes.

However, while technology is moving forward swiftly, law does not move to the same speed. Law moves a little slower.

History teaches us technology and law have always acted at different times. For instance, in 1839 UK adopted a decree which imposed restrictions to road transport. The decree forced people to travel at a maximum rate of 16 Km/h and outside the residential area. This restriction concerned steam engines. In 1839, this type of engine was considered an old tech product because other engines were experiencing.

Nowadays there is the same scenario in EU, where Directive 2007/46/CEE[250] regulates vehicles that refer only to «any power-driven vehicle which is moved by its own means, having at least four wheels, being complete, completed or incomplete, with a maximum design speed exceeding 25 km/h». Technology progress of vehicle is quicker than safety regulation on vehicles.

The study proceeds as follows. **2.1.)** The description of the implications between technology and law in terms of safety design and technological choices. **2.2.)** A framework on current regulation of robot cars will carry out.

2.1. Law and technology implications.

On implication between technology and law, we include driver-vehicle interface (DVI) and the control systems' safety.

Driver-vehicle Interface (DVI) is «element or sub-element of a system with which the driver can interact, i.e. all the input and output devices (e.g. knobs, switches, levers, displays), which permit the interaction between the driver and one or more vehicle systems»[251]. The design of autonomous vehicles has a significant relevance. Consumer's safety depends on design of interfaces because the form and function of interfaces enable the communication between human and driving system.

These interfaces are the social representation of technology and their absence would lead to inappropriate use of automated system by consumers.

Researchers of RoboLaw project deal with this issue. They point out that

[250] DIRECTIVE 2007/46/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 5.09.2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles.
[251] Glossary 2.2. n. 34 Code of ADAS.

empirical and philosophical studies are important in order to establish rules for design of interfaces. These latter guide the actions of drivers and prevent dangerous situations. So, designers will have to understand what qualities the interfaces should have in order to reach safety for consumers. For this scope it is important the type of sound that has a greater impact in terms of driver's careful. Scholars refer to «technological mediation»[252] - that is the way in which technologies affect human perceptions and actions[253]. In particular, scholars refer to different type of mediation, such as pragmatic and hermeneutic one, in order to describe how automated cars and their design communicate with the users.

The pragmatic mediation refers to how technology influences drivers' act. This study assesses how the «interfaces mediate drivers' actions and their awareness of their roles and responsibilities is a first step to understand whether drivers' perception is correct under the current framework and will lead to a desirable behavior». The hermeneutic mediation refers on how technology makes the world's representation. «The desirable type of hermeneutic mediation should be incorporated into the design of human-machine interfaces in order to explore how they alter the users' perception of the outside world, and the meanings and representations connected to them». Finally, European scholars give careful on hazards caused by customs of driving an automated car. For instance, the custom of forgetting that car is automated. In this regard, scholars suggest an action by designers and regulators to reduce at least these hazards. «This can be done by technical means, by continuously reminding the driver to control the road or by sending sound signals»[254].

NHTSA is dealing with the same issues with a different approach. The Agency is studying these questions as regards 2 and 3 levels of AVs categorization. The main points to study are the following:

> «Driver/vehicle interaction – Evaluating communication methods between driver and vehicle to ensure safe vehicle operation;
> Ensuring proper allocation of vehicle control functions between the driver and the vehicle;
> Driver acceptance – Factors leading to driver acceptance (false alarm rates, nuisance

[252] The study related to relationship between technologies, cognitive processes and cultural dynamic was developed by INNIS HAROLD A., master of McLUHAN M. (*see Id.*, McLUHAN E., *La legge dei media. La nuova scienza*, Roma, 1994). Based on these studies the School of Toronto began to develop its works.
[253] VERBEEK P.P., *What things do: Philosophical reflections on technology, agency, and design.* University Park, Pa., Pennsylvania State University Press, 2005.
[254] RoboLaw , *op. cit*., 2014, p. 46 ss.

warnings, automation system availability and reliability);
Driver training – Evaluating training requirements that may be needed for level 2 and 3 systems;
Developing human factors research tools – Developing the appropriate test and evaluation tools (e.g. simulators, test vehicles, etc.) to evaluate driver and system performance for various automated vehicle concepts».[255]

NHTSA assesses that the use of some technological systems allowance in place of others, could lead to different results. It's clear that interfaces characterised by visual and acoustic alert is better than systems that have a few alert features.

The choice of the type of interfaces increases several issues in relation to safety regulation. To ensure safety, it is not possible adopt the same precautions. Every category's consumer needs different safety level. Moreover, into every category it needs carry out some distinction. For instance, drivers' needs are different from those ones of assistive robot's consumer. Then, a disabled driver senses alerts in a different way than other drivers.

NHTSA also deals with the issue related to control of system's safety in order to ensure the confidence of vehicle and consequently to avoid hackers. To achieve the safety of the system, NHTSA identifies two statements concerning safe reliability and cyber security. NHTSA has designed different points on which to conduct the corresponding studies.

On secure reliability the topics are:

«Functional safety - Defining functional safety requirements for electronic control systems.
Failure modes -Evaluating failure modes and associated severities.
Failure probability - Evaluating the likelihood of a failure to occur.
Diagnostics/prognostics - Evaluating the need and feasibility of enhanced capabilities that can self-detect or predict failures and investigating how to communicate potential system degradation to the driver.
Redundancy - Investigating what additional hardware, software, data communications, infrastructure, etc. may be needed to ensure the safety of highly automated vehicles.
Availability (of the automated system).
Ability to perform even at a degraded level in case of failure.

Certification - Requirements and processes to validate that the system is safe at deployment and remains safe in operation, including vehicle software»

On Cyber security the topics are:
«Security - Capability of system to resist cyber-attacks.

[255] PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES, op. cit., 2013.

Risks - Potential gaps in the system that can be compromised by cyber-attacks.
Performance - Effectiveness of security systems.
Unintended consequences - Impact of cyber security on performance of the system

Certification - Method to assure that critical vehicle subsystems such as communications are secure»[256].

Hence, EU and US have a different regulatory procedure level and approach on regulatory of robots.

In EU, there is no a central administrative procedural legislation and EU regulatory standards are often set by the legislature. In addition, the standards are set in a political process and any change requires legislative amendments[257]. Then, Europe uses the precautionary principle - which is deemed to apply also in the area of health and safety - in both legislative and regulatory procedures[258]. As regards AVs, EU amendment Regulation 661/2009[259] concerns type-approval requirements for general safety of motor vehicles, their trailers and systems, components and separate technical units. UNECE is preparing new technical regulatory for automated system. Guidelines for regulating autonomous vehicle and their automated system are adopted.

Instead, in the US the Supreme Court «requires federal regulatory agencies to provide strong and reliable scientific evidence and to undertake economic cost-benefit analysis which has helped to ensure America's economic and technological advancement and competitiveness during the past several decades»[260]. The US built its regulatory process on science-based risk assessment, cost-benefit analysis, and cost-

[256] *Id.*
[257] Under the TFEU, policies in the areas of health, safety, environmental protection and consumer protection, are to «take as a base a high level of protection, taking account in particular of any new development based on scientific facts» article 114(3), TFEU.
[258] Case C-180/96, UK v. Commission (1998) ECR 1-2265, at 99 ("*When there is uncertainty as to the existence or extent of risks to human health, the institutions may take protective measures without having to wait until the reality and seriousness of those risks becomes fully apparent*").
[259] REGULATION (EC) N. 661/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13.07.2009 amended by Commission Regulations (EU) n. 407/2011, 523/2012 and 2015/166 (the 'General Safety Regulation).
[260] Industrial Union Department, AFL-CIO v. American Petroleum Institute, 448 U.S. 607, 639 (1980) (wherein the Supreme Court had decided that benzene could be regulated only if it posed a "significant risk of material health impairment"); Joseph C. Morelli, "The Benzene Case: Life, Liberty, and the Pursuit of Health — Industrial Union Department, AFLCIO v. American Petroleum Institute", 3 W. New Eng. L. Rev (1980), p. 311 (discussing how the US Supreme Court "*set up a two-part test for carcinogen regulation cases. The first prong…requires the Secretary to demonstrate the existence of a significant risk to employee health. The second prong deals with the existence of a cost-benefit test.*") *see* BERGKAMP L., KOGAN L., *Trade, the Precautionary Principle, and Post-Modern Regulatory Process Regulatory Convergence in the Transatlantic Trade and Investment Partnership*, European Journal of Risk Regulation 4, 2013, pp. 497.

effectiveness analysis[261]. Instead, Statutes stipulate the general requirements or objectives that products must meet and they authorize regulatory agencies to develop and adopt detailed rules or standards to implement these general requirements and objectives consistent with congressional intent.

As regard AVs regulatory, this process took place at local level, where some States adopted statues for regulate AVs. After, NHTSA adopted statements policy to ensure the uniform level of safety on all US States. Finally, only regulatory agency of Nevada adopted the regulation on AVs.

2.2. Smart cars regulatory scenarios: the state-of-art.

2.2.1. (…) at the International level.

The art. 8 of *Vienna Convention on Road Traffic*[262] establishes:

> 1. Every moving vehicle or combination of vehicles shall have a driver.
> 2. It is recommended that domestic legislation should provide that pack, draught or saddle animals, and, except in such special areas as may be marked at the entry, cattle, singly or in herds, or flocks, shall have a driver.
> 3. Every driver shall possess the necessary physical and mental ability and be in a fit physical and mental condition to drive.
> 4. Every driver of a power-driven vehicle shall possess the knowledge and skill necessary for driving the vehicle; however, this requirement shall not be a bar to driving practice by learner-drivers in conformity with domestic legislation.
> 5. Every driver shall at all times be able to control his vehicle or to guide his animals.

This text was based on the assumption that driver is made of flesh and blood rather than of circuits and sensors. Treaty required that driver should control car at all time.

In 2014, United Nations approved an amendment of the Vienna Convention on

[261] Executive Order 12866, "Regulatory Planning and Review", 58 FR 51735, 4 October 1993; Circular No. A-4, "Regulatory Analysis", Office of Management and Budget, 17 September 2003, (providing "guidance to Federal agencies on the development of regulatory analysis as required under Section 6(a)(3)(c) of Executive Order 12866 "Regulatory Planning and Review," and also providing "guidance to agencies on the regulatory accounting statements that are required under the Regulatory Right-to-Know Act."); Executive Order 13563, "Improving Regulation and Regulatory Review", 76 FR 3821, 21 January 2011; Executive Order 13497, "Revocation of Certain Executive Orders Concerning Regulatory Planning and Review", 74 FR 6113, 4 February 2009; White House, "Regulatory Impact Analysis: A Primer" ("providing a primer to assist agencies in developing regulatory impact analyses (RIAs), as required for economically significant rules by Executive Order 13563, Executive Order 12866, and OMB Circular A-4."), *Ibidem*

[262] The Convention on Road Signs and Signals, commonly known as the Vienna Convention on Road Signs and Signals, is a multilateral treaty designed to increase road safety and the international road traffic by standardizing the signing system for road traffic (road signs, traffic lights and road markings). GENEVA CONVENTION ON ROAD TRAFFIC art. 1, Sept. 19, 1949, 3 U.S.T. 3008, 125 U.N.T.S. 3.

safety of road traffic. This amendment allows the circulation of autonomous vehicles on public roads in the countries identified by Treaty, in accordance with article 8 and 13, 1 paragraph[263].

In the new amendment - submitted by the Governments of Austria, Belgium, France, Germany and Italy - the driver still has to be present and able to take over the steering wheel at any time. However, the amendment allows that car can self-drive as long as the system «can be overridden or switched off by the driver»[264].

They proposed amendments to the Annex of the 1971 European Supplement to the 1968 Convention on Road Traffic. These amendments aim to include systems, which influence the driving. In this way, current technical developments are considered.

Ad article 8 of the Convention (Drivers) shall be read as follows:

> «Domestic legislation must provide that pack, draught or saddle animals, and, except in such special areas as may be marked at their entrances, cattle, singly or in herds, or flocks, shall have a driver able to guide the animals at all times».

Paragraph 5:

> «This paragraph shall be read as follows: "Every driver shall have his vehicle under control so as to be able to exercise due and proper care at all times. He shall be acquainted with the road traffic and safety regulations, and be aware of the factors which may affect his behavior such as fatigue, taking of medication and driving under the influence of alcohol and drugs
> (a) Vehicle systems which influence the way vehicles are driven shall be deemed to be in conformity with the first sentence of this paragraph and with paragraph 1 of Article 13, when they are in conformity with the conditions of construction, fitting and utilization according to international legal instruments concerning wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles.
> (b) Vehicle systems which influence the way vehicles are driven and are not in conformity with the aforementioned conditions of construction, fitting and utilization, shall be deemed to be in conformity with the first sentence of this paragraph and with paragraph 1 of Article 13, when such systems can be overridden or switched off by the driver».

Additional paragraph to be inserted immediately after paragraph 5 of this Article This paragraph shall be read as follows:

«Domestic legislation shall establish specific provisions concerning driving under the

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[263] [Online] *Cars could drive themselves sooner than expected after European push*, 2014 available at, http://www.reuters.com/article/2014/05/19/us-daimler-autonomous-drivingidUSKBN0DZ0UV20140519.

[264] ECONOMIC COMMISSION FOR EUROPE INLAND TRANSPORT COMMITTEE. Consistency between the 1971 European Supplement to the Convention on Road Traffic (1968) and Vehicle Technical Regulations Working Party on Road Traffic Safety Sixty-eighth session Geneva, 24–26 March, 2014.

influence of alcohol and determine a legal blood-alcohol level and, if appropriate, a legal breath-alcohol level, incompatible with driving a vehicle. Under domestic legislation, the maximum alcohol level shall in no case exceed 0.50 g per litre of pure alcohol in the blood or 0.25 mg per litre in the air expelled».

These amendments have been justified because of some concerns related to i.e. Driver Assistance Systems (ADS)[265]. They give rise doubts and uncertainties because they may influence the way vehicles are driven. Thereby, they have the potential to take immediate beneficiary influence on road safety or to do the same by reducing drivers' workload.

These amendments pose the driver in a superior role. Therefore, the driver maintains the power on vehicle. This role influences the civil liability of driver.

Even though the amendments of Convention of Vienna are a major step towards the real application of automated vehicles, there are still legal hurdles at work. These obstacles need of corrective in order to apply vehicle automation on highways. One of such obstacles is the UNECE regulation n. 79[266] on steering equipment. It awards, for instance, automated steering only at lower speeds. It is clear that current regulation shall be adapted with the aim to regulate autonomous vehicles.

The above amendments allow EU States carrying out a new juridical draft on autonomous vehicles.

In addition, US system may benefit of this amendment. United States Constitution provides that: «This Constitution, and the Laws of the United States which shall be made in Pursuance thereof; and all Treaties made, or which shall be made, under the Authority of the United States, shall be the supreme Law of the Land; and the Judges in every State shall be bound thereby […] »[267]. This Treaty may hinder the use of autonomous vehicles[268] in US, too.

Organization for Standardization (ISO) imposed an international group of study (called ISO/TC204/WG14) to evaluate guidelines on design and tools of robot cars in order to avoid accidents.

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[265] They support drivers in their driving task. They may influence the way vehicles are driven. Thereby, they have the potential to take immediate beneficiary influence on road safety or to do the same by reducing drivers' workload.
[266] United Nations Economic Commission for Europe (UN/ECE) realizes standards, which deal with vehicle safety, environmental protection, fuel efficiency, and anti-theft performance.
[267] U.S. CONST. art. VI, cl. 2.
[268] SMITH B. W., *Automated vehicles are probably legal in the United States*, Tex. A&M L.Rev., 1, 2012, p. 34-33 in which he discusses the possibility that Article 8 is binding and enforceable as federal law.

2.2.2. (…) in EU law.

The European vehicle regulatory includes both EU Regulation and Directives (which must be implemented by all EU States) and technical regulatory promulgated by United Nations Economic Commission for Europe (UNECE). National governments may implement technical regulation[269].

Nowadays EU presents two Directives on safety vehicles. Directive 2007/46/EC that establishes a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles[270]. Directive 2009/40/EC[271] is on roadworthiness tests for motor vehicles and their trailers. Regulation (EU) n. 661/2009[272] concerns type-approval requirements for general safety of motor vehicles, their trailers and systems, components and separate technical units[273].

The Regulation establishes requirements for the type-approval of the motor's safety vehicles and their trailer; of the energy efficiency of motor vehicles by introducing the mandatory installation of type pressure monitoring systems and gear shift indicators; of the safety and energy efficiency of types and their levels of noise emissions.

The types of vehicles concerned are motor vehicles used for the carriage of

[269] CANIS B., LATTANZIO R.K. (2014). *U.S. and EU Motor Vehicle Standards: Issues for Transatlantic Trade Negotiations*. Congressional Research Service.
[270] The «EU type-approval system is based on the principles of third-party approvals and mutual recognition of such approvals. Under the type-approval regime, before being put on the market, the vehicle type is tested by a national technical service in accordance with the legislation and the national approval authority delivers the approval (CE certificate) on the basis of these tests. The manufacturer may make an application for approval in any EU country. It is sufficient that the vehicle is approved in one EU country for all vehicles of its type to be registered with no further checks throughout the EU on the basis of their certificate of conformity. A certificate of conformity is a statement by the manufacturer that the vehicle conforms to EU type-approval requirements. The manufacturer has the responsibility to ensure the conformity of production to the approved type», available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3An26100.
[271] DIRECTIVE 2009/40/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 6.05.2009.
[272] REGULATION (EC) N. 661/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 13.07.2009 amended by COMMISSION REGULATIONS (EU) n. 407/2011, 523/2012 and 2015/166 (the 'General Safety Regulation).
[273] COMMISSION REGULATION (EU) 2015/166 OF 3.02.2015 SUPPLEMENTING AND AMENDING REGULATION (EC) N. 661/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL as regards the inclusion of specific procedures, assessment methods and technical requirements, and amending DIRECTIVE 2007/46/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, AND COMMISSION REGULATIONS (EU) N. 1003/2010, (EU) N. 109/2011 AND (EU) N. 458/2011.

passengers having at least four wheels (category M)[274]; motor vehicles intended for the transportation of goods having at least four wheels (category N)[275]; trailers (category O)[276].

Finally, in order to improve road safety, all vehicles must be equipped with an electronic stability control system. Furthermore, vehicles in categories M2[277], M3[278], N2[279] and N3[280] must be equipped with an advanced emergency braking system and a warning system of lane departure[281].

Manufacturers shall guarantee that new vehicles sold, or registered or put into service within the European Union (EU) are type-approved in accordance with the provisions of technical regulation elaborated by UNECE. The EU type-approval system is a Whole Vehicle Type-Approval System (WVTA) that allows manufacturer to obtain the certification for a vehicle type in one EU country. Then, manufacturer may market this vehicle without the need for further tests.

United Nations Economic Commission for Europe (UN/ECE) carries out standards, which deal with vehicle safety, environmental protection, fuel efficiency and anti-theft performance. UNECE - based on 1968 agreement on vehicle construction - promotes EU-wide integration of vehicle design, construction and safety[282]. Nowadays, UNECE's World Forum for Harmonization of Vehicle Regulations (WP.29) is working on a new Technical Regulation for the approval of Advanced Emergency Braking Systems (AEBS) that will become mandatory for new vehicles starting in 2015[283]. However, the study is limited to automated systems. Smart cars are interpreted as the sum of

[274] Category M: «Motor vehicles with at least four wheels designed and constructed for the carriage of passengers», ANNEX II Definition of vehicle categories and vehicle types, DIRECTIVE 2007/46/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 September 2007, establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles.

[275] Category N: «Motor vehicles with at least four wheels designed and constructed for the carriage of goods», *Ibidem.*

[276] Category O: «Trailers (including semi-trailers) », *Ibidem.*

[277] «Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes».

[278] «Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes».

[279] «Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 3,5 tonnes but not exceeding 12 tonnes».

[280] «Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 12 tonnes».

[281] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:mi0053.

[282] WP.29 is the regulatory and administrative entity that oversees UNECE activities and agreements, much like NHTSA and EPA administer U.S. vehicle laws and regulations.

[283] *See* http://www.unece.org/press/pr2011/11trans_p10e.html.

individual components.

The real tools that deal with smart cars are European guidelines. For instance, European Commission elaborated the guidelines as regard ADAS. These guidelines may be used in order to specification and implementation of ADAS.

These guidelines are in the Code of Practice (CoP) [284], that:

> «comprises a suitable ADAS (Advanced Driver Assistance System) description concept including ADAS specific requirements for system development. It summarises best practices and proposes methods for risk assessment and controllability evaluation. The Code of Practice has been produced by a group of experts within the RESPONSE 3 project, a subproject of the integrated project PReVENT, a European automotive industry activity, co-funded by the European Commission, to contribute to road safety by developing and demonstrating preventive safety applications and technologies»[285].

In addition, the first focus on Robotic took place through RoboLaw project. This project formulated Guidelines on Regulating Robotics (EU FP 7 Project)[286]. This study adopted a new approach. It examines the ethical, legal and social implications of robotics and it renounced to the idea of developing a uniform solution for robots as a single category.

Then, RoboLaw project determined that the best approach was to undertake a case-by-case analysis, addressing single kinds – or classes – of applications, pointing out the technical peculiarities of each. Through that, this study identifies both the ethical and legal implications that the emergence and diffusion of a similar technology may give raise to. Based on this above-mentioned approach they set out some of the following recommendations for policy makers with respect to automotive sector:

> « (2) There is a need for research into the position of insurers with respect to automated cars with special emphasis on the question whether the interests of insurers are aligned with the values and interests held by society. In particular, it should be researched how conditions can be created to (make and) keep the insurance market competitive.
> (3) In order to reduce chilling effects of product liability on innovation in the field of automated cars, it is recommended to – softly – separate the compensation function of

[284] Van WEES, KILIAAN A.P.C, *Vehicle Safety Regulations and ADAS: Tensions Between Law and Technology*," IEEE International Conference on Systems, Man and Cybernetics, Vol. 4, 2004, pp. 4011-4016.

[285] CODE OF PRACTICE (CoP): GUIDELINES FOR PROCEDURES AND PROCESSES THAT MAY BE USED DURING SPECIFICATION AND REALISATION OF ADAS IN ORDER TO STATE REASONABLE SAFETY AND DUTY OF CARE. [IP_D4 06]2 http://www.acea.be/uploads/publications/20090831_Code_of_Practice_ADAS.pdf

[286] RoboLaw, D6.2 Guidelines on Regulating Robotics. EU FP 7 Project: *Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics (RoboLaw)*, Pisa, 2014.

> liability law from its accident prevention function. Victims are compensated by insurers (compensation function) and insurers decide whether to claim product liability based on a rational assessment of what is necessary for accident reduction (accident prevention function) ».

ERTRAC, European Road Transport Research Advisory Council, acknowledges its important role to ensure a harmonized approach towards the implementation of higher levels of Automated Driving functionalities. In 2014, ERTRAC established a task force with stakeholders and experts from its member associations and individual members to define a joint roadmap for Automated Driving[287].

A Task Force - consisting of members of the European Technology Platform on Smart Systems Integration (EPoSS) - published European Roadmap on Smart Systems for Automated Driving in 2015[288], where there are recommendations in order to achieve the milestones for the introduction of higher levels of automated driving in Europe. It is relevant for our studies the following recommendations:

> «A vital obstacle that needs to be overcome is the lack of an appropriate legal framework for both testing and use of higher degrees of automated driving in Europe. Firstly, this concerns the fast adoption of the modified Vienna Convention into national practice, which would enable European countries to keep up with competing regions. Secondly, legal issues and regulations, as e.g. liability in case of accidents, and data security and privacy in the cloud, are of the highest priority for insurance companies. Harmonization of laws and smart solutions like an insurance fund are therefore of great importance for an acceptance of automated driving in general, and particularly for autonomous vehicles. Thirdly, ethical issues of decision making by machines have to be considered».

Finally, recently EU financed a program that developed ICT - based systems and services that will help the innovation in European road transport, thanks to a co-operation with the mobility companies, industrial associations and public sector stakeholders[289].

2.2.3. (…) in US law.

Manufacturers car have had a primary interest in the marketing of autonomous cars and in their safety. However, there is a legal vacuum at the federal level with regard to safety regulation of autonomous vehicles. We analyse the **A)** Federal regulation and

[287] ERTRAC, EPoSS AND SMARTGRIDS, EUROPEAN ROADMAP ELECTRIFICATION OF ROAD TRANSPORT, 2nd edition, 2012.
[288] European road map smart systems for automated driving (2015).
[289] MOBILITY AS ONE AREA OF THE DAFE, VARIOUS ICT FOR TRANSPORT.

B) State law and regulations.

A) The federal law on conventional vehicle is National Traffic and Motor Vehicle Safety Act of 1966 (Safety Act)[290]. Based on Safety Act[291], the Secretary of Transportation is obligated to propose safety standards that motor vehicles must meet, such as Federal Motor Vehicle Safety Standards (FMVSS)[292].

Federal regulation of transportation is published in the Federal Register and compiled in the US Code of Federal Regulations – 49 CFR[293]. This Code contains a series of safety rules and regulations on design, building, performance of motor vehicles and these latter are regulated in each their components.

NHTSA is responsible for safety standards on motor vehicle that are adopted on the basis of those detected in FMVSS. This latter are a «minimum standard for motor vehicle performance, or motor vehicle equipment performance, which is practicable, which meets the need for motor vehicle safety, and which provides objective criteria» (chap. 301 Motor Vehicle Safety, in title 49, United States Code).

In addition, NHTSA, based on New Car Assessment program (NCAP), influences market of car. This influence takes place after the put cars in circulation. Agency delivers from one to five-stars to model of car based on their performance in the crash testing. These assessments are indicated on labels applied on car, so consumers are informed on car to acquire[294]. To implement these tests, NHTSA buys vehicles from dealers and tests whether cars comply with standards. In addition, every individual State can conduct periodic and technical checks on cars.

[290] NATIONAL TRAFFIC AND MOTOR VEHICLE SAFETY ACT OF 1966, PUB. L. n. 89-563, 80 STAT. 718.

[291] 49 U.S.C. § 30111(a).

[292] They are U.S. federal regulations specifying design, construction, performance, and durability requirements for motor vehicles and regulated Automobile safety-related components, systems, and design features. They are the U.S. counterpart to the UN Regulations developed by the World Forum for Harmonization of Vehicle Regulations and recognized to varying degree by most countries except the United States FMVSS are currently codified at 49 C.F.R. 571. FMVSS are developed and enforced by the National Highway Traffic Safety Administration (NHTSA) pursuant to statutory authorization in the form of the National Traffic and Motor Vehicle Safety Act of 1966, which is now codified at 49 U.S.C. chap. 301. FMVSS are divided into three categories: crash avoidance (100-series), crashworthiness (200-series), and post-crash survivability (300-series), https://en.wikipedia.org/wiki/Federal_Motor_Vehicle_Safety_Standards

[293] CFR Title 49 - Transportation is one of fifty titles comprising the United States Code of Federal Regulations (CFR). Title 49 is the principle set of rules and regulations (sometimes called administrative law) issued by the Departments of Transportation and Homeland Security, federal agencies of the United States regarding transportation and transportation related security.

[294] http://www.nhtsa.gov/webapi/Default.aspx?SafetyRatings/API/5.

If NHTSA determines that there is noncompliance, it can encourage manufacturer to recall the model in order to correct the problem or can order a recall[295]. This is coherent with certification of compliance procedure that establishes that «a manufacturer or distributor of a motor vehicle or motor vehicle equipment shall certify to the distributor or dealer at delivery that the vehicle or equipment complies with applicable motor vehicle safety standards prescribed under this chapter. A person may not issue the certificate if, in exercising reasonable care, the person has reason to know the certificate is false or misleading in a material respect. Certification of a vehicle must be shown by a label or tag permanently fixed to the vehicle. Certification of equipment may be shown by a label or tag on the equipment or on the outside of the container in which the equipment is delivered» (P.L. 89-563, 49 U.S.C. §30115).

In relation to autonomous cars, National Transportation Safety Board (NTSB) – an independent US government investigative agency responsible or civil transportation accident investigation -, published a report in 2001. The report points to the importance of regulation and safety of AVs standard performances[296], because the use of a range of systems without HRI regulations could create confusion for the driver (unable to respond to alerts of system). Therefore, non-governmental organizations will begin to implement different standards as regards AVs[297].

In 2013, U.S. Department of Transportation's[298] National Highway Traffic Safety Administration (NHTSA) announced a new policy concerning vehicle automation, including its plans for the research on safety issues and recommendations for States related to the testing, licensing, and regulation of self-driving vehicles.

This policy statements offer four distinct recommendations to State legislators, such as:

> «1) Recommendations for Licensing Drivers to Operate Self-Driving Vehicles for Testing with the aim to ensure that the driver understands how to operate a self-driving

[295] WILBUR V., EICHBRECHT P., *Transatlantic Trade, the Automotive Sector: The Role of Regulation in a Global Industry, Where We Have Been and Where We Need to Go, How Far Can EU-US Cooperation Go Toward Achieving Regulatory Harmonization*, German Marshall Fund Academic Policy Research Conference, Ann Arbor, MI, 2008, pp. 8-9.

[296] http://www.ntsb.gov/Pages/default.aspx.

[297] National Transportation Safety Board Washington, D.C. 20594 Safety Recommendation Intelligent Transportation Society of America (2001).

[298] The Federal Department of Transportation (DOT) is responsible to ensure safety for all infrastructures network and within which NHTSA operates, this latter establishes standard for safety on public road, prevention of car theft, control of fuel consumptions through education, research, standard of safety and control activities.

Vehicle Safely;
2) Recommendations for State Regulations governing testing of self-driving Vehicles according to the following directives: a) to ensure that on-road testing of self-driving vehicles minimizes risks to other road users. b) To limit testing operations to roadway, traffic and environmental conditions suitable for the capabilities of the tested self-driving vehicles. c) To establish reporting requirements to monitor the performance of self-driving technology during testing;
3) Recommended basic principles for testing of self-driving vehicles»[299].

Nevada created regulation on smart cars in accordance with these above-mentioned recommendations[300]. (See *infra* B).

Then, NHTSA and Federal Trade Commission (FTC) announced a legislative proposal in order to protect privacy of drivers. This announcement is preceded by a report entitled Tracking and Hacking: "Safety" and Privacy" in which is contained a study on 16 car manufacturers. It has outlined safety procedures of data and the results relating to collection, transmission and use of data.

Based on this report, a legislative proposal entitled "Security and Privacy in Your Car Act", or "Spy Act" has been presented for introducing standard of privacy's safety on infotainment systems that are located into vehicles[301]. This proposal would give to NHTSA and FTC new supervisory powers in order to ensure cyber security for cars and establish a rating system to evaluate the safety level of the AVs. The scope is to inform consumers. The attention of America on cyber security is justified by the failing's detected on-board system[302].

B) At state level, some US States adopted a legislature in order to regulate self-driving cars (corresponding to level 3). These States are the following: State of Nevada (2011); Florida (2012); Michigan (2013); California (2014); District of Columbia[303]. Some State legislators begun to enacted laws and regulation on AVs. Other States have considered - or are considering - legislation on AVs, such as Arizona, Hawaii, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Oklahoma, Oregon,

[299] PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES, *op. cit.* (2013).
[300] NEV. ADMIN. CODE CH. 482A (2014) adopted regulations on February 15, 2012.
[301] Two senators, Blumenthal R. and Markey E., presented this proposal after the discovery of safety failure of on-board computer.
[302] In 2015 BMW updated the infotainment of 2,2 millions of cars.
[303] http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action

South Carolina, Texas, Washington, and Wisconsin[304]. Only Nevada created the corresponding safety regulation through its States' Department of Motor Vehicle (DMV)[305].

These legislations and regulations foresee a testing procedure of car. A vehicle must be tested before running on public road. These tests are, for example, test driver training program and test driver qualifications. The approval of DMV is necessary on the outcome of the tests.

These legislations are fundamental to understand the AVs phenomena, because they give a definition to AV for the first time.

For instance, Nevada legislation (NRS 482A.025) contains the first definition of AV, such as:

> «technology which is installed on a motor vehicle and which has the capability to drive the motor vehicle without the active control or monitoring of a human operator»[306] and «the Department will interpret the term "autonomous vehicle" to exclude a vehicle enabled with a safety system or driver assistance system, including, without limitation, a system to provide electronic blind spot assistance, crash avoidance, emergency braking, parking assistance, adaptive cruise control, lane keep assistance, lane departure warnings and traffic jam and queuing assistance, unless the vehicle is also enabled with artificial intelligence and technology that allows the vehicle to carry out all the mechanical operations of driving without the active control or continuous monitoring of a natural person» (482A.010)[307].

The Nevada's State has considered human driver as an operator:

> «a person shall be deemed the operator of an autonomous vehicle which is operated in autonomous mode when the person causes the autonomous vehicle to engage, regardless of whether the person is physically present in the vehicle while it is engaged» (NAC 482A.020).

This above distinction is an innovation compared to the conventional vehicles.

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[304] H.R. 2932, 83d Leg., Reg. Sess. (Tex. 2013); H.R. 1649, 63d Leg., 2013 Reg. Sess. (Wash. 2013); H.R. 1439, 63d Leg., 2013 Reg. Sess. (Wash. 2013); S. 80, 2013–2014 Leg., 101st Reg. Sess. (Wis. 2013)H.R. 2167, 51st Leg., 1st Reg. Sess. (Ariz. 2013); H.R. 2679, 50th Leg., 2d Reg. Sess. (Ariz. 2012); S. 13-016, 69th Gen. Assemb., 1st Reg. Sess. (Colo. 2013); H.R. 1461, 27th Leg., Reg. Sess. (Haw. 2013); H.R. Res. 163, 26th Leg., Reg. Sess. (Haw. 2012); H.R. 3369, 188th Gen. Ct., Reg. Sess. (Mass. 2013); H.R. File 1580, 88th Leg., Reg. Sess. (Minn. 2013); H.R. 444, 163d Gen. Ct., 2013 Reg. Sess. (N.H. 2013); S. 2898, 215th Leg., 2d Ann. Sess. (N.J. 2013); Assemb. 3020, 215th Leg., 1st Ann. Sess. (N.J. 2012); S. 4912, 236th Leg., 2013–2014 Reg. Sess. (N.Y. 2013); H.R. 3007, 53d Leg., 2d Sess. (Okla. 2012); H.R. 2428, 77th Leg. Assemb., 2013 Reg. Sess. (Or. 2013); H.R. 4015, 120th Gen. Assemb., 1st Reg. Sess. (S.C. 2013).

[305] NEV. ADMIN. CODE CH. 482A (2014) adopted regulations on February 15, 2012.

[306] NEV. REV. STATUTE CH. 482A - Autonomous Vehicles.

[307] NEV. ADM. CODE CH. 482A - Autonomous Vehicles.

Then, the enacted legislation requires to DMV a regulation on requirement for insurance or bond (NRS 482A.060); requirements for safety and control of vehicle (NRS 482A.070); requirements for testing or operating upon highways in this State (NRS 482A.080); endorsement on driver's license to operate (NRS 482A.200)[308].

The situation in US is different compared to EU. In US many governmental and non-governmental organisations are working on AVs. The regulation is starting at bottom where different States are developing legislations and - in accordance with NHTSA's policy statements - regulations. Then, society of automotive engineers (SAE)[309] is developing standard i.e. related to ACC[310] and these standards are voluntary rules. There is not a federal regulation on AVs.

In EU, the work is operated at central level on the basis of research projects that indicates recommendations in order to improve future legislations.

3. The interaction between safety regulation and civil liability: product safety standards and beyond.

This paragraph is a bridge between this chapter and the next chapter. It aims to identify the basic implication between safety regulation and civil liability as regards robot. Robotic is a sector where tech and law are destined to converge and coincide.

> «(s)i l'on s'attache aux modes de réception des normes techniques dans l'ordre juridique [...] il semble que l'on puisse affirmer que la normalisation est bien une source de droit. Elle participe de ce mouvement contemporain d'élaboration complexe du droit et de déplacement des sources du droit vers les pouvoirs privés économiques»[311].

Safety is the other side of the coin of civil liability and both are interrelated. This relationship is relevant because their balance enables to find a suitable regulation of robots in order to protect consumers against risks derived.

The debate about interaction between safety and civil liability took place in the US[312] and then in EU at the end of the 19th century, after the first accidents at works.

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[308] In relation to driver's license, Nevada's DMV will issue a testing license along with sets of red license plates for the vehicles. «*When autonomous vehicles are eventually made available for public use, motorists will be required to obtain a special driver license endorsement and the DMV will issue green license plates for the vehicles*», http://www.dmvnv.com/autonomous.htm.

[309] State governments often used SAE recommendations to enact requirements for vehicle equipment, such as dual brakes, headlamps, and windshield wipers. Other SAE standards were adopted directly by manufacturers. CANIS B., LATTANZIO R.K., *op. cit.*, 2014.

[310] Adaptive Cruise Control (ACC) Operating Characteristics and Interface.

[311] BOY L., *Normes*, RID éco., n. 2, 1998, p. 127.

[312] This debate took place with CALABRESI G., *The Cost of Accidents.* op. cit., 1970; HOWELLS G., *The relationship between Product liability and Product Safety – Understanding a necessary Element in*

Over the years, this discussion was resumed on mass torts where the mass products caused the same accident to related consumers.

Owen represents this interaction in the following way. «Product safety law operates *ex ante*, by seeking to prevent product-caused accidents and diseases before they occur […]. The law of Product Liability governs the private litigation of product accidents. Operating *ex post* after a product accident has already occurred; its rules define the legal responsibility of sellers and other product transferors for the resulting damages»[313].

Safety regulations have a fundamental role with regard to the assessment of risk and liability. Safety regulation ensures the reduction of damages and identifies which risks are acceptable by the society even if the product is dangerous. The point of contact between safety and civil liability is how safety regulation could affect the judgment of civil liability.

In EU, Directive General Product Safety Directive (GPSD) n. 2001/95/EC and other specific-sector Directives establish safety requirements of many products. All these Directives give a particular emphasis to technical regulation that represents the state of-art in specific sectors. These regulations - defining the product's features - are the benchmarks of evaluating of product's safety. In fact, the declaration of conformity presented by manufacturer or the certificate of conformity determine a presumption of conformity. This presumption enables plaintiff to demand the establishment of the compliance of product with other standards. However, where this establishment is positive, product will be safe and manufacturer will not be liable.

In addition, technical regulations create consumer's expectations on product's safety. Therefore, whether manufacturers conform to regulations, there is a presumption of product's safety and consequently there is the satisfaction of reasonable consumers' expectations on product's safety[314].

However, the relation between safety and civil liability may be interpreted in different way. Safety also operates *ex post* the product is put onto the market. At this

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European Product Liability through a comparison with the U.S position, Washburn LJ., 2000, 305, 307; OWEN D.G., *op. cit.*, 2010; CAFAGGI F., *A coordinate approach to Regulation and civil liability in European Law, Rethinking Institutional Complementarities,* in CAFAGGI F. (a cura di), The institutional framework of European Private Law, Oxford, 2005; IZZO U., *Sangue infetto e responsabilità civile: responsabilità, rischio e prevenzione* in DR, III, 2000, p. 229.

[313] OWEN D. G., MONTGOMERY J.E., DAVIS M.J., *op. cit.,* 2010, p. 13 ss.

[314] AL MUREDEN E., *La sicurezza dei prodotti e la responsabilità del produttore,* Torino, 2015, p. 63 ss.

moment, although the product complies with technical regulation, it can be recalled or withdrawal if it is dangerous. Product liability also has a preventive function before the product is put in circulation through the mechanism of development risk[315].

In U.S. system, the interaction between safety and civil liability assumes different aspects. Some courts consider that whether an industry standard has been adopted by State, as part of a regulatory code, its violation may be negligence *per se*[316]. In this case there is an evidence of negligence that does not admit the otherwise proof.

The negligence *per se* concept is in §288B of the Restatement (Third):

> (1) The unexcused violation of a legislative enactment or an administrative regulation, which is adopted by the court as defining the standard of conduct of a reasonable man, is negligence in itself.
> (2) The unexcused violation of an enactment or regulation, which is not so adopted, may be relevant evidence bearing on the issue of negligent conduct;

The negligence *per se* is also applied to strict product liability *ex* Restatement in §4(a). This latter extends the negligence *per se* with regard to design and warning defects and it provides that a «product's noncompliance with an applicable product safety statute or administrative regulation renders the product defective with respect to the risk sought to be reduced by the statute or regulation». The negligence *per se* requires following requirements. Plaintiff shall prove the defendant violated the statute. The statue protects some group of people from harm. Plaintiff is part of this group. The defendant's actions caused the kind of injury that the statute was designed to protect the plaintiff.

Instead, other courts hold that industry standards are relevant a regards the duty of care in negligence[317]. So, even if manufacturers comply with safety standards, this proof does not represent a conclusive issue. In fact, manufacturer may be negligent[318].

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[315] This observation is made by QUERCI A., *Sicurezza e danno da prodotti medicali*, Torino, 2011, p. 49.

[316] See Comment of Restatement Third, Torts: Products Liability section 4, "*when a product design is in violation of a safety statute or regulation, there is no necessity to prove an alternative design in order to establish defect. Section 4 makes it clear that a product design that is in violation of safety standards is defective per se*". Palmer v. AH. Robins Co., Inc. 684 P. 2d 187(Colo. 1984); Dura Corp v. Harned 703 P 2d 396 (Alaska 1985) 173.

[317] Brady *v.* Melody Homes Mfr., 121 Ariz. 253, 256, 589 P.2d 896, 899 (1978); Ferguson v. Benson NOS. 4537045374. 244 N.W.2d 116 (1976) Maize *v.* Atlantic Refining Co., 352 Pa. 51, 41 A.2d 850 (1945). Victorson *v.* Milwaukee & Suburban Transp. Co., 234 N.W.2d 332, 344 (Wis. 1975).

[318] Restatement (3d) Torts: Liability for Physical Harm § 16 cmt. b «compliance is evidence of non-negligence but is not conclusive». Bradley v. Boston & Me. R.R., 56 Mass. 539 (1848); Grand Trunk Ry. Co. v. Ives, 144 U.S. 408 (1892); Lane v. .A. Sims, Jr., Inc., 241 F. 3d 439 (5th Cir. 2001); Moss v. Parks Corp., 985 F. 2d 736 (4 Cir. 1993); Ferebee v. Chevron Chemical Co., 736 F.2d 1529.

Then, some courts concern that federal and statute regulations impose only minimum standards. State law may integrate these standards[319]. In particular, art. 49 USC 30102 (a) (9) defines FMVSS «means a minimum standard for motor vehicle or motor vehicle equipment performances». The standards' breach is not sufficient to held liable manufacturer («compliance with a motor vehicle safety standard prescribed under this chapter does not exempt a person from liability at common law» 49 USC §30103(e)). Even if vehicle complies with law, plaintiff may demonstrate that manufacturer could adopt a different feasible alternative design[320].

A few courts have excluded the evidence of compliance[321].

Safety federal regulation may restrict the scope of private litigation, or preclude it, in application of federal preemption[322].

Preemption is a particular doctrine developed in US under art. IV, Sec. II of the US Constitution. This clause states that «Constitution and the laws of the United Sates […] shall be the supreme law of the land […]anything in the constitutions or laws of any State to the contrary notwithstanding». Preemption occurs when «the court hold, pursuant to the Supremacy Clause of the U.S. Constitution, the federal regulation of a

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And some but not conclusive evidence on the issue of defect in a strict liability case: Hohlenkamp v. Rheem Manufacturing Company, 123 Ariz. 535, 601 P.2d 298; Stevens v. Parker, 121 Wash. 134, 208 Pac. 6 (1922); Zacher v. Budd Co., 396 N.W.2d 122 (S.D. 1986); Hancock v. Paccar, Inc., 204 Neb. 468, 283 N.W.2d 25 (1979). Walker v. Maxwell City, Inc., 117 III. App.3d, 571, 73 III. Dec. 92, 453 N.E.2d 917 (1983).

[319] Caraker v. Sandoz Pharm. Corp., 172 F. Supp. 2 d. 1018, 1033 (S.D. Ill.2001), in which "*the FDA's drug labelling decisions impose only "minimum" standards that are open to supplementation by state law through a jury's verdict enforcing a manufacturer's common law duty to warm*"; Moss v. Parks Corp., 985 F. 2d 736 (4th Cir. 1993) (S.C. law); Ferebee v. Chevron Chem.Co., 736 F. 2d 1529 (D.C. Cir. 1984) (Md. Law); Brooks v. Beech Aircraft Corp., 902 P. 2d 54, 63 (N.M. 1995).

[320] There are several sentences on liability of maker car. Grimshaw v. Ford Motor.Co, 174 Cal. Rptr. 348 (Ct. App.1981); Anderson v. General Motors Corps, No. BC116926 L.A. Cty. Super. Ct. 1999); Jablonky v. Ford Motor Co. III App. 2010 (a fire to container was caused by container's defect design that were not ensure a reasonable safety in case of rear-end collisions, even it was conform with if federal standard); Nissan Motor Co. v. Nave 740 A.2d 102 (Md.Ct. Spec. App. 1999 (a steering column's defect of design); Superior Indus. Int'.v. Faulk 695 So.2d 376 (Fla. 5th DCA 1997) (warning defect in order to functioning of lift block). Feldman v. Lederle Labs., 132 N.J. 339, 625 A.2d 1066 (1993) (relating to permanent damage caused because of drug use in childhood. Compliance with federal rules regarding instructions on the use of the drug was not considered sufficient to exclude a liability of the manufacturer; it would have to take additional precautions and to inform the consumer even in this specific situation).

[321] Rexrode v. American Laundry Press Co 674 F 2d 826 (10th Cir 1982); Toliver v. General Motors Corp., 482 So. 2d 213 (Miss. 1985); Lewis v. Coffing. Hoist Division, 528 A.2d 590, 594 (Pa. 1987); Jemmott *v.* Rockwell Manufacturing Co., 216 A.D.2d 444, 628 N.Y.S.2d 184 (1995).

[322] A primary preemption case concerning NHTSA regulations was recently before the Supreme Court.282 In deciding Geier v. American Honda Motor Co., the Court had to determine if FMVSS 208283.

given area of concern precludes state regulation of the same area»[323]. Preemption can be express or implied and Courts «must then determinate whether Congress meant to preempt, both state regulatory law and state common law». When Congress expressly preempts a state law, courts have to determine whether federal law is intended to prempt the challenged state law. There is an implied preemption when federal regulation deals with a particular sector. In this case, the federal law prevails over the state law if there is a conflict between these two regulations. This conflict takes place when it is impossible for the manufacturer to comply with both regulations[324].

In automotive sector, express preemption are used for some standards, i.e. roof crush-resistance that preempts any non-identical state or local standard (art. 9 USC 30103 (b)). If damages depend on vehicle that is complied with federal standards, manufacturer's tort claims are preempted. The air-bag claims are a leading case[325] where courts stated that there is an implied preemption clause as regards federal standards on air bags. There is a prevalence of these latter standards on State's statute and regulations. This prevalence takes place even if safety regulation of State ensures a higher level of safety.

In this way, the preemption doctrine could represent a way to overcome the difference between statutes law and regulation and to limit manufacturer's liability. In case of absence of preemption clause, manufacturer is held liable when there is a gap between minimum standards and those standards that might ensure a feasible alternative design.

In EU and USA, the interaction between safety product law and civil liability pursues the same scope, which is the uniformity of safety in all Members States in order to protect the fundamental values of product's consumer. However, this interaction is assuming a new aspect with regard to safety product law.

At international level, EU and US «are creating a process for regulatory cooperation, harmonization, and convergence»[326] through the Transatlantic Trade and

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[323] OWEN D.G., *op. cit*., 2010.

[324] Freightliner Corp. v. Myrick , 514 U. S. 280. Crosby v. Nat'l Foreign Trade Council, 530 U.S. 363 (2000),

[325] Geier v. American Honda Company 529 U.S. 861 (2000); Morgan v. Ford Motor Co., No. 34139 (W.V. Sup. Jun., 18, 2009) (in order to laminate crystals federal preemption doctrine lead to exclude liability's manufacturer because the statute should be considered overcome by federal regulations).

[326] BERGKAMP L., KOGAN L., *Trade, the Precautionary Principle, and Post-Modern Regulatory*, op. cit., 2013, pp. 494 explain that: «*Regulatory harmonization and regulatory compatibility are flip sides of*

Investment Partnership (TTIP) agreement[327]. This agreement aims to harmonize reciprocal safety product standards in order to create a common economic area through the removal of differences among product standards. The compliance of a product with this common regulation will ensure its safety[328].

TTIP agreement gives an example concerning the safety of cars:

> «The safety regulations that apply to cars are different in the US and the EU - even if the end result is comparable levels of safety. In fact, it is already possible to drive some US approved cars on European roads, under a special European approval system. Through TTIP, the Commission would like regulators to formally recognize that important parts of our two regulatory systems are broadly the same in safety terms. Example: The EU and US have different but similar safety requirements in relation to lights, door-locks, brakes, steering, seats, seat-belts and electric windows. Many of these could be formally recognized as providing the same level of safety»[329].

EU Commission states that «today's transatlantic trade relationship, the most significant trade barrier is not the tariff paid at the customs, but so called 'behind-the-border' obstacles to trade, such as different safety or environmental standards for cars»[330]. So, the safety regulation of autonomous vehicle is involved in this new approach.

4. Recapitulation.

The challenge of these technologies is to plan AVs able to have the same abilities of a human being while driving, such as the subtext exchanged among drivers[331] or pedestrians' intuition of behavior.

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the same coin. Regulatory convergence is the rate at which harmonization is achieved. Regulatory cooperation is a process aimed at achieving convergence».

[327] *See* http://trade.ec.europa.eu/doclib/press/index.cfm?id=1230.

[328] AL MUREDEN E., *La sicurezza dei prodotti*, op. cit., 2015, p. 4 recognizes the important role of TTIP agreement on relation between safety and civil liability: «*L'imminente conclusione del Transatlantic Trade and Investiment Partenership (TTIP) […], mediante il quale Unione Europea e mirano ad armonizzare i reciproci standard di sicurezza dei prodotti e creare uno spazio economico comune, impone all'interprete una l'esigenza di una rinnovata attenzione nei riguardi di articolati sistemi di norme (quello sulla responsabilità del fabbricante e quello che può sinteticamente indicarsi con il termine di legislazione di sicurezza dei prodotti) tra loro profondamente interconnessi e destinati ad essere interessati da modificazioni riconducibili in via diretta e indiretta proprio dalla annunciata soppressione delle cosiddette barriere non tariffarie, ossia di quelle disomogeneità ed incongruenze che tuttora caratterizzano i diversi standard di sicurezza dei prodotti negli ordinamenti*».

[329] TRANSATLANTIC ECONOMIC COUNCIL HIGH LEVEL WORKING GROUP ON JOBS AND GROWTH, "FINAL REPORT", 11 February 2013.

[330] http://trade.ec.europa.eu/doclib/press/index.cfm?id=918.

[331] In Pittsburgh, Pennsylvania, "left Pittsburgh" is a local customary, under which the first driver, in front of a red light, will stop for a few minutes (seconds?) after the green light. This will allow other driver – who is coming – to turn left.

1) It would be necessary the drawing up of regulations but it is not a simple process, considering that technology of AVs generates uncertainty because of its constant changes. So, regulations become obsolete very fast[332] and it is hard to reach a consensus[333]. Until now, current safety regulation does not include any references to intelligence and autonomy. Their inclusion requires a new way of thinking technologies or ensuring safety – or better a probable safety. It is hard to involve these features, because stakeholders should adopt a different operational way. In other words, test-systems of vehicles should be written by imaging several conditions in which robots will operate. In the simulated environment all the relevant critical safety situations have to be tested as quickly as possible. This is a new method of thinking safety.

A safety regulation on AVs is important because it represents a starting point toward a homogeneous regulation in all Members States. It is obvious that a homogeneous procedure of conformity of AVs requires the understanding of the functions of AVs and of their influence on both the driver and the environment. For instance, safety standards on AVs cannot be compared with any other rules on safety, considering that for this technology the DVI (driver-vehicle interfaces) is relevant. Therefore, a standard on diver alert system should consider both the consumer's expectations on AVs functioning, and the consumer's ability to understand the instructions given by system.

2) Standards should be aligned in different ways depending on weather the vehicles are semi-autonomous or fully autonomous. Firstly, in both cases standards of AVs technology have to indicate different testing procedures in connection with different environmental conditions in which AVs could operate. The number of testing changes according to the vehicles autonomy. A semi-autonomous car already has a human driver who monitors the driving and who intervenes to avoid accidents. Consequently testing procedures will consider the most frequent environmental conditions. On the contrary, a full autonomy vehicle should be brought under several testing, in order to foresee the range of all possible ambient conditions.

The absence of a safety regulation causes some doubts. AVs, able to self-drive, generate a misunderstanding since drivers think cars could replace them. This is a problem when the car is always semi-autonomous because the drivers' attention may

[332] Van WEES, KILIAAN A.P.C, *Vehicle Safety Regulations and ADAS:* op. cit., 2004, pp. 4011-4016.
[333] KALRA N., ANDERSON J., WACHS M., *op. cit.,* 2008.

decrease. This issue above of all worries manufacturers who prefer to avoid their liability by using efficient alert systems in order to ensure safety and consequently shift liability to human drivers.

3) By studying safety, we are going to analyze it under a new perspective: the driver's perspective. To achieve a reasonable safety level, both manufacturer and driver's activity has to be considered: this is a bi-dimensional point of view. To guarantee drivers are more careful, the right to information on risks related to robot cars has a fundamental role on their awareness. Highway codes contain set of rules which are behavioral norms indicating the instructions on safety of driving. The current Highway Codes do not forbid autonomous driving and in order to solve this vacuum, legislators should intervene to indicate the needed requirements, such as license requirements and minimal distance. Then, it is obvious that the safety of AVs is also related to adequate infrastructures, such as dedicated road lane or specific spaces.

CHAPTER IV
CIVIL LIABILITY: IARs MEET EXISTING RULES OF CIVIL LIABILITY.

This chapter will be dedicated to study of civil liability on intelligent autonomous systems. It has been split into two sub-chapters, the first analyses general issues raised by robotic, while in the second we are going to conduct a specific study on conventional categories of civil liability, under two different points of view.

SUB-CHAPTER 1
CHALLENGING THE CONVENTIONAL CATEGORIES OF CIVIL LIABILITY

TABLE OF CONTENTS:

1. 1. IARs meet existing rules of civil liability.

An IAR - provoking injuries - raises a main legal question, such as the identification of liable. Civil liability may resolve this question because it may identify the responsible[334]. However, you need to understand if conventional legal categories are suitable to deal with hypothesis where robot causes damages to humans.

Civil liability is in each legal civil system, and in most of these systems there are two types of liability, such as contractual and extra-contractual liability[335].

Our research considers contractual liability, product liability and tort law in two EU States – Italy and France – and in US. The two European States have similarities about statutory liability schemes. These two States present a special contractual liability as regards sale of consumer goods, transposed with EU Directive n. 44/1999[336] and a similar contractual liability inserted into their civil codes. With regard to Product Liability, Italy and France transposed the Directive n. 85/374/EEC, corrected by Directive n. 1999/34/EEC. It was transposed by Italy with D.P.R. 24 May 1998, n. 224 and inserted into Title II, Part IV, cod. cons. Instead, France inserted the product liability into *le titre* IV*bis* composed by articles from 1386-1 to 1386-18 under the title *De la responsabilité du fait des produits défectueux* -.

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[334] The identification of liable is one of the functions of civil liability. FLEMING J., *The law of Tort.* 9th ed., Law Book Co, Sydney, 1998, p. 7; TRIMARCHI P., *Economia e diritto nel sistema della responsabilità civile. Politica del diritto inglese*, 1971, p. 353; ATIYAH P., *Accidents, Compensation ad Law*, London, 1975, p. 51; ALPA G, *La responsabilità civile. Parte generale*, Italia, Milano, 2010, p. 160 ss.

[335] In the most of civil liability systems there are these distinction, *see* TORRENTE A., SCHLESINGER P., *Manuale di diritto privato*. ed. 19, in ANELLI e GRANELLI, Milano, 2009, p. 817.

[336] DIRECTIVE 1999/44/EC of the European Parliament and of the Council of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees.

Finally, both European legal systems contain a series of tort law that cover damages to third parties. In both systems, there is a correspondence with regard to tort law: *Responsabilità di cose in custodia* (2051 cod. civ.), *Responsabilità per l'esercizio di attività pericolose* (2050 c.c.) and *Responsabilitè des choses* (art. 3084, al. 1 c.c.); *Responsabilità per danni causati da animali* (2052 c.c.) and *Responsabilitè du fait des anuimaux* (1385 c.c.); *Responsabilità dei genitori* (2048, co.1 c.c.) and *Responsabilité parentale* (art. 1384, al. 4), *Responsabilità dei precettori* (art. 2048, co. 2) and *Responsabilitè de l'instituteur du fait des élèves* (1384, al. 6.)

US system has a different approach on civil liability. In US there are three theories of civil liability, such as a) negligence; b) strict liability; c) breach of warranty (represented by Uniform Commercial Code – art. 2).

The conventional tort theory requires the negligence of defendant who acts deliberately in a way that he knows will cause consequences condemned by society. Instead, the strict liability is applied when defendant makes untrue representations knowingly or reckless of their falsity with the intent that the plaintiff will rely on them[337].

US Product liability is the result of combination between tort theories and Restatement of Torts. The modern Product Liability is based on Restatement (Third) of Torts[338], which was adopted in order to limit the spread of Product Liability litigation[339]. Restatement (Third) of Torts is the rewording of §402A Restatement (Second) of Torts. In particular, under §402A, a strict product liability developed, so consumers could claim compensation against manufactures or distributors.

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[337] OWEN D. G., MONTGOMERY J.E., DAVIS M. J., *Products liability and safety*, op. cit., 2010, p. 42.

[338] Product liability based on theory of negligence until the beginning of the 1960s, so manufacturer could be held liable whether plaintiff had be able to demonstrate his fault conduct, in order words the breach of a duty to care. Since of the 1950s, manufacturer could be held liable on breach of warranty theory until, too. Then, since of the 1960s manufacturer was held liable on strict liability theory (*see* In Henningsen v. Bloomfield Motors, Inc., 32 N.J. 358, 161 A.2d 69 (N.J. 1960) where a third parties of a contract had a breach of warranty action against manufacturer; Greenman, v. Yuba Power Products, 59 Cal.2d 57, 377 P.2d 897, 27 Cal. Rptr. 697, 13 A.L.R.3d 1049 (1963).

[339] In May 1997, the American Law Institute (ALI) completed the Restatement (Third) of Torts: Products Liability. The Third Restatement is «*an almost total overhaul*» of the Restatement (Second) of Torts, which was issued in 1965. The Second Restatement contained a single provision dealing with products strict liability: Section 402A. The major thrust of this section was to eliminate privacy, so that any person injured by a defective product could directly sue the manufacturer and members of the chain of distribution. The substantive focus of §402A was on manufacturing defects. The Third Restatement greatly expands the coverage by addressing the many developments in products law occurring over the ensuing 35 years. SILVERGLATE S. H., *The Restatement (Third) of Torts Products Liability: The Tension Between Product Design and Product Warnings*. Florida bar J., vol. 75, 2001, pp. 10-17.

In 1988, ALI completed its restatement of the law as regards products liability. Restatement (Third) of Torts contains three types of defects (manufacturing/design/warning). Strict liability theory is applied on manufacturing defect. Instead, about the other two defects the theory of reasonableness is applied. In order to evaluate the standard of reasonableness, courts use two tests such as consumer's expectations and utility-risk test.

Nowadays, the application of Product liability is not uniform in US States. Some States did not code strict liability rules that are included into §402A Restatement (Second) of Torts. These States use implied warranty of quality in order to condemn manufacturer. These States are Delaware, Massachusetts, Michigan e Virginia.

The study of statutory liability schemes implies the knowledge of liability's functions. The knowledge of these functions enables to assess if conventional categories are appropriate or not. These functions are periodically objected of new interests for the civil law doctrine. It releases (in every time and place) four fundamental functions. 1) Function of reacting to illegitimate harmful act, to compensate people suffering damages; 2) function of reset the status *quo ante* in which the injured was before suffering injuries; 3) function of establishing a State's power of sanction; 4) function of deterrence for everybody who would realize acts that cause prejudicial effects towards thirds. Other subsidiary functions are added, such as the function related to economic effects of civil liability that enables the assignment of the losses and the allocation of the costs.

1.1. Before the law: preliminary ethical considerations.

A brief discussion on ethic of robots is unavoidable before studying civil liability. An ethical approach allows us to identify what people's interests could be satisfied through robotics improvement. This is a fundamental substrate in order to develop rules for the manufacturing of robots, in particular design's rules of robots. Then, an ethical deepening plays a basic role on assessment of risks derived from the use of IARs.

The ethical question takes place when robots leave the factories and they began to interact with people. This evolution changed the social sense of robots and consequently a new ethical thought takes into account all specific features of IARs, such as their tasks, the environment where they operate and their degree of autonomy.

Ethic prospective also analyses the social benefits of IARs with regard to consumers' needs and to protection of them from probable risks related to their use. In order to carry out this evaluating, it is necessary consider fundamental values involved and, in particular, probable conflicts among these values and social benefit of IARs[340]. At European level, this analysis is conducted on the basis of values including into Charter of Fundamental Rights of the European Union, which is currently transposed into Part II of the Treaty Establishing a Constitution for Europe[341].

Military field is the first area of robots' application where ethic issues assume especial importance. The spread of military robot raises serious ethical questions. Nowadays, scholars conclude that operational morality cannot regulate complex environment characterized by unforeseeable situations that could disable the robots' architecture of control[342].

A new approach originated from the ethical research on robots. This new approach is the Roboethic coined by Veruggio. He considers Roboethics as «an applied ethics whose objective is to develop scientific/cultural/technical tools that can be shared by different social groups and beliefs. These tools aim to promote and encourage the development of Robotics for the advancement of human society and individuals and to help preventing its misuse against human kind».[343] This approach refers that rules of robots should be turned in rules related to their design, manufacturing and use[344]. Therefore, designers of robot meet a series of norms to follow in specific situations.

Roboethic deals with at least three issues, such as robot's ethic, the ethic of robot engineers – who design a robot - and people's behaviour towards robots. According Asaro the combination of these issues is the best approach to achieve the robot's safety.

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340 This approach has been adopted by European Group in BISOL B., CARNEVALE A., LUCIVERO F., *Diritti umani, valori e nuove tecnologie Il caso dell'etica della robotica in Europa*. Metodo. International Studies in Phenomenology and Philosophy Vol. 1, issue 2, 2014, pp. 235-252. This research has been financed by European project Robolaw (Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics).

341 OPINION n. 20 OF THE EUROPEAN GROUP ON ETHICS IN SCIENCE AND NEW TECHNOLOGIES TO THE EUROPEAN COMMISSION adopted on 16/03/2005 on ethical aspects of its implants in the human body.

342 ARKIN R. C., *Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberative/Hybrid Robot Architecture*, Report GIT-GVU-07-11, Atlanta, GA: Georgia Institute of Technology's GVU Center, 2007; [Online] *Les robot militaires peuvent-ils-adopter une étique?* Paris Tech. Rev. (describes a symmetry question between operational morality and environment where robots operate).

343 VERUGGIO G., *Il cammino della Roboetica*, Le Scienze, 461, 2007, pp. 34-35.

344 ALLEN C., SMIT I., WALLACH W., *Artificial morality: Top down, bottom up, and hybrid approaches*. Ethics and Information Technology 7 (3), 2005, p. 149. WALLACH W., *From Robots to Techno Sapiens: Ethics, Law and Public Policy* in the Development of Robotics and Neurotechnologies, 3 Law, Innovation & Tech., 2011, pp. 185-194.

He says that: «what we should want from a robot ethics is primarily something that will prevent robots, and other autonomous technologies, from doing arm»[345].

In particular, Robot's Ethic considers that principles and moral decision-making procedure (as Asimov laws) have to be entered into robots through an ethic code. The application of an ethic code into robots is dubious with regard to specific situations, because these laws consider robots as humans able to have a specific behaviour. Actually, robots are not comparable to humans, they are *sui generis* objects built by designers and programmers[346].

Robot's Ethic approach was anticipated by some literature authors – pioneer in ethic on robots – who offered ethical laws that guide the behaviour of automata that interact with humans. Asimov elaborated three robot laws, such as:

> «A robot may not injure a human being or, through inaction, allow a human being to come to harm.
> A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law.
> A robot must protect its own existence as long as such protection does not conflict with the First or Second Law».

Originally, a robot capable of making-decisions will act in context where its freedom of action is limited. Then – in accordance with technological evolution - a robot could become a moral artificial agent - based on ethical laws - even if the acquisition of intelligence and moral acumen is not immediate. Nowadays, IAR is not a moral agent but it is not a simple amoral artefact. However from moral agent and amoral artefact there is a continuum[347].

The ethical approach has been a preliminary step for some States. In 2007, South Korea government published ethic code of robot to ensure social safety against robotic revolution. This code contains three parts: standards of production, rights and duties of users and owners; rights and duties of robots[348].

In 2010, Danish Ethic Council drew up Recommendations on social robots and

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345 ASARO P.M, *What should we want from a robot ethic?.* International Review of Information Ethics 6(12), 2006, pp. 9-16.
346 LOISEAU G., BOURGEOIS M., *Du robot en droit à un droit des robots*, JCP G., 1231, 2014, p. 2162; BENSOUSSAN A., *Les droit des robots. De l'éthique au droit: Planète Robots*, n. 24, 2013, p. 24 (They proposes to elaborate an ethic code to insert into mind's robot).
347 ASARO P.M, *What should we want from a robot ethic?*, op. cit., 2006.
348 BENSOUSSAN A., *Le droit des robots: la charte coréenne*, Planète Robot n. 25, 2014.

technology cyborg[349]. In the same year, Institute of Technology of Illinois drew up an ethic code on robots[350].

In 2005, European Robotics Coordination Action (EuRobotics) and European Commission started to work in order to develop strategy and roadmap into robotics field. These researches led to some reports, such as Ethical Legal and Societal issues in robotics; EURON, Roboethics Roadmap (2006)[351]; Robotics 2020, Strategic research agenda for Robotics (EuRobotics) (2013)[352]; Suggestion for a green paper on legal issues in robotics (2012)[353]. SPARC is a Public Private Partnership (PPP) between the European Robotics Association (EuRobotics AISBL) and European Commission[354]. From 2005 to 2008, Ethicbots (Emerging Technoethics of Human Interaction with Communication, Bionic, and Robotic systems) was conducted[355] and, from 2009 to 2011, Ethical Issues of Emerging ICT Applications (ETICA) deals with ethical issues as regards Information and Communication Technologies (ICT)[356]. These European projects offer a legal perspective of study on robots referring to fundamental values of European Charter.

1.2. Civil liability as an *ex post* regulatory tool: implications for our analysis.

The majority of scholars prefer to analyse robots through a structural approach, in others words they evaluate if conventional categories of law are adequate in case of tortious event involving robots that provoke damages. Scholars conduct the civil liability analysis on the basis of IARs' features. IARs are: interactive or they are able to react to inputs of environment through the change of its internal status or values; autonomous or they are able to modify these states following the external inputs;

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349 [Online] *Recommendations concerning Social Robots*, http://www.etiskraad.dk/en/Temauniverser/Homo-Artefakt/Anbefalinger/Udtalelse%20om%20sociale%20robotter.aspx

350 WORCESTER POLYTECHNIC INSTITUTE (2011) *Code of Ethics for Robotics Engineers*, http://ethics.iit.edu/ecodes/node/4391

351 VERUGGIO G., *Euron Roboethics Roadmap*. In: Proceedings of the 6th IEE-RAS International conference on humanoid robots, Genoa, Italy, 4-6, 2006, pp. 612-617.

352 European Robotics Technology Platform (EUROP), *Robotic Visions To 2020 And Beyond* – The Strategy Research Agenda for Robotics in Europe, 2009.

353 EuRobotics , The European Robotics Coordination Action, *Suggestion for a green paper on legal issues in robotics*, 2012.

354 http://www.sparc-robotics.net/.

355 http://ethicbots.na.infn.it/

356 http://ethics.ccsr.cse.dmu.ac.uk/etica/deliverables.

adaptive or they are able to adapt their states in relation to environment[357].

Robots' behaviour is often governed by complex software. This complexity may depend on combination of multiple behaviours of intelligent robots that communicate and interact with each other. These implications improve the utility of these robots, but, at once, the technological complexity raises some issues, such as the determination of responsible of their unpredictable behaviour.

The consequences deriving by IARs' behaviour have features that are incompatible with fault, negligence, predictability, agreement. These characteristics give raise some difficulties in proving the causation[358]. For example the custodian will always be able to demonstrate the liberating proof as regards to damages caused by robot because of their unpredictable behaviour[359].

Semiautonomous robots could yet be considered as products, things, objects. However, they give raise some questions because of their technological complexity. Instead, fully autonomous robots raise more troubles than semiautonomous robots because their full autonomy enables to compare them to entity having rights and wrongs. However the effective advent of fully autonomous robot represents a future scenario, not yet known by layman.

These questions led doctrine to elaborate some solutions[360]. Generally, **A)** on one side, there is the trend to proceed by qualifying IARs, **B)** on the other side, scholars seek tools of allocate the risk regardless to qualification of robot. **C)** On the contrary we will try of analysing robots as socio-tech systems.

A. Some scholars[361] consider IARs as objects that meet a particular liability

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[357] This robot capability classification has been proposed by ALLEN C.,VARNER G., ZINSER J., *Prolegomena to any future artificial moral agent*. J. Expt. Theor. Artif. Intell. 12, 2000; ALLEN T., WIDDISON R., *Can Computers Make Contracts?*. 9 Harvard Journal of Law & Technology, 1996, p. 26; PAGALLO U., DURANTE M. *Manuale di informatica giuridica e diritto delle nuove tecnologie*, Torino, 2012, 151.

[358] KARNOW C.E.A., *Liability for Distributed Artificial Intelligence*. 11 Berkeley Technology Law Journal, 1996, pp. 147-148.

[359] The "Act of God" consists in an unpredictable and inevitable event, that is sufficient to cause damaged event outside to the custodian sphere of action (art. 2051c.c.).

[360] WILZIG S.L., *Frankenstein Unbound Towards a Legal Definition of Artificial Intelligence*, Futures 442, 1981, p. 178 explores various models of accountability for artificial beings. These include product liability, dangerous animals, slavery, diminished capacity, children, agency, and personhood. *See* also ASARO P.M., *A Body to Kick but No Soul to Damn: Legal Perspectives on Robotics,* in LIN P., ABNEY K., BEKEY G. (eds.) *Robot Ethics: The Ethical and Social Implications of Robotics*. Cambridge, MA: MIT Press, 2011, pp. 169-186 (invokes the same categories).

[361] LOISEAU G., BOURGEOIS M., *Du robot en droit à un droit des robots*, op. cit., 2014, p. 2162 : «*La détermination de la garde, traditionnellement caractérisée par le pouvoir d'usage, de direction et de*

scheme. The French doctrine submits IARs to two different liabilities based on the difference between structure and behaviour of IARs. Manufacturer is held liable for defect of safety in accordance with *responsabilité du fait des produits défecteux* («garde de la structure»), while users are held liable for damages caused by use of product («garde du comportement»). (See §*infra* 1.3)

Others consider the equivalence between robots and servants[362]. Under Roman law the slaves were considered as things; they had no rights, no obligations and no legal capacities, but they could act under them own name. In fact, they could have legal relationship with third parties on the behalf of and under the authority of their master. By applying to IARs the legal status of slaves, robots are qualified like things and they have limited legal capacities to act on its own name whereas they can act on behalf of the user. Therefore, the vicarious non-fault liability will be applied on owners or users of the robots[363]. Following this approach a new type of artificial agency has been proposed for robots, such as digital *peculium*. In order to create this latter, the Roman institute of *peculium*[364] has been readapted. Based on the similarity between robot and slaves[365] (considered as things), digital *peculium* could represent a «form of warranty for suitable balance between manufacturers, programmers or seller of robot and consumer interest, in respect of agreement stipulated with robots»[366].

Anyway, some scholars do not agree with this theory because slave was a *res* and his liability should be a strict liability in favor of the *dominus* and this

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contrôle exercé de manière effective et indépendante, peut-être plus complexe s'il devait être considéré que les capacités cognitives du robot, qui lui confèrent une certaine autonomie d'action, sont susceptibles de le soustraire à ce pouvoir de l'utilisateur. On pourrait alors songer réactiver la distinction entre la garde de la structure et la garde du comportement».

[362] This equivalence means that robots will have no legal status, so they cannot institute proceedings himself, for his own recovery, wherein damages are recovered for his pain and suffering *see* STONE C.D., *Should Trees Have Standing: Towards Legal Rights for Natural Objects.* Los Altos, California, WILLIAM, A. KAUFMAN, 1974; ROBY H.J., *Roman Private Law in the times of Cicero and of the Antonines*, 1, Cambrigde, 1902, p. 432.

[363] CHOPRA S., WHITE L.F. *A Legal theory for autonomous artificial agents.* Ann Arbor. The University of Michigan Press, 2011, pp. 128-130.

[364] *Peculium* is an interesting mechanism of Roman law. In Digest of Justinian there is a definition of *peculium* that was "*the sum of money or property granted by the head of household to a slave or son-in-power. Although considered for some purposes as a separate unit, and so allowing business run by slaves to be used almost as limit company, it remained technically the property of the head of the household*" (*see* WATSON A., *The digest of Justinian,* vol. I. Philadelphia: University of Pennsylvania Press: XXXV, XXXVI, 1988).

[365] KATZ A., *Intelligent agents and internet commerce in ancient Rome*. Society for Computers and Law 20, 2008, pp. 35-38.

[366] PAGALLO U., *Killers, fridges, and slaves: a legal journey in robotics.* AI & Society, 26(4), 2011(a), pp. 347-354.

reconstruction disadvantages the damaged[367]. The counter-argument against this objection is that although many slaves never claimed right against their owner, others had a relative autonomy, such as the *institor* who operated in different convenience store (*taverns*)[368].

The parallel between robot and slaves are attractive, because a sort of digital *peculium* would consent to lawyers to address the open questions of the new fragile responsibility thesis. By admitting that right and obligations established by robots can be guaranteed by their own portfolio, this form of artificial accountability might avoid legislation to stop the use of robots due to the unpredictability of their behaviour[369].

Others assumed that robots are like dangerous animals which move and have a sense of intelligence. In this way they are transformed into a legal entity with properties of consciousness[370].

Others assimilate robots to children[371], and they suggest that robots should be equipped with an ethical code composed by an algorithm enabling robot to learn through «example based learning». It ensures robot to understand if its behaviour is in accordance with values embedded into it.

This comparison is paradoxical but it bases on similar training carried out by both child and robot. The robot's owner becomes a sort of «adoptive parent» who has the same rights and duties of natural parent, who is liable to educate and supervise robots. However, the application of parental liability is not adequate. Although both child and robot could share the same training, a broad interpretation of parental liability is excluded[372] because there is a flaw consisting in the absence of pre-conditions of parental liability, such as the legal status of children and the parentage.

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[367] TADDEI ELMI G., *Soggettività artificiali e diritto*, 2004 available at http://www.altalex.com, proposes that intelligent agents, operating in web, are sleepwalkers. A. says that although artificial agents act as human, they are not conscious of themselves and the others.

[368] *See* DIGEST XIV, 3, 11, 3; XV, 1, 47.

[369] PAGALLO U., *What Robots Want: Autonomous Machines*, *Code and New Frontiers of Legal Responsibility*, in HILDEBRANDT M., GAKEER J., Human Law and Computer Law: Comparative Perspectives, 2013, p. 59.

[370] MCNALLY P., INAYATULLAH S. *The Rights of Robots: Technology, Culture and Law in the 21ST Century*, Futures, 20, 1998, pp. 119-136.

[371] EuRobotics . The European Robotics Coordination Action, *Suggestion for a green paper on legal issues in robotics*, 2012, p. 37; CHOPRA S., WHITE L.F., *op. cit.*, 2011, p. 120.

[372] French Courts refused an extensive application of art. 1384, al. 4 for people having similarities powers: Civ. 2e, 29.04.1976, JCP, 1978, II, 18793, note N. DEJEAN DE LA BÂTIE; Civ. 1er, 18.09.1996, Bull. Civ., I, n. 270, LPA, 27.02.1997, p. 6, obs. M.-.LEBRETON. For a deepening VINEY G. et. al, *Le*

A child is no longer a child when he reaches the age of majority, at this time child is capable to act, making legal act for which is liable, in accordance of law. This presumption of maturity based on scientific background containing long-established and recognised science. A similar presumption of maturity cannot relate to robots. In addition, the parentage could not exist between humans and robot even in terms of adoptive parent given that the adoptive procedure is characterised by relationships among humans.

The robot's owner could be its teacher. In fact some scholars[373] assume that robots (like children) learn during their formative path, by acting on the basis of received education. These premises lead to the application of the art. 2048, 2° cod. civ.[374] under which «i precettori e coloro che insegnano un mestiere o un'arte sono responsabili del danno cagionato dal fatto illecito dei loro allievi e apprendisti nel tempo in cui sono sotto la loro vigilanza». In this way, users can teach the ethic and conduct principles, if the robot has a program that can be managed by the same user[375].

Others, based on idea of recognizing constitutional rights to robot[376], assign them a full independence through legal personality. This theory takes place on a principal requirement, that these robots will be a sort of "being *sui juris*", capable of sensitivity. They are capable of autonomous decisions similar in all relevant aspects to the ones humans make[377]. By following this theory, 1) robots have legal personality, and consequently they have rights and duties; 2) robots are able to take decision themselves; 3) robots become legal person through registration on a public register in which they are registered with a specific ID; 4) robots have a patrimony used as found in case of harmful[378]. This theory consider that the robot as person registered into a register with an identifying code, a capital holders, an insurance coverage and

conditions de la responsabilité, 3e éd., 2006, p. 1118, n. 874. «*Cette position a été affirmée sans aucune restriction tant à l'égard des membres de la famille que es étrangers*».

373 EuRobotics , *op. cit.*, 2012.

374 Under art. 2048 cod. civ., who teaches a work or an art is liable of the damage causing by illicit act of their students and apprentices during they are under their control. There is a liability presumption on preceptor as either *culpa in vigilando* or *culpa in educando*.

375 SANTOSUOSSO A., *Diritto, Scienza e nuova tecnologia*, Padova, 2011, p. 276. Liability of educator supposes the educating freedom to move and act.

376 SOLUM L., *Legal Personhood for Artificial Intelligences*. North Carolina Law Review 70(2), 1992, pp. 1231-87; BENOUSSAN A., *Les robots sont-ils responsables de leurs actes?* Planète Robot n. 20, 2013.

377 CHOPRA S., WHITE L.F., *op. cit.*, 2011, pp. 179-180.

378 BENSSOUSAN A., *Le droit des robots: un droit en devenir*, Planète Robot n. 22, 2013.

personhood, is necessary because « […] En tout état de cause, la création de ce nouveau droit de robots s'impose»[379]. On the contrary, some scholars consider that a robot with personality does not correspond to a social need as legal persons. In fact, these latter are collective groups having social interests[380].

B. Some researchers concern that Codes of conduct could be the solution. Ethical and social norms can determine what is "good" or "acceptable". Consequently, these norms are not legally binding, but they may function as instruments of soft law which have a "comparative function". This function of soft law- particularly evident in the field of regulation of robotics - means that the respect of non-binding rules by the producers and sellers is enforced by the market and social forms of regulation[381].This regulation will be the result of human ethic's improvement carried out through Roboethic. It gives answers to new challenges in respect of human rights[382].

Some scholars point at the risk to forget benefits of this advanced technology through the application of civil liability. So, regardless of the qualification of robot, the principle of indemnity could represent an alternative. They assume that the manufacturer of open robotic platforms should be held immune for tort liability. In robotic field, liability should be hold in the same way in which it was managed in the cases of Internet, where Section 230 of Communications Decency Act 1996 recognizes

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[379] BENSOUSSAN A., *Plaidoyer: pour un droit des robots: de la personne morale à la personne robot*. Les lettres de justices d'affaires, n. 1134, 2013 «*il est temps de créer un droit des robots pour que demain il deviennent des sujets de droit […] créer un statut juridique adapté, en reconnaissent au robot une personnalité propre et singulière résultant de ses interactions avec l'humain […] créer un identité de robot avec un numéro identifiant comme celui qui figure sur nos cartes d'identité […] les robots devrait être doté d'un patrimoine […]*». However, A. recognises that current robots are not fully autonomous, so their theory is running into future, when IARs will reach a higher intelligent level. VEBER PH., *Droit&Robotique: Le choix du pragmatisme et du réalisme*, op. cit., 2014 he states that existing liability should encourage liability for robots including their specificities.

[380] On the contrary, LOISEAU G., BOURGEOIS M., *Du robot en droit à un droit des robots*, op. cit., 2014, p. 2162 say robots cannot have personhood because i.e. there is not a social interest on that. They concern that legal person has a legal personality because there is a social interest as announced by Cour de Cassation, 2e civ., 28 janvier 1954, n. 54-07-081, D. 1954, Jur., p. 217, note LEVASSEUR G. «*la personnalité juridique appartient à tout groupement pourvu d'une possibilité d'expression collective pour la défense d'intérêts licites, dignes*».

[381] HIROSE S., *A code of conduct for robot coexisting with humans beings. Robotics and autonomous system* 18, 1996, pp. 101-107.

[382] A Code for programmers of robot is the CODE OF ETHICS FOR ROBOTICS ENGINEERS (an Interactive Qualifying Project Report Submitted to the faculty) of WORCESTER POLYTECHNIC INSTITUTE (Illinois Institute of Technology's Center for the Study of Ethics). This project developed a draft code of ethics for professional robotics engineers by researching into the fields of robotics, ethics and roboethics to develop the necessary understanding.

the indemnity of «interactive data processing from the liability for the information inserted into their sites»[383].

Certain scholars suggest form of limited responsibilities in the contract field using the personal accountability of robot to regulate new types of transaction mediated by artificial agents and tomorrow's smart AI vehicles, i-Jeeves 2.0, and similar[384]. This allows avoiding any legislation preventing the use of robot due to the excessive burdens on the owners of these machines. This aim is reached by other scholars proposing new types of artificial intelligence by registering some machines, just like corporation[385], by conferring them capital[386]; or at least by creating a transparent financial position of such machines[387].

For this purpose, Turing Register could be an alternative that should certificate the intelligent autonomous agents which are insured against the risk of pathologic decisions. This theory could resolve issues related to causation because, although it is not possible to determine the events constituting the proximate cause, the agent is insured to compensate damages. Then a periodic control on each single robot should be done in order to prevent robot deviance[388].

C. A functional representation of IARs allows us to see the interested robots' social implications[389]. There are two methods of interpreting IARs. They may be considered as a series of elements where each component will be regulate regardless of other components. Then, robot could be represented as an un-split entity, where each component interact each other. The first representation creates some issues related to

[383] CALO R., *Open Robotics*, Maryland L. Rev., 2011, p. 571 (proposes the scheme to immunize manufacturers of "open robotic platforms" from tort liability, and to, perhaps, require robot owners to carry liability insurance).

[384] PAGALLO U., *Designing data protection safeguard ethically*. Information 2(2), 2011, pp. 247-265.

[385] LEROUGE J.F., *The use of electronic agents questioned under contractual law.* John Marshall Journal of Computer and Information Law 18(2), 2000, pp. 403-433; WEITZENOBOEK E.M., *Electronic agents and the formation of contracts*. International Journal of law and Information Technology 9(3), 2001, pp. 204-234.

[386] BELLIA A. J., *Contracting with electronic agents.* Emory Law Journal 50(4), 2000, pp. 1047-1092.

[387] SARTOR G., *Cognitive automata and the law: Electronic contracting and the intentionality of software agents*. Artificial intelligence and law 17(4), 2009, pp. 253-290.

[388] KARNOW C.E.A., *Liability for distributed Artificial Intelligence*, Berkeley Technology Law Journal 193, 11(3), 1996 proposed for intelligent agents; LOISEAU G., BOURGEOIS M., *op. cit.*, p. 2162 («*une obligation d'immatriculation*»).

[389] It is clear that this point of view is not used in relation to i.e. software which without a body comes down to a mere thing as shown by EU Commission. The Commission considers software as a tangible, movable and immaterial goods including into artistic and literary works. In order to compare software to spiritual work, EU Commission states the presence of «*effort personnalisé du programmeur*» is required, by conferring an objective dimension for ensuring originality. Under French statutory scheme, software has a different protection than author of literature work CPI art. L.121-7, 1° et 2°.

coordination between different juridical disciplines that should be applied to each component of robot.

In addition, robot is composed by different interrelated subsystems, so even if the source of the problem is the software, the whole robot is involved. In other words, it would be better say: the source of the problem takes place in software, and then it spreads into robot by generating a harmful action.

It is interesting to pose the question in relation with the qualification of the good simple or complex. In Italy the complexity of a good was promoted by Trimarchi[390] White[391], which developed the concept of "complex goods" in relation to the *universalità di beni.* Their reflection led to a distinction between *beni necessariamente complessi* and *beni eventualmente complessi*. However, the concept of "complex good" has not a legal definition. It is cited into art. 1 of the Act of 18 June 1998 on the subcontracting agreement, in which it is as the result of the more semi-finished products that are part of a business enterprise. The good has a commercial sense that is not the mere juxtaposition of goods but this sense is the result of their transformation[392].

In addition, also art. 35 of d.lgs. n. 30/2005 (Industrial Property Code) refers to the C.D. as a complex product with regard to the drawings and models. The concept of "complex good" refers to a good that is uniform materially and that, even if physically broken down into individual components, it can have one legal image with regard to its unitary function that transcends its own individual components. In other words, the ontological plurality remains absorbed by the logical destination when the unitary impression is conferred to each single good considered[393].

[390] TRIMARCHI M., voce *Universalità di cose,* in Enc. dir., Milano, 1992, XLV, 821.
[391] BIANCA C.M., *Diritto civile,* vol. VI, Milano 1999, 87.
[392] ROMANO R., *Sul diritto al rimborso del prezzo del software preinstallato dal produttore dell'hardware. Suggestioni intorno ai beni complessi e la buona fede oggettiva*, Corriere Giur., 2015, 5, 647. A. says that «*Storicamente (Cass. civ. n. 523/48) si ricorda la distinzione tra "cosa semplice" (intesa come fusione in un unicum organico di più elementi) e "cosa complessa" o "composta" (intesa come unione occasionale di più elementi, che perdono la propria individualità per la realizzazione uno scopo unitario)» Per la prima universalità il nesso organico di coesione è oggettivo, per la seconda soggettivo, ma entrambe le universalità possono esprimere un bene complesso»*. This distincion has been reproduced by Cass. civ. n. 391/1985, Cass.civ. n. 377/2011 In CED Cassazione, 2011. «*in materia di accessione verticale (di cosa mobile in cosa immobile: art.934 - possono distinguersi due tipi di incorporazione, una apparente ed una reale; la prima è quella che svolge "la funzione di ottenerne la stabilità necessaria all'uso", la seconda invece - lungi dall'essere una mera adesione di beni - è quella che produce "una connessione fisica idonea a dar luogo ad un bene complesso". Per la prima la complessità del bene sarà un'eventualità rimessa alla voluntas domini, per la seconda un attributo ineluttabile della cosa*».
[393] *Ibidem*.

This representation helps us to deal with the robots. Robots are systems characterized by the complexity of their functioning that absorbs the structure. Under a juridical prospective, they are complex goods that are indistinguishable because they have a unitary destination conferred them by manufacturers and users. Of course, none of them produces or purchases a robot as an entity composed by different component.

2. Insurance issues and the possible roles of special compensation fund.

The insurer's function is «to aggregate uncorrelated (that is, independent) risks and segregate these risks into separate risk pools. The uncorrelated character of the risks distinguishes insurance from savings. Risks that are uncorrelated are risks of which the incidence of loss is spread out, either in terms of time or in terms of the individuals suffering the loss»[394].

The system of insurance is considered an efficient method of allocation of the accident's costs[395]. The cost of damages is transferred from author of harmful event to contractors of insurance[396].

Insurance is another solution that goes along with the widespread of automated robots; in fact insurance companies will create special insurance coverage for robots, in particular in the automotive sector. Of course, the level of insurance should depend on both the nature of the robot and on the uses to which the consumer presumes to appoint the robot.

Small robots would only need to be insured minimally, while more autonomously operating robots would require greater coverage[397]. Second, users who use robots for relatively dangerous activities, such as house perimeter security, should probably purchase a substantial insurance coverage. Instead, those who purchase robots largely for a sense of companionship would need a relatively smaller coverage, if any.

[394] PRIEST G.L., *The Current Insurance Crisis and Modern Tort Law*, 96 Yale L.J., 1987, 1540.

[395] WILLIAMNS G.L., HEPPLE B.A, *I fondamenti del diritto dei «torts»*, trad. it. Di M.SERIO, Camerino-Napoli, 1983, pp. 103-115; ABEL R. L., *A Critique of Torts*, 37 UCLA L. Rev. 785, 1990, pp. 808-17. PIERCE JR, *Encouraging safety the limit of the torts law and government regulation*, in Vand L. Review, 33, 1980, p. 1281; ENGLAND L., *The system Builders: a critical appraisal of modern American tort theory* in J. Legal Studies, 1980, 27. PRIEST G.L., *The Current Insurance Crisis and Modern Tort*, op. cit., 1987.

[396] French doctrine consider the liable as an interpose person between damaged and insurer see SAVATIER R., *Les metamorphoses èconomiques et sociales du droit civil aujourd'hui*. Première série, Panorama des mutations, III, Paris, 1964, p. 344.

[397] Researchers have already begun to classify robots for insurance purposes according to their general capacity to cause damage, HUTTUNEN A. et al., *Liberating Intelligent Machines with Financial Instruments*, 2010, pp. 5–7, available at http://ssrn.com/abstract=1633460 (classifying intelligent machines into different "risk-categories").

Other factors could include the presence of children or pets in the house or the overall likelihood that the robot will come in contact with strangers. A user could initially buy minimal insurance only to later purchase a dangerous hardware module requiring a higher level of insurance, without making the necessary insurance adjustment[398].

About insurance, advanced technology will raise some issues, such as the change of actuarial calculations because a variation of accidents distribution is expected. The tables of actuarial are elaborated based on characteristics of people, but the advent of IARs will lead to consider other features, such as the most of accident will be cause by algorithms. For example the advent of AVs will lead to a few accidents compared to those happening now, but this few accident will provoke deadly damages (due i.e. to AVs performance).

Insurance companies will have difficult to calculate costs of these accidents compared to those related to minor and common accidents. This difficult will lead to reduce the expectation of fall in costs[399].

Also, insurance covers foreseeable and known risks but, in case of robotic, this restriction is a problem because risks of robots are unforeseeable. Perhaps the solution may be to insert general clauses that cover all risks, but this solution will not be approved by insurance companies.

In the past, similar issues related to insurance led to the creation of compensation funds that aim to expand compensation of personal injuries which have not insurance protection[400]. In 80s, there was the crisis of insurance that led to give up a system based on third-party insurance in favor of compensation system[401].

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[398] CALO R., *Open Robotics*, op. cit., 2011, 138- 139.

[399] KALRA N., ANDERSON J., WACHS M., *Liability and Regulation of Autonomous Vehicle*, op. cit., 2008; FEOLA D.M., PROCIDA MIRABELLI DI LAURO A., *La responsabilità civile: Contratto e torto,* Torino, 2014, p. 664: *«Nel sistema assicurativo la ripartizione dei rischi avviene in riferimento a un numero eccessivamente limitato di soggetti. Il costo ei danni è trasferito dall'autore all'insieme dei contraenti che hanno stipulato con ogni singola compagnia, ma soprattutto nelle piccole imprese assicuratrici il complesso dei premi non è sempre sufficiente a garantire la copertura di gravi incidenti che coinvolgono una grande quantità di persone»*.

[400] The funds of guarantee are different from compensation funds. The fund of compensation takes place in case of default by insurance; therefore, it operates in subsidiary way. The second operates on a primary basis. However, the use of these two terms does not reflect this distinction.

[401] FEOLA D.M., PROCIDA MIRABELLI DI LAURO A., *La responsabilità civile, op. cit.*, 2008, p. 661: «*Una campagna lanciata da una potente federazione di assicuratori, tese a individuare le cause del dissesto nel movimento verso la responsabilità senza colpa, nelle istanze di ripartizione sociale dei rischi, nell'estensione del concetto di causalità, nella responsabilità solidale delle compagnie , nella formidabile crescita dell'ammontare dei risarcimenti allocati per la ripartizione dei danni alla persona e dei punitive damages , nel caso eccessivo delle spese giudiziarie»*.

The crisis began when «Insurers had increased premiums drastically for an unusual set of products, such as vaccines, general aircraft, and sports equipment, and for an equally diverse set of services, such as obstetrics, ski lifts, and commercial trucking. In still other cases- intrauterine devices, wine tasting, and day care, - insurers had refused to offer coverage at any premium, forcing these products and services to be withdrawn from the market»[402].

This crisis in insurance has disrupted product and service markets in the United States and the third-party insurance demonstrated to be inefficient because it is not able to internalise both primary and secondary costs of accident[403]. Instead, «first-party mechanisms are typically superior in defining the level of insurance coverage and in segregating consumers according to levels of coverage appropriate to their income»[404].

This scenario allowed the development of compensation fund that operates in accordance with principles inspired to «efficienza e giustizia sociale»[405]. There are different examples in the past. In 1986 US Congress approved Childhood Vaccine Injury Act (Vaccine Act o NCVIA)[406]. Injured children can demand compensation to federal government by bringing a vaccine injury claim to Vaccine Court, located at Federal Court of compensation. This is a federal no-fault system for compensating vaccine-related injuries or death[407].

General Aviation Revitalization Act (GARA) of 1994 aims to avoid the effect of liability for manufacturers of aircraft carrying fewer than 20 passengers, and aircraft parts involving their products that are 18 years old or older (at the time of the accident), even if manufacturer negligence was a cause[408].

An Italian example is the *Fondo di garanzia per le vittime della strada*[409] which ensures compensation for accidents provoked by circulation of unidentified vehicles or

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[402] PRIEST G. L., *op. cit.*, 1987, p. 1521.

[403] PONZANELLI G., *Diritto privato, diritto pubblico, diritto misto, nella responsabilità civile nordamericana negli anni '80*, in Riv. Crit. Dir. priv., 1988, p. 307.

[404] PRIEST G. L., *op. cit.*, 1987, p. 1521.

[405] TUNC A., *Le spectre de la responsabilité civile*, in Rev. dir. Comp., 1986, 1163 where A. refers to US «*Tort policy Working Group on the Causes, Extent and policy Implication of the current crisis in Insurance availability and affordability*».

[406] The National Childhood Vaccine Injury Act (NCVIA) of 1986 (42 U.S.C. §§ 300aa-1 to 300aa-34).

[407] The procedure has been written in National Vaccine Injury Compensation Program (NVICP).

[408] KOVARIKT K.V., *A Good Idea Stretched Too Far: Amending the General Aviation Revitalization Act to Mitigate Unintended Inequities*, 31 Seattle, U. L. Rev. 2008, p. 973.

[409] This was created by virtue law n. 990/1969 and operatives from 12.06.1971; revoked by Cod. ass. priv.

vessels, or in the case they are not insured or when they are insured in company failed (art. 19 L. 990/69).

In France, to deal with the large number of asbestos victims Loi n. 2000-1257 *du* 23 *décembre* 2000 has set up an asbestos victims' compensation fund, such as *the Fonds d'Indemnisation des Victimes de l'Amiante.* Then *Loi Badinter*[410] provided a fund for victims of circulation while Loi 90-589 of 6.06.1990 states a fund in favor to victims of terrorist attacks.

These funds pursue a function of solidarity and they fill gaps existing in the interaction between insurance a tort law. However, these structures have a drawback that is the compensation of victims without discrimination, in relation to the type of tortious event or to the characteristic of victims. In addition, their functioning does not correspond to solidarity scope because of their mechanism of financing which has a complicated winding-up proceedings and the measures of compensation are derisory[411].

This mechanism does not allow of pursuing deterrence function[412], but it causes moral hazard phenomenon when this system is no-fault because it doesn't allow the confrontation between defendants and victims. This comparison is possible if this system provides the rights of recourse[413]. In this way, the compensation funds reflect both function of compensation - with the allocating of costs - and of deterrence. Some scholars affirm that this action reproduces the issue related to civil liability, in particular their expensive procedure of assessment.

To avoid a rigid social system, some European States as Norwegian decided to intervene on premium by establishing a gradation based on the criterion of classification included into Accident Rehabilitation and Compensation Insurance Act (1992)[414].

[410] LARROUMET C., *Il nuovo sistema francese di risarcimento del danno alle vittime di incidenti stradali fra responsabilità civile e indennizzo automatico (a proposito della loi n. 85-677 del 5 luglio 1985)*, in Riv. dir. civ., I, 1986, p. 451; SICA S., *Circolazione stradale e responsabilità: l'esperienza francese ed italiana*, Napoli, 1990; DE LORENZO C., *La nuova disciplina francese dell'infortunistica stradale: tre anni di "sperimentazione" giurisprudenziale*, in Riv. dir. civ., 1, I, 1990, p. 97.

[411] DESCHAMPS C.L., *La réparation du préjudice économique pur en droit français*, in BANAKAS K.E. (ed.), Civil Liability for Pure Economic Loss, 1996, p. 89.

[412] ABRAHAM K.S., *Insurance law and Regulation*, Foundation Press, 1990, p. 4.

[413] In Italy, the right of recourse is established in art. 10 l. n. 302/1990 in favor of victims of terrorism and for victims of organized crime.

[414] The criteria refer to history of insurance companies and to user. In particular «drivers between the ages 16 and 24 has a particularly high accidents rate and therefor has a disproportionate effect on public health costs».

Section 134 lays down «Levies paid or payable […] shall be demedeed to be premiud paid or payable for the purposes of this Act».

The combination between a compensation fund and the differentiation of compensation in favour of victims could be a proposal with regard to traffic accident caused by AVs[415].

3. Evidentiary issues: scientific expertise, black boxes, dash board camera.

We have another issue to deal with, such as evidence because of the complexity of technology that requires, i.e., many scientific experts[416].

The plaintiff will have to employ many experts in order to analyse the actions of robot. They will study software, or better algorithms, to understand their functioning, their alternative model (how they could be written) and their functioning with respect to the whole robot.

To prove algorithm's functioning is required a large knowledge, so a suitable expertise on this matter could be carried out by many consultants that are: tech experts, mathematicians and specialized engineers of particular field of robot application. It is obvious that many costs will be charged to plaintiff.

Nowadays an expertise on automated robot is already complicated (i.e. elevator's malfunctioning)[417], so an expertise on semi or fully autonomous will be more complicated. This complexity will cause the improvement of legal costs; consequently these economic obstacles scare off consumers to demand the compensation. A proposal against that could be the promotion of class action where plaintiffs could share the legal costs.

Black boxes - called data recorder (EDR) - are non-standard evidences which allow detecting dynamic reproduction of road accidents[418]. They are algorithms, installed into AVs that collect and record every movement and action of AVs[419]. The

[415] See *infra* chap. V.

[416] In Italy expertise is an evidence to evaluate data already acquired, however it become evidence tout court in *extrema ratio* case, COMOGLIO L.P., *La consulenza tecnica*. Le prove civili, parte V, cap. III, Torino, 2010.

[417] Cass. 3ème civ., 20.01.2015, pourvoi n. 13-24.694, arrêt n. 43 (there are a complicated analyses about malfunctioning of elevator).

[418] ROSSETTI M., *Il diritto delle assicurazioni*, vol. III, L'assicurazione delle responsabilità civile. L'assicurazione sulla vita. Assicurazione e prescrizione. Assicurazione e processo, Padova, 2013, p. 227 ss.

[419] NICOLOSI G., op. cit., 2011, p. 121, presents this proposal.

objection of the reconstruction of events will be done by those who consider a different dynamic (including injured persons) or those who affirm the faulty of black boxes.

Black boxes are sealed and equipped with an internal battery for data storage. Data are recorded on a chip and it can be read through a computer. It is difficult to fake or change them. This safety of black boxes is not ensured by technological systems, which have an open access to all users.

These systems are called EDR and they are connected to other sensors, such as the anti-lock brake computer. It collects data from these sensors and continually replaces previously stored data every five seconds. Only the most recent data are retained when airbags are deployed in a crash situation. A cable of the EDR retrieves the data from the vehicle's onboard diagnostic port (known as OBD-II) located near the steering wheel[420].

In Italy, art. 132, 1 co., cod. ass. lays down a discount to drivers who install black boxes that collect, record movement and speeded up of their cars. The justification of this article is to prevent fraudulent drivers' behavior, so black boxes aim to realize evidence to redrawing the dynamic of accident, in terms of causation. It is an atypical proves and it is source of opinion for judges as long as facts collected are conclusive. Courts will evaluate these data case-by-case and when there will be a black boxes' malfunctioning, the burden of proof remains on who contests the reliability of registration.

However, black boxes are considered a better solution than open technology systems that could be hacked. This happens about «advanced Automatic Crash Notification systems (such as GM's OnStar) that transmit EDR information to a central location when software in the vehicle determines that a crash has occurred, based on data from the EDR. In vehicles with wireless data transmission capabilities, it would be possible to have regular or continuous transmission of EDR data»[421].

An example of these systems is dashboard camera (dash cam). Dashboard is the result of black boxes evolution. It has some cameras that recover what is happening in front and back vehicle and a microphone collecting voices.

Some EU Members States are studying these latter systems.

[420] CANIS B., PETERMAN D.R., *Black Boxes*, Passenger Vehicles: Privacy Implications, 2014, p. 3.
[421] CANIS B., PETERMAN D.R. *op. cit.,* 2014, p.11.

In Italy, was presented a draft law in 2013 (A.C.1588), that shall delegate Executive to reform Highway Code, also in terms of introducing this above cited system[422].

In France, *Conseil national de securitè route* in 2013 announced a proposal of recommendations by European Commission in order to insert an electronic chip with cameras (probably dash camera based on descripted features) in every vehicle[423].

The collected data represent element of prove which can be submitted to judgment with other probative elements.

In addition, USA knows EDRs. Recently, Senate Bill 1813 (known as Map-21) mandates to automakers of installing EDRs into new vehicles starting in 2015: «new passenger motor vehicles sold in 6 the United States shall be equipped with an event data recorder that meets the requirements under that 8 part».

In order to privacy of data, Act establishes:

> «Data recorded or transmitted by such a data recorder may not be retrieved by a person other than the owner or lessee of the motor vehicle in which the recorder is installed unless:
> (A) a court authorizes retrieval of the information in furtherance of a legal proceeding;
> (B) the owner or lessee consents to the retrieval of the information for any purpose, including the purpose of diagnosing, servicing, or repairing the motor vehicle;
> (C) the information is retrieved pursuant to an investigation or inspection authorized under section 1131(a) or 30166 of title 49, United States Code, and the personally identifiable information of the owner, lessee, or driver of the vehicle and the vehicle identification number is not disclosed in connection with the retrieved information; or
> (D) the information is retrieved for the purpose of determining the need for, or facilitating, emergency medical response in response to a motor vehicle crash». (Sec. 31406 – 2)

The Bill was recently passed and is expected to be approved by the House.

It seems that EU Members States, by following the example of USA, are introducing a regulation about probable evidence on accident caused by cars. This proof is very important to solve issues on identification of causation about sophisticated and advanced products, like robots. In particular, they are important with regard to swarm robotic where different IARs communicate among each other. However, this system

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[422] The draft law requires: «*disposizioni atte a favorire l'istallazione e la diffusione di sistemi telematici applicati ai trasporti ai fini della sicurezza della circolazione e in un'ottica di semplificazione delle procedure di accertamento delle violazioni*» http://www.camera.it/_dati/leg17/lavori/documentiparlamentari/indiceetesti/057/002/00000056.pdf.

[423] [Online] *Vers une boîte noire dans les voitures françaises* (2013) http://www.lefigaro.fr/actualite-france/2013/06/20/01016-20130620ARTFIG00718-vers-une-boite-noire-dans-les-voitures-francaises.php.

could be hacked with consequent unreliability of reconstruction of accident's dynamic.

Finally, presumptions have a particular role as regards tortious event caused by scientific and technological progress. In particular, courts often use presumptions as long as they are serious and consistent[424]. This allows compensating for difficulties related to evidence, leading to favorable assessment of presumptions provided by defendant. French courts have adopted this attitude in relation to *contamination du fait de la transfusion* ex art. 1353 code civil[425]. This approach, operating on cause in fact, leads to invoke the allocation of accident's costs that could cause the automatism of compensation. As regard robots, presumptions could have a relevant role in evaluating of causation because of the complexity to prove the causal effects.

4. Going robots: the right to know and to consent to the exposure to robot's risk.

Information is a pre-condition of IAR's use and it has a greater significance in this matter. This right had not the same focus in digital revolution.

Digital revolution imposed as social phenomenon when digital consumers were using internet by prating trial and error alone. Their right to know and to consent to the exposure to internet's risk was raised after that the most of people used internet. A similar approach took place with regard to automated devices. Consumers are using, i.e., automated gates and they do not know these products. This cannot happen again with semi and fully autonomous robots.

In this case, consumers have to be informed with a specific attention on exposure of robot's risks. You need point out qualitative differences among products; offer an appropriate level of transparency in order to clarify the price performance; allow consumers informed choices; ensure free and fair market competition.

To understand what information need consumers of robots, let me first say that these consumers do not belong to the same categories, each IAR's application lead to

[424] In France, courts used *une présomption d'imputabilité du dommage* when vehicle is involved into an accident *see* VINEY G., *op. cit*., 4 éd., n. 365-1, 2013, p. 273 «*simple présomption de fait, dont l'application est autorisée en fonction des circonstances e du dégrée de probabilité qui s'en dégage[…] La présomption n'est légitime que lorsque les circonstances rendent vraisemblable le lien causale entre le dommage et l'accident*».

[425] Civ. 1re, 22 Mai 2008, n° 06-10.967, Bull. civ. I, n. 149, D. 2008. 1544, obs. I. GALLMEISTER « […] *si l'action en responsabilité du fait d'un produit défectueux exige la preuve du dommage, du défaut et du lien de causalité entre le défaut et le dommage, une telle preuve peut résulter de présomptions, pourvu qu'elles soient graves, précise et concordantes*». Civ. 1re, 10 juill. 2013, n° 12-21.314, publié au Bulletin, D. 2013, 2311:«*Attendu qu'en se déterminant ainsi, par une considération générale sur le rapport bénéfice/risques de la vaccination, après avoir admis qu'il existait en l'espèce des présomptions graves, précises* […]».

different categories: drivers of car robot are different from assistive IARs' consumers. Thus, consumers of robots do not represent a unitary category; consequently, the content of information will be different depending on type of robot acquired.

However, this variety has the same basic requirements, such as: 1) warnings should not be summary, but suitable, express, intelligible sufficiently and it needs an intellectual collaboration by the recipient. 2) information also means education of consumer, so for instance manufacturer should advertise their car in a truthful through video in which the effective use of vehicles are explained (how ACC and lane departure function; warnings about how driver can interact with interfaces)[426]. 3) Information to consumers' IARs should be inform to precautionary as established by Commission where all interested parties should be involved to the fullest extent possible in the study of various risk management options that may be envisaged once the results of the scientific evaluation and/or risk assessment are available and the procedure be as transparent as possible[427].

Now, we are going to study if this right to know (and to obtain the consumers' consensus) is protect in this specific field. For this purpose, different time periods - where this right occurs - will be analysed.

This right notes at following periods. At moment of robot's adverting, manufacturer/distributor should avoid presenting IARs having features they are not and if they give consumers false information, causing damages, they are held liable.

For instance, a consumer think that a car is self-driving, in the sense that the vehicle can drive without intervention of human, because the advertising on autonomous car has carries out this draft in his mind. Therefore, he is convinced that it is not necessary his attention while driving. Now, if advertisement creates this unrealistic representation through diverted information, on which driver reposes

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[426] On this point, *see* Corte Giust. UE, 30.4.2014, causa C-26/13) «*è di rilevanza essenziale per il consumatore, ai fini del rispetto dell'obbligo di trasparenza, non soltanto l'informazione fornita prima della conclusione del contratto sulle condizioni dell'impegno, ma altresì l'illustrazione delle peculiarità del meccanismo di presa a carico delle rate dovute al mutuante nel caso di inabilità totale al lavoro del mutuatario, come pure la relazione tra tale meccanismo e quello prescritto da altre clausole, di modo che tale consumatore sia posto in grado di valutare, sul fondamento di criteri precisi e intelligibili, le conseguenze economiche che gliene derivano. Ciò vale nella misura in cui il consumatore deciderà, alla luce di tali due tipi di elementi, se intende vincolarsi contrattualmente a un professionista mediante l'adesione alle condizioni predisposte preventivamente da quest'ultimo*»; Corte Giustizia UE, 30.4.2014, causa C-26/13).

[427] COMMUNICATION FROM THE COMMISSION of 2.02.2000 ON THE PRECAUTIONARY PRINCIPLE [COM(2000)], Brussels, 2/02/2002.

reasonable confidence, manufacturer/distributor are held liable if they are aware about falsity of information and if driver suffer damages because of this reasonable confidence[428].

Within the limits of their respective activities, producers shall provide consumers with the relevant information to enable them of assessing risks inherent in a product throughout the normal or reasonably foreseeable period of its use, where such risks are not immediately obvious without adequate warnings, and to take precautions against those risks.

To protect consumers it is possible resort to theory of misrepresentation that in some US States requires the burden of prove of negligent or malice, while in others is used strict liability for misrepresentation (23§402B Restatement (Second) Tort)[429]. Instead, EU promulgated Directive n. 2006/114/EC concerning misleading and comparative advertising received by Italy with d.lgs. n.145/2007 and introduced into art. 21 ss. cod. cons. and by France (art. L. 121-1 code de la consommation)[430].

At pre-contractual stage, current laws regulate probable cases of breach of information's duty from Directive 2001/95/EC. The sense of this duty can be achieved through French experience, where Courts introduced *the obligation d'information* that included the *obligation de rensegnement* and *obligation de conseil*[431]. In fact, the European provisions on right of warning remind to French *status* prior to the adoption of Directive on consumers protection.

[428] Boos v Claude, 69 SD 254 1943 (used cars marketed as cars in full working order despite defective brakes); Berkebile v. Brantly helicopter Corp., 462 Pa 83, 1975 (advertising for helicopters do not lead to liability of manufacturer based on statements like "helicopter was safe and trusted" and it is fly for starters).
[429] VINEY G., JOURDAIN P., *op. cit*., 2013, p. 37.
[430] *See* also DIRECTIVE 2005/29/EC OF 11 May 2005 concerning unfair business-to-consumer commercial practices in the internal market. AA.VV., *Pratiche commerciali scorrette e codice del consumo*, DE CRISTOFARO G. (a cura di), Torino, 2008; AA.VV., *I decreti legislativi sulle pratiche commerciali scorrette. Attuazione e impatto sistematico della direttiva 2005/29/CE*, a cura di An. GENOVESE, Padova, 2008; ID., *La normativa sulle pratiche commerciali scorrette*, in Giur. comm., 2008, 766; MAUGERI M., *Violazione della disciplina sulle pratiche commerciali scorrette e rimedi contrattuali*, in NGCC, 2008, II, 477 s.; ID., *Pratiche commerciali scorrette e disciplina generale dei contratti*, in I *decreti legislativi sulle pratiche commerciali scorrette*, op cit., 267 ss.; CAMARDI C., *Pratiche commerciali scorrette e invalidità*, in Obbl. contr., 2010, 408; GENTILI A., *Pratiche sleali e tutele legali: dal modello economico alla disciplina giuridica*, in Riv. dir. priv., 2010, p. 37 ss.; CARLEO L.R., *Consumatore, consumatore medio, investitore e cliente: funzionamento e sintesi della disciplina delle pratiche scorrette*, in Europa dir. priv., 2010, p. 685; PIRAINO F., *Diligenza, buona fede e ragionevolezza nelle pratiche commerciali scorrette*, ivi, 1117; AA.VV., *European Fair Trading Law. The Unfair Commercial Practices Directive*, a cura di HOWELLS G.- H.W. MICKLITZ ; F. GOMEZ, *The Unfair Commercial Practices Directive: A Law and Economics Perspective*, in ERCL, 2006, p. 4 ss.
[431] *Idem*, n. 763-7.

Before the conclusion of a contract, *the obligation de rensegnement* requires seller to direct the choice of consumer giving advices related to relevance of contract as regard consumer's scopes and his expectations. Sellers have to seller product considering consumers' wishes and specific needs as follows : seller «doit mettre le consommateur en mesure de connaître les caractéristiques du bien vendu» (art.L.111-1) and «doivent être clairement indiqués les prix, les limitations éventuelles de la responsabilité contractuelle et les conditions particulières de la vente» (art L.111-3). This latter obligation is the *obligation de conseil* that allows consumer of using product in accordance with its destination. It reminds to Courts' power of assessing the nature and the scope of obligation based on social and professional conditions of consumer[432].

Product liability establishes liability for warning defect. Manufacturer is held liable whether consumer is not informed on risks of product, its method of use, its physical and juridical features, its attitude to meet individual requirements. Manufacturer will have to give warning to consumer for avoiding product – not adequately presented – can lead to an inappropriate use compared to that one imagined by manufacturer[433]. Product liability is not the only statutory scheme containing this duty, there are several laws concerning this aspect - also by distributor and sellers - who must inform consumers, particularly when product is sophisticated.

In addition, the right of information also refers to safety regulation, which is important to detect imperative rules for labelling and robot's use. This argument inherits to a proposal on particular Directive that should regulate this phase by ensuring information. These warnings should be clear, intelligible and suitable to alleged knowledge of consumer to which product is typically spent. This should reproduce the same system occurred with EU Dir. n. 92/27 for labelling and use of medicine[434], EU Reg. n. 1169/2011[435] on the provision of food information to consumers; Reg. (EU) n.

[432] HUET J., *La responsabilité du fait de l'information,* RTD civ., 1988, p. 355.
[433] VINEY V., JOURDAIN P., *Les conditions de la responsabilité,* Traité de droit civil, 2e éd., LGDJ, Paris, 1998, n. 774, who concern information as implied circumstance in assessment of defect.
[434] SARGOS P., *L'information sur les médicament vers un bouleversement majeur de l'appréciation des rées*, JCP, I , n. 4, 1999, p. 1441.
[435] REGULATION (EU) N. 1169/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2011 on the provision of food information to consumers, amending REGULATIONS (EC) No 1924/2006 and (EC) n. 1925/2006 of the European Parliament and of the Council, and repealing COMMISSION DIRECTIVE 87/250/EEC, COUNCIL DIRECTIVE 90/496/EEC, COMMISSION DIRECTIVE 1999/10/EC, DIRECTIVE 2000/13/EC of the European Parliament and of the Council, COMMISSION DIRECTIVES 2002/67/EC and 2008/5/EC and COMMISSION REGULATION (EC) n. 608/2004

1007/2011 on textile fibre names and related labelling and marking of the fibre composition of textile products[436]; Delegated Reg. (EU) n. 665/2013[437] with regard to energy labelling of vacuum cleaners (that is not apply to robot vacuum cleaners).

In US the Federal Hazardous Substances Labeling Act[438] requires precautionary labeling on the immediate bottle of hazardous household products. Consumer Product Safety Commission, based on this Act, interdicts certain dangerous products or its hazard nature is such that the labeling required by the Act is not adequate to protect consumers. The role hired by this Act, could lead to include robots under it whether a dangerous nature will be recognized.

The information also plays a role as regards privacy protection because consumers have to be informed on how their data will be processed. This involves privacy notice that allows consumers to understand how their data can keep control over the data processing practices. To achieve this scope privacy notice has to be clear and short as suggested by FTC's Report which states Privacy notices should be clearer, shorter, and more standardized to enable better comprehension and comparison of privacy practices[439].

5. Recapitulation.

Following the framework on safety regulation, we have studied different aspects related to the improvement of robotics.

1) Roboethic is part of ethic, which deals with issues related to robots in relation to their interaction with humans, privacy, social dignity and others issues. This is the preliminary step to understand how to deal with the current robotics spread and it paves the way to hard law development.

2) Robots are interactive, autonomous and able to adapt to the environment. On the basis of these features, we have studied the application of conventional categories of

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[436] REGULATION (EU) N. 1007/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 September 2011, on textile fibre names and related labelling and marking of the fibre composition of textile products and repealing Council Directive 73/44/EEC and Directives 96/73/EC and 2008/121/EC of the European Parliament and of the Council.

[437] COMMISSION DELEGATED REGULATION (EU) n. 665/2013 of 3 May 2013 supplementing DIRECTIVE 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of vacuum cleaners.

[438] FEDERAL HAZARDOUS SUBSTANCES ACT (Codified at 15 U.S.C. §§1261−1278) (Public Law 86-613; 74 Stat. 372, July 12, 1960, as amended).

[439] Protecting Consumer Privacy in an Era of Rapid Change: Recommendations for Businesses and Policymakers, An FTC Report, Mar. 26, 2012, available at http://www.ftc.gov/os/2012/03/120326privacyreport.pdf, which proposes different method for labelling.

civil liability, through two different approaches. The first one meets different difficulties with regard to the inclusion of robots into traditional categories of products, animal, and children: these last two are inadequate to include IARs, while the first one meets a question inherent in robots' autonomy which makes them as lively things. However robots are developing from simple automated thing to new entities with different degrees of autonomy, varying from semiautonomous to fully autonomous. They are *sui generis* products, comparable to systems where the software is embodied into a body. The intelligence of this system is not enough to qualify the robots as new entities. Therefore they are still products even if *sui generis* products. The second approach use different tools to deal with robotic legal implications, such as the contract used in order to allocate risks.

3) Insurance could solve different questions with regard to the compensation of victims. However the cost of such insurances will impact on the users and this could lead to discourage the use of new technologies. Compensation funds are possible tools in fields where robots could cause massive damages. This solution is not suitable in the domestic field where the frequency and the entity of damages are low.

4) The right of information plays a fundamental role in this field, not only during the sales but also in all the phases of contact with consumers, including advertising. The information also includes the education of consumers to use robots.

SUB CHAPTER 2
TWO DIFFERENT APPROACHES ON CIVIL LIABILITY OF ROBOTS

TABLE OF CONTENTS:

1. The structural approach: the traditional categories of liability applied to the IARs context.

We are going to study civil liability under structural and functional approaches. The first allows us to analyse different conventional legal categories of liability and understand if they could be apply both to automated and semi-fully autonomous robots.

As concerns contract law, it is likely that doctrine contract would prove sufficiently flexible to address intelligent autonomous robot.

In regard to product law, the terms such as defective product (manufacturing, design or warning defects), risk, safety, must be interpreted in relation to intelligent autonomous robots. Also in product liability there is a particular issue that is the proof of causation in case of multiple suppliers. In EU the general rule is that the manufacturers of assembled product are liable if it is defective. In US the seller or the distributor of the single component is not liable unless the defect is related to the single part, or they participate in integrating the component into the design and the integration causes the defect. However, if these problems exist, it may be hard to prove that a component was defective or that the seller or distributor of a component participated in a defective integration of the component.

A very interesting issue is related to the use of robot provoking damages to third parties. In these cases it is hard to understand how to allocate the civil liability.

Consumers experiencing property and personal injuries - caused by simple robotic machines like thermostats that are not different than toasters or conventional cars[440] -, can sue retailers, manufacturers or others for breach of Contract or invoking tort law[441].

The risk of damages from the sale of robots will be governed by contract law and product liability (including also contract and tort doctrines[442]); while damages from the use of products will be regulated by tort law (extra-contractual liability).

In the Italian and French systems, the term used is e*xtra-contractual obligations* and *responsabilité delictuelle* respectively which comprise specific forms of torts liability, to which corresponds the idea of objective responsibility or liability without fault in the civil law tradition. People are held liable both for the damages caused by their own dangerous activities, as in the case of some torts of product liability, and for the harm caused by their own children, animals and even employees.

In the American system products liability law (a multi-layered set of rules and principles) is an on-going process of fashioning legal theories that set basic standard for liability, defining the type of product failure that will support a claim. It includes a system of classification in order to assess the liability of particular types of distributors of the product, and rules about legal responsibilities of consumers in the use of product.

The following analysis considers robots having close software embodied.

1.1. Contractual liability.

In Europe[443] if a robot lacks of conformity with the contract (art. IV. 2:301 *Draft Common Frame of reference* - DCFR)[444], the buyer can terminate the contract (art. IV

[440] Robots, that are not intelligent, could be considered as “social things” that interact with humans. Sociality makes them “particular things”.

[441] For an analysis of the border areas, *see* among others BUSNELLI F.D., *Itinerari europei nella «terra di nessuno» tra contratto e fatto illecito: la responsabilità da informazioni inesatte*. Contratto e impr., 1991, p. 539 ss.; CASTRONOVO C., *La nuova responsabilità civile*, 3[a] ed., Milano, 2006, p. 443 ss.; ID, *Liability between Contract and Tort*, in Perspectives of Critical Contract Law, ed. by WILHELMSSON, ALDERSHOT, 113, p. 273 ss.

[442] SHAPO M.S., *Tort Law and culture*, Carolina Academic Press, 2003, p. 178.

[443] In RESOLUTION of 26 May 1989 (on action to bring into line the private law of the Member States - OJ C 158, 26.6.1989, 400), of 6.05.1994 (on civil and commercial law harmonization of some private law sectors of the Member States OJ C 205, 25.07.1994, 518); 15 November 2001 (on approximation of the Member States OJC 140 E, 13.06.2002, 538); 2.11.2003 (on communication of the Commission to both European Parliament and Council that aims to realizing un action plan for a greater coherence in contractual European law OJ C 76 E, 25 march 2004, 95) The European Parliament sustained the idea of a wide private law harmonization, based on results of research projects.

[444] The Study Group on a European Civil Code (the ‘Study Group’) and the Research Group on Existing EC Private Law (the ‘Acquis Group’) presented the revised and final academic DRAFT OF A COMMON FRAME OF REFERENCE (DCFR) (published two versions: in 2008 the “interim outline edition” and in 2009 “final outline edition” - VON BAR C. et al.:, *Principles, Definitions and Model Rules of European Private Law. Draft Common Frame of Reference*, Munich, 2009). It contains Principles, Definitions and Model Rules of European General Private Law in an outline edition. DRAFT refers to the: PECL

4:201) and, generally, remedies for non-performance - due to an impediment - are applied. If an obligation is not performed by the debtor, the unsatisfied creditor may make use of the right to damages (art. III 3:701) and the debtor is liable only for the loss which he foresaw or could reasonably be expected to have foreseen at the time when the obligation was incurred as a likely result of the non-performance (art. III- 3:703)[445].

In Italian system, a consumer who buys a robot non conformal with contract may recourse to primary and secondary remedies[446] (art. 128 ss., d.lgs. 6 September 2005, n. 206[447]); at last[448] he can make a recourse for damages (art. 135, 2, cons. cod. and art. 1490[449], 1494 cod. civ.) against the seller.

To integrate these regulations, art. 1218 cod. civ. establishes that a debtor, who cannot prove that the breach is not due to an impediment, is liable for breach of

(PRINCIPLES OF EUROPEAN CONTRACT LAW) elaborated by Commission on European contract Law (available on lie http://frontpagecbs.dk/law/commisssion_on_european_contrat_law/); UNIDROIT Principles on International Commercial Contracts (2004) (available on www.unidroit.org.); NU Convention on Contracts for the International Sale of Goods (CISG) of 11.04.1980); Acquis Principles (Principles of the Existing EC Contract Law elaborate based on *acquis communautaire*); project of European code Gandolfi (Accademia dei Giusprivatisti Europei, Code Européen des contrats: Avant-projet, Livre premier, coordinatore Gandolfi, Milano, 2a ed., 2002; ID., Code Européen des contrats: Avant-projet, Livre deuxième, vol. I, coordinatore Gandolfi, Milano, 2007; *Id*., Code Européen des contrats: Avant-projet, Livre deuxième, vol. I, coordinatore Gandolfi, Milano, 2a ed. completa delle relazioni, 2008) comments of French Association Henri Capitant and Société de législation comparée (that published *Principes contractuels communs*, Paris, 2008 e *Terminologie contractuelle commune*, Paris, 2008), HONDIUS E., *Towards an Optional Common European Sale Law*. Eur. Rev. Priv. Law, 2011, p. 710.

[445] In this context *see* the current adoption proposal of a REGULATION on a common European Sales law (Common European Sales Law, c.d. CESL Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL ON A COMMON EUROPEAN SALES LAW, COM (2011) 653 final). The European Commission presented to both European Parliament and Council its official regulation for the adoption of a Regulation on common European sales law.

[446] Consumer has a right to resort the conformity through the reparation or substitution, then the reduction of the price or the termination of the contract (art. 130, comma 2 Cons. cod.).

[447] REGULATIONS on sale of consumer goods, at first disciplined in paragraph 1-bis, art. 1519-bis e ss., section of civil code introduced through D.GLS. 2 February 2002, n. 24 – effecting of the DIRECTIVE 25 May 1999, n. 44 transfused into art. 128 e ss. Cons. cod.

[448] Some scholars exclude the application of the warranty for defects related to single types of contract on regulation of consumer goods sales *see* ZACCARIA A., DE CRISTOFARO G., *La vendita di beni di consumo. Commento agli artt. 1519-bis-1519-nonies del codice civile*, Padova, 2002, p. 144 ss.; LUMINOSO A., *Le garanzie nella vendita dei beni di consumo,* curato da BIN M., LUMINOSO A., Trattato diritto commerciale Galgano, Padova, 2003, p. 118; GAROFALO L., *Commentario alla disciplina della vendita dei beni di consumo*, curato da GAROFALO L., MANNINO V., MOSCATI E.,VECCHI P.M., coordinato da GAROFALO L., Padova, 2003, p. 718; *contra* BUZZELLI D., *Commentario alla disciplina della vendita dei beni di consumo*, curato da GAROFALO L. - MANNINO V., MOSCATI E., VECCHI P.M., coordinato da GAROFALO L., Padova, 2003, p. 314.

[449] The seller must guarantee that the good has no defects that make it unsuitable for its use or defects considerably diminishing its value. The defects consisted in material imperfections of the thing that impress on its usability or value BIANCA C.M., *La vendita e la permuta.* Trattato VASSALLI, Torino, 1993. When a good is defective, the buyer may ask the termination of the contract or the reduction of the price (c.d. azioni edili). Defects are different from both the lack of essential qualities or promises (art. 1497 c.c.) and the sale c.d. *aliud pro alio*.

contract; the right to damage is limited to the immediate consequences (art. 1223 cod. civ.) and it must be foreseeable from the debtor (art. 1225 cod. civ.).

The ordinance n. 2005-13 17.02.2005, on conformity for goods sold by sellers to consumer transposed the Directive n. 99/44/CEE[450] into art. 211-1/211-17 Code de la consummation and code civil supplements these norms.

Art. 1243 code civil lays down: «Le créancier ne peut être contraint de recevoir une autre chose que celle qui lui est due, quoique la valeur de la chose offerte soit égale ou même plus grande» and «est interdite [comme abusive au sens de l'alinéa 1er de l'article L. 132-1 du code de la consommation] la clause ayant pour objet ou pour effet de réserver au professionnel le droit de modifier unilatéralement les caractéristiques du bien à livrer» (art.132-2, al. 1er code de la consommation).

Art. 1603 code civil complements special framework and it lays down that seller shall deliver «la chose qu'il vend» (*obbligation de dèlivrance*) and he shall have a duty to ensure the enjoyment of the good (*obbligation de garantie*). To apply this latter, the vice, that identifies an anomaly of the good[451], shall be a significant alteration and material deterioration of delivered product[452].

The integration between this two above frameworks leads to dissipate the difference between conformity and warranty.

Hence, the current contractual liability deals with the absence of compliance with the agreed terms and this would lead to the nonperformance. A delivered robot must comply with contractual provisions, but also with administrative rules and with the use expected by consumer. Therefore, any harm occurred under, i.e., the license agreement coverage should be considered as contractual liability.

In US system[453] manufacturer, who inserts a warranty[454], is liable for injuries deriving from the «breach of warranty» to people and property[455] (art. 2 U.C.C.[456]).

[450] DIRECTIVE 1999/44/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees.

[451] TOURNAFOND O., *Le prétendus concours d'actions et le contrat de vente*, D, chr. n. 35, 1989, p. 237.

[452] There are two interpretations of defect of product: that one strict «*conceptuelle*» and that one «*fonctionelle*» including non-conformity.

[453] The various theories of recovery that may support a product liability action against a manufacturer are: 1) negligence; 2) misrepresentation, both tortious and by breach of warranty and 3) strict liability in tort for defective products. The principles of these liability theories are often applicable to suppliers generally.

[454] Uniform Commercial Code according to product liability law expresses 1) warranty section 2-313; 2) implied warranty of merchantability 2-314; 3) the implied warranty of fitness for particular purpose are relevant.

Warranties can be expressed[457] - when there is an affirmation, or a promise, or a description -; or implied on merchantability good[458] or implied on good fit for particular purpose.

The first occurs when a seller ensures some goods which are not conform to general rules of merchantability and consumer can claim against seller[459] (2-213 U.C.C.).

Implied warranty of merchantability is defined as: «a warranty that the goods shall be merchantable is implied in a contract for their sale if the seller is a merchant with respect to goods of that kind. Under this section the serving for value of food or drink to be consumed either on the premises or elsewhere is a sale» (§2-314 U.C.C.)[460].

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455 However the sellers can avoid being subject to this warranty by excluding or modifying it § 2-316(2); U.C.C. § 2A-214(2). «If the seller doesn't exclude or modify the warranty, the merchant will almost certainly be liable for physical injuries caused by breach of the warranty even though he is intuited to limit or exclude liability for economic losses caused by the breach» *see* U.C.C. § 2-302; § 2-719(3); § 2A-108; § 2A-503(3); § 2A-520(2)(b).

456 U.C.C. has been written as a uniform law model by scholars association at federal level, private institution, the American Law Institute (A.L.I.) and the National Conference of Commissioners on Uniform States Law (N.C.C.U.S.L.). All the Unite States (except Louisiana) have adopted the Code. U.C.C. is a state law, not federal. Though the U.C.C. is the product of state legislation, it is applied by the court.

457 «(1) Express warranties by the seller_are created as follows: (a) Any affirmation of fact or promise made by the seller to the buyer which relates to the goods_and becomes part of the basis of the bargain creates an express warranty that the goods shall conform to the affirmation or promise. (b) Any description of the goods, which is made part of the basis of the bargain, creates an express warranty that the goods shall conform to the description. (c) Any sample or model, which is made part of the basis of the bargain, creates an express warranty that the whole of the goods shall conform to the sample or model».

458 The meaning of merchantability, its essential nature and how it may or may not differ from the standards underlying the other theories of liability are issue of central importance in U.U.C. §2-314 litigation. Committee of revision has individualized some principles to reduce the difference between merchantability e defective in case of personal and property injuries.

459 2-313 «(2) It is not necessary to the creation of an express warranty that the seller use formal words such as "warrant" or "guarantee" or that he have a specific intention to make a warranty, but an affirmation merely of the value of the goods or a statement purporting to be merely the seller's opinion or commendation of the goods does not create a warranty». *See* Sylvestri v Warner & Swasey Co., 398 F.2d 598 1968; Caboni v. General Motors Corp. (398 F.3d 357, 2005).

460 Art 2: «(2) […] Goods to be merchantable must be at least such as: (a) pass without objection in the trade under the contract description; and (b) in the case of fungible goods, are of fair average quality within the description; and (c) are fit for the ordinary purposes for which such goods_are used; and (d) run, within the variations permitted by the agreement, of even kind, quality and quantity within each unit and among all units involved; and (e) are adequately contained, packaged, and labeled as the agreement may require; and (f) conform to the promise or affirmations of fact made on the container or label if any. (3) Unless excluded or modified (Section 2-316) other implied warranties may arise from course of dealing or usage of trade […] ».

Finally, the last warranty takes place when «at the time of contracting has reason to know any particular purpose for which the goods are required and that the buyers relying on the seller's skill or judgment to select or furnish suitable goods» (§2-315).

Manufacturers of IARs will not use express warranty because it is inconvenient to do so. Robots are unknown goods and their risks are still undefined. Instead, implied warranty on merchantability good will not be used because the most of US States resort to strict liability theory, that is an interesting economic analysis area.

1.2. Product liability.

A consumer suffering injuries by an automated vacuum cleaner can sue also the manufacturer who has a duty towards people who may be affected by his products, but with whom he did not directly deal.

In Europe, a principle states that the manufacturer of a product is accountable when a defective product provokes personal injuries and consequential losses (art. VI - 3:204). This principle resumes the Directive of the Council n. 85/374/EEC of 25 July 1985 on liability for defective product (corrected by Directive n.1999/34/EEC[461]). This directive has been received in Italy with D.P.R. 24 May 1998, n. 224 - inserted into Title II, Part IV, cod. cons. - and in France with L. 19 March 1998 inserted into Title IV, code civil. Both systems transposed Directive without significant changes.

European Product liability reflects some concepts of US Product Liability laid down in Restatement (Third) of Torts, as can be seen below.

The manufacturer is liable for damages caused by his product's flaws to the buyer. The defectiveness of the product could be: a) manufacturing defect; b) design defect; c) absence or failing of information. Then, as pointed out by the case law, product defects correspond to lack of safety for users.

A. Is a robot a product? French system states the product is «tout bien meuble, même s'il est incorporé dans un immeuble, y compris les produits du sol, de l'élevage, de la chasse et de la pêche. L'électricité est considérée comme un produit» (art. 115, 1-2 code consommation and 1386-3 code civil). Italian product liability contains the same definition (art.115 cod. cons.).

Products are goods, which can bring some utilities, and they could be potentially

[461] COUNCIL DIRECTIVE N. 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, OJ L 210, 07.08.1985, 29.

misappropriated[462]. They could be tangibles - when they have material texture – or intangible. This distinction, although is not included in above-mentioned articles, was confirmed by Commission of European Community[463].

This broad definition can be interpreted extensively, as long as included all products that are not animate. For instance a semiautonomous IAR is not yet animate, while it could have this feature in the future when IARs will be truly autonomous (considered the development of state-of-art in this matter).

Instead, the term "tangible" is specified in Restatement (Third) of Torts, which states §19: «a product is tangible personal property distributed commercially for use or consumption. Other items, such as real property and electricity, are products when the context of their distribution and use is sufficiently analogous to the distribution and use of tangible personal property that it is appropriate to apply the rules stated in this Restatement; Services, even when provided commercially, are not products».

IARs are composed by hardware and software: the first is a product, while the second is an operating system, which should not fall under the paragraph 19, because it is an information technology product, so it is an intangible product.

IARs are particular tech-social system which has particular functions that are different compared to other products, i.e. an elevator. The difference between them is not their structure but their functioning. Software embodied into a body creates a *sui generis*[464] product where software improves the function of several combined elements. This approach enables to insert semiautonomous robots into product category, just until robots become truly autonomous. Thus, a defect of software should be considered as a defect of hardware component, a unitary defect.

B. Who produce a robot? Both European systems defines the producer as the manufacturer of the good or the retailer of the service, or intermediary, and the importer of the good or service in the territory of the European Union or any physical or juridical person that identifies the good or the service with its name, brand or mark badge

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[462] LACANTINERIE B.G., CHAUVEAU M., *Traité théorique et pratique u droit civil. Des biens*, 1er éd., n. 10, 1986p.10.

[463] *See* Question 5/07/1988, in JOCE n. C 114/42, 8.05.1989, p. 42.

[464] «*Les robots sont des objets, certes particuliers, dotés d'intelligence et d'autonomie, mais ils restent encore aujourd'hui à l'état de chose et donc objet de droit et non sujet de droit*» VEBER PH., ROBOTIQUE: *Les robots et les hommes naitront-ils et demeureront-ils libres et égaux en droits?*, 2013 http://www.veberavocats.com/blog/robotique-les-robots-et-les-hommes-naitront-ils-et-demeureront-ils-libres-et-egaux-en-droits_a266/.

(art.103 lett. d) cod. cons.). The French definition is simpler, in fact art. 1386-6, al. 1, code civil lays down that: «est producteur, lorsqu'il agit à titre professionnel, le fabricant d'un produit fini, le producteur d'une matière première, le fabricant d'une partie composante [...]» and «le producteur de la parte composante est celui qui a réalisé l'incorporation sont solidairement responsables en cas de produits défectueux» (art. 1386-8).

C. When a robot is defective? As concerns product liability, both European systems consider the same requirements of defectiveness. The French provision lays down that: «Un produit est défectueux au sens du présent titre lorsqu'il n'offre pas la sécurité à laquelle on peut légitimement s'attendre. Dans l'appréciation de la sécurité à laquelle on peut légitimement s'attendre, il doit être tenu compte de toutes les circonstances et notamment de la présentation du produit, de l'usage qui peut en être raisonnablement attendu et du moment de sa mise en circulation. Un produit ne peut être considéré comme défectueux par le seul fait qu'un autre, plus perfectionné, a été mis postérieurement en circulation» (art. 1386-4 code civil). This is similar to the Italian provision[465] (art. 117 cod. cons.).

These above requirements reproduce the *ratio legis* expressed by European legislator who offers a notion of defectiveness related to the absence of safety. He relies on interpreter the definition of product's defectiveness (or not) based on safety expected by consumers. Council Directive 85/374/EEC states that: «to protect the physical well-being and property of the consumer, the defectiveness of the product should be determined by reference not to its fitness for use but to the lack of the safety which the public at large is entitled to expect; whereas the safety is assessed by excluding any misuse of the product not reasonable under the circumstances».

Hence, EU Directive adopts a consumer expectation test based on presentation, normal use and warnings of product introduced onto market[466]. This test could raise several issues on robots, as we will see later.

[465] Italian doctrine on defectivenss of product *see* BITETTO A., PARDOLESI R., *Risultato anomalo e avvertenze generica: il difetto nelle pieghe del prodotto*, in DR, n. 3, 2008, p. 292; Trib. Vercelli 7 aprile 2003, in DR, 2003, p, 1001; PONZANELLI G., *Responsabilità oggettiva del produttore e difetto di informazione*, DR., I, 2003, p. 1005; RAINERI E., *L'ambigua nozione di prodotto difettoso al vaglio della Corte di Cassazione italiana e delle altre Corti Europee*, in Riv. dir. civ., II, 2008, p. 163.

[466] In Italy, some sentences on product defective: Trib. Milano 31 gennaio 2003, in Resp. civ. e prev., 2003, p. 1151, con nota di DELLA BELLA, *Cedimento di scala estensibile e responsabilità del produttore-progettista: la nozione di danneggiato nella disciplina della responsabilità del produttore*; in DR, 2003,

Thus, IARs are defective if they have not a reasonably safety expected by consumers[467]. The product's safety is that expected by consumers therefore there are different thresholds of safety as regards different robots application.

But, there is a problem for evaluating safety of robot, based on factors identified by legislator, because it's hard to understand the meaning of «reasonably expected». Consumers do not know what they can expect about the use and the presentation of robots, they get an idea of an unknown product by comparing the presentation, the normal use and warnings to technical regulation. [468] By contrary, it is hard that consumers can have a reasonable level of safety.

European legislator adopted strict liability[469]as well as many US States, despite Restatement (Third) of Torts, based product liability for design and warning defects on strict liability theory. However, Courts apply theory of negligence with respect to these latter defects[470].

In American system, Restatement (Third) of Torts[471] establishes: 2§ (a) contains a manufacturing defect when the product departs from its intended design even though all possible care was exercised in the preparation and marketing of the product; (b) is defective in design when the foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative design by the seller or other distributor, or a predecessor in the commercial chain of distribution, and the

p. 634; Trib. Vercelli 7 aprile 2003, in Danno e resp., 2003, p. 1001, con nota di PONZANELLI G., *Responsabilità oggettiva del produttore e difetto di informazione.* Cass. 4 giugno 1998, n. 5484, in Studium Juris, 1998, p. 1119; Cass. 19 gennaio 1995, n. 567, in Mass. Giust civ.,1995, c. 97; Cass. 26 luglio 2012, n. 13214, in De jure; Cass., 15 marzo 2007, n. 6007, in Resp. civ. e prev., 2008, II, p. 1587, con nota di GORGONI M., *Responsabilità per prodotto difettoso: alla ricerca della (prova della) causa del danno*; Cass. 13 dicembre 2010, n. 25116, in Nuova giur. civ. comm., 2011, I, p. 590, con nota di KLESTA DOSI, *L'incerta disciplina dei prodotti abbronzanti.* Trib. Pisa 16 marzo 2011, in Resp. civ. e prev., 2011, 10, p. 2108, con nota di CARNEVALI, *Il difetto di progettazione negli autoveicoli*, in Danno e resp., 2012, p. 67, con nota di BITETTO, *Dal biscotto al pan carrè: il tortuoso percorso della responsabilità da prodotto.*

[467] LARENZ K., *Lehrbuch des Schuldrechts*, BT, vol. II, 13 éd., Muenchen, 1991, p. 645.

[468] However, if there is not a particular regulation on safety, DPGS is applied in which there is not written a presumption of conformity, but only a reference to technical norms.

[469] PONZANELLI G., *Casi e questioni di diritto privato*, in BESSONE, ed. 4, Milano, 2002, p. 452 product liability is not a no-fault system, but a strict liability system.

[470] The calculation of risk is included in United States v. Carroll Towing Co.) in which judge Hand explains that. Based on "Hand formula" if cost for precaution measures is less than benefits related to these measures (P x L), failure to adapt of these latter lead to negligence of manufacturer (→ N).

[471] Restatement of the Law third, Torts, Products Liability, (1998) produced by ALI and having the same nature of PETL. Among States there are differences, some of these have adopted parts of Restatement (Second) of Torts (ALI, 1977) and Restatement (Third) of Torts (ALI, 1998). ALI, as PETL, are not mandatory however many Courts refer to these Principles.

omission of the alternative design renders the product not reasonably safe; (c) is defective because of inadequate instructions or warnings when the foreseeable risks of harm posed by the product could have been reduced or avoided by the provision of reasonable instructions or warnings by the seller or other distributor, or a predecessor in the commercial chain of distribution, and the omission of the instructions or warnings renders the product not reasonably safe.

This system of liability is mixture because it is articulated into both presumption of liability or fault according to defect. Product liability law establishes a strict liability for building defects; meanwhile for both planning and information defects manufacturer may prove that the product is safe or it is not safe because of the consumer behaviour (in this way the criteria of professional carefulness has been chosen).

(a) The first defect may take place when manufacturer breach its duty to produce and sell products free of manufacturing defects. First, he can construct the product with raw materials or components that contain physical flaws. Second, although a component of the product has not flaws, the manufacturers may make an error in assembling the component into the final product. In both cases when manufacturing process goes awry, the product fails to meet even the manufacturer's own design specification standards[472]. The proof of manufacturing defect leads to strict liability of manufacturer who shall ensure consumers against all risks of product, so he shall be held liable regardless of fault[473].

An IAR having a manufacturing defect will be rare, considering that manufacturing process will be sophisticated as their products[474].

(b) The design defect involves the absence of some types of safety device, such as i.e. a guard on power lawnmower. In addition to this standard way of thinking about design dangers, there are numerous other ways in which products may be defectively designed – from flammable fabrics not treated with flame retarding chemicals, to products whose moving parts are made of metal too soft or screws too short to perform the product's normal functions safely over its useful life[475]-. To avoid design defect,

[472] Magnuson v. Kelsey-Hayes, 844 SW2d 448, 1992.
[473] OWEN D.G., *The Moral Foundations of Products Liability Law: Toward First Principles*. 68 Notre Dame L. Rev. 427, 1993, pp. 467-74.
[474] KALRA N., ANDERSON J., WACHS M., *op. cit.*., 2008.
[475] OWEN D.G., MONTGOMERY J.E., DAVIS M.J., *op. cit.*, 2010, p. 236.

during their jurisprudential activity, Courts establish restrictions which are followed by designers[476].

In particular, the standard for liability of product design is negligence. This concept has been based on the notion of reasonableness, predicated on the idea that proper decisions involve selecting proper balance of expected advantages and disadvantages, of expected benefits and risks[477]. So, product has a design defect whether the risk inherent in the use of product could be avoided by adopting a reasonable alternative design as long as the removal of the risk does not sacrifice utility of product, excessively.

The design defect carries out its functions in Human-Robot Interfaces. These shall be designed in a manner that ensures a safe use in order to avoid injuries and through design you can prevent risks by attaching design to consumers' needs.

Design has a fundamental role in order to avoid risk of violation of privacy. It should be adjusted to the risks raised to individual's privacy and manufacturer should be obliged to consider these risks and adopt suitable measures to avoid their breach.

To identify design defect, courts use two different criteria, such as «consumer expectations test»[478], Restatement (Second) of Torts § 402 A)[479] or «risk-utility test», (or «cost-benefit analysis» Restatement (Third) of Torts 2§ b).

Under art. §402 A):

> «(1) One who sells any product in a defective condition unreasonably dangerous to the user or consumer or to his property is subject to liability for physical harm thereby caused to the ultimate user or consumer, or to his property, if:
>
> (a) the seller is engaged in the business of selling such a product, and
>
> (b) it is expected to and does reach the user or consumer without substantial change in the condition in which it is sold.
>
> (2) The rule stated in Subsection applies although
>
> (a) the seller has exercised all possible care in the preparation and sale of his product, and
>
> (b) the user or consumer has not bought the product from or entered into any contractual relation with the seller».

The key word of this article is «unreasonably dangerous to the consumer»,

[476] Allen v. Beneficial Finance Company, 531 F.2d 797 (7th Cir. 1976), 277, 282; Compare State v. Hunter, 7 Computer L. Serv. Rep. 980 (Md. Cir. Ct. 1980), Burnett v. Westminster Bank, 3 All E.R. 81, 1965 (Q.B.), in which court has a relevant role on determination of criteria for design product.
[477] Learned Hand in United States v. Caroll Towing Co. 159 F.2d 169 (2nd Cir. 1947).
[478] *See*, e.g., Potter v. Chi. Pneumatic Tool Co., 694 A.2d 1319, 1333 (Conn. 1997).
[479] This was used before by Restatement (Third) of Torts.

because it evaluates his expectations on product based on common and ordinary knowledge of product. This latter is defective whether product is more dangerous compared to expectations of a normal consumer. This criterion has been abandoned because it is not able to prevent a standard for complex design.

Instead, risk-utility test evaluates both utilities and risks provided by design of product. This assessment bases on different factors, including utilities; safety; possibility of removing the hazardous nature of product; the behaviour of consumer. Manufacturer is held liable whether under the current product design the probability of injuries is higher than costs of a reasonable alternative or the diminished utility deriving from the modifying the design.

Wade created a list of factors to apply in order to determine the unreasonably dangerous standard. These factors are: « (1) the usefulness and desirability of the product-its utility to the user and to the public as a whole. (2) The safety aspects of the product-the likelihood that it will cause injury, and the probable seriousness of the injury. (3) The availability of a substitute product which would meet the same need and not be as unsafe. (4) The manufacturer's ability to eliminate the unsafe character of the product without impairing its usefulness or making it too expensive to maintain its utility. (5) The user's ability to avoid danger by the exercise of care in the use of the product. (6) The user's anticipated awareness of the dangers inherent in the product and their avoid ability, because of general public knowledge of the obvious condition of the product, or of the existence of suitable warnings or instructions. (7) The feasibility, on the part of the manufacturer, of spreading the loss by setting the price of the product or carrying liability insurance»[480].

Now, a few courts use the first test; others combine the two tests[481] and the most of courts use risk-utility test[482].

To demonstrate that an IAR has a design defect, courts should use one of the two tests. The first allows to demonstrate the expectations on robot by consumer, however real expectations on robots are unknown by consumer who cannot get an idea of robots even in the absence of related safety regulation.

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[480] WADE J., *On the Nature of Strict Tort Liability for Products,* 44 Miss. L.J. 825, 837-38, 1973, p. 673.
[481] Barker v. Lull Engineering Co., 20 Cal. 3d 413, 1978 Potter v. Chicago Pneumatic Tool Co., 241 Conn. 199, 1997.
[482] Sedlock v. Bic Corp., 741 F. Supp. 175 (W.D. Mo. 1990). 188 Floyd v. Bic Corp., 790 F. Supp. 276 (N.D. 1992). 189 Troja v. Black & Decker Mfg. Co., 62 Md. App. 101, 488 A2d 516 (1985).

This subject becomes a relevant question for fully autonomous robots that will not have foreseeable behaviour, so consumers could have a misreprestation of them. Then, there is another issue on difficulty of demonstrating the adaptation of a reasonable alternative design by plaintiff.

(c) Manufacturer shall provide risks of product and there is a warning defect if a product does not provide information and warnings to avoid risks resulting from its use. Courts consider that manufacturers shall inform consumers of the foreseeable risks at the time of sale[483]. Warning is related to design of product because it informs consumers on knowable hazards inherent in a product.

Warning should be comprehensible and establish an objective suggestion of the risks related to use of product[484]; proportional to the level of risk[485].

A warning or instruction concerning a risk is required whether the risk is foreseeable by the seller, and it is not foreseeable whether a significant number of users will not be aware of the risk[486].

A warning defect of a robot raises some issues. It is not clear what warnings are necessary, because advanced technology has an unpredictable evolution. So, manufacturers will provide a limited number of situations because of the complexity of technology. In addition, other essential warnings will discover go along when courts will study individual cases in which new warnings will be detected. Plaintiff will support the lowest cost of these warnings, while defendant will support the unforeseeable of the risks involved.

D. How many traders produce a robot? IAR is a complex product and many traders work to produce it, such as designers, programmers, engineers. The identification of liable could be hard.

In France and Italy, Product Liability establishes that all traders are jointly and severally liable in respect of the consumer and responsibility is shared between them based on their fault[487]. This plurality of traders is not a problem for consumer

[483] In 1960s §402A del Restatement (Second) of Torts adopted strict product liability in tort and court compliance *see* Beshada v. Johns-Manville Product Corp, 447 A. 2d. 539 (N.J. 1982). Then court changed opinion *see* Feldam v. Lederle Laboratories, 479 A. 2d. 374 (N.J. 1984).
[484] OWEN D.G., *Products liability law*, op. cit., 2008, p. 566.
[485] GEISTFELD M. A., *Principles of products liability*, Foundation press, New York, 2006, p. 137.
[486] *See* HUBBARD F.P., *op. cit.*, 2014.
[487] BORGHETTI J.S., *Responsabilité du fait des produits défectueux: régime de produit incorporés* - Cour de Cassation, 1er civ. 26.11. 2014, D, 2015, p. 405.

considering the solidarity among tortfeasors involving in the production[488] (in France, art.1386-8 code civil and in Italy art. 120 cod. cons.). In this regard, the issue rises with respect to shared liability among tortfeasors, given that it will be hard to prove what component was defective because of the complex structure of robot.

In US, some States[489] accept market share liability[490] while others establish that every tortfeasor is held liable in proportion to injuries causing unless some cases[491]. This system does not introduce the theory of jointly and severally liable of tortfeasors and consumer will not be facilitating in evidence.

To share liability among manufacturers, you can consider the relation between these latter (i.e. among manufacturer and a software provider). If the defect is related to component used into manufacturing process and this part causes injuries, manufacturer is held liable. If the component part became unreasonably dangerous after delivery, software provided will not be held liable. If manufacturer does not communicate hazard of component to principal manufacturer, the first will be held liable[492].

E. Burden of proof[493]. Both EU Members States requires that consumer shall demonstrate the harmful event, the damage and the causation between these latter. However this burden of proof is not easy as regards causation of complex product, in fact a current relation of EU Commission[494] considers that the evidence for advanced

[488] This external claim (to relationship between multiple liabilities) bases on *fictio iuris*, which allows overcoming the difficulties of victim about burden of proof in order to identify manufacturer of defective component. This claim presents a corrective with right of recourse, which has effect in internal relationship between manufacturers where liability shall be distributed because of their fault.
[489] Unless some of U.S. State, such as i.e. Mississipi.
[490] The first sentence adopted this theory is Sindell v. Abbott Labs., 26 cal. 3d 588, 607 P. 2d 924, 163 (Cal. 1980); PONZANELLI G., *Il caso Brown e il diritto italiano della responsabilità civile del produttore*, Foro It., IV, 1989, p. 128.
[491] In Pennsylvania, for claims proposed after 28.06.2011 every tortfeasor is only liable in proportion to damage caused. However, joint and several liability is still practiced when tortfeasor id held liable for intentional misrepresentation or intentional tort or if he is liable for more than 60%.
[492] EADES R.W., *Mastering Series: Products Liability*, Carolina Academic Press., 2008.
[493] CARNEVALI U., *Prodotto difettoso e oneri probatori del danneggiato*, in Resp. civ. prev., 2008, 354, nota a Cass. 10 ottobre 2007, n. 20985 «*il difetto, per comportare una responsabilità del produttore, non deve rimanere allo stato latente, ma deve causare nel mondo naturale degli effetti di carattere materiale o fisico (rotture, incendio, esplosione, allagamento, corto circuito, effetti collaterali nocivi per l'uomo, ecc.). Il consumatore, una volta dimostrata la 'insicurezza' del prodotto, dovrà provare - e sarà sufficiente - che i suddetti effetti di carattere materiali o fisici derivati dal difetto hanno causato il danno di cui chiede il risarcimento: tali effetti rappresentano la causa prossima del danno, mentre la causa remota risale al difetto*». GORGONI M., *Responsabilità per prodotto difettoso: alla ricerca della (prova della) causa del danno*, in Resp. civ. prev., 2008, 1592 ss., nota a Cass. 10 ottobre 2007, n. 20985.
[494] REPORT FROM THE COMMISSION (2011) TO THE EUROPEAN PARLIAMENT, THE COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE. Fourth report on the application of Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws,

technology is hard because it is technically complicated and it will be used many expert opinions, thereby increasing costs[495]. This difficult leads to some courts, for example in Belgium, France, Italy or Spain, to state it is enough for the plaintiff to prove that the product did not fulfil the function for which it was intended[496].

This type of issues (related to other statutory scheme) have been solved, in different area, by government through the creation of automatic compensation systems, which ensure compensation of victims regardless the proof of causation (see *Loi Banditer sur les accidents de la circulation*- chap. V), or with the inclusion of a presumption of the producer's liability or of a mechanism to reverse the burden of proof[497].

In American system, consumer shall demonstrate the causality between defect of product and injuries on condition that product has been produced by defendant and defect is a condition *sine qua non.* Thus, consumer shall demonstrate proximate causation and, with regard to design and warn defects, plaintiff shall prove the duty of manufacturer, in terms of negligence. Also in this system, the burden of proof is hard considering the manufacturing process is multi-layered and complex.

Then, these provisions do not establish standards on degree of proof and that is a problem for consumers who have not technical knowledge and don't access to information concerning the product which are in availability of manufacturer.

F. Manufacturer defence. The development risk and regulatory compliance. European Product liability provides that the manufacturer is not held liable whether he proves that defect is caused by the over-age product or intervention of a third-party or risk of development. In this last case, the time limit considered is when product is put into circulation.

«L'état des connaissances scientifiques et techniques, au moment où il a mis le

regulations and administrative provisions of the Member States concerning liability for defective products amended by DIRECTIVE 1999/34/EC of the European Parliament and of the Council of 10 May 1999.

495 «Consumers emphasize the difficulty, in particular due to the economic costs, of furnishing proof of the defect of certain highly technical products as well as proving the causal link between the defect and the damage when such damage is complex in nature. In order to better guarantee consumer protection, they believe the burden of proof should be reversed», p. 7.

496 LOVELLS, *Product liability in the European Union* – A report for the European Commission – (The Lovells Report), 2003.

497 JOURDAIN P., *Implication et causalité dans la loi du 5 juillet 1985*, JCP, I, 1994, 3794; LARROUMET C. *L'indemnisation des victimes d'accidents: l'homogame de la responsabilité de la responsabilité et de l'indemnisation automatique*, D, chr., 1985, p. 237.

produit en circulation, n'a pas permis de déceler l'existence du défaut»[498]. (art. 1386-11, 4 al. code civil. The same provisions is in art.118 lett. e), Italian cod. cons.))[499] and «le producteur peut être responsable du défaut alors même que le produit a été fabriqué dans le respect des règles de l'art ou des normes existantes ou qu'il a fait l'objet d'une autorisation administrative», (art. 1386-10 code civil. The same norm is in art.118, lett. d) cod. cons.) and manufacturer is not held liable if «défaut est dû à la conformité du produit avec les règles impératives d'ordre législatif ou réglementaire» (art. 1386-11, al. 5 code civil; art. 105 cod. cons.).

State of scientific and technical knowledge is a set of subcategories, including subset which contains professional rules[500]. EU Court of Justice pointed out that «state of scientific and technical knowledge is not related to industrial sector where manufacturer works, but it is the highest level existing at put into circulation time»; «this cause of discharge […] considers objective state of scientific and technical knowledge which manufacturer should know»[501].

Court of Justice considers that this scientific and technical knowledge is accessible at put into circulation time; it has a global nature and manufacturer shall be obligated to collect information existing at international level [502]. Precautionary principle[503] and not only prevention principle is implemented, in this way[504] considering

[498] COUNCIL DIRECTIVE 85/374/EEC states «whereas, for similar reasons, the possibility offered to a producer to free himself from liability 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 a defect to be discovered may be felt in certain Member States to restrict unduly the protection of the consumer; whereas it should therefore be possible for a Member State to maintain in its legislation or to provide by new legislation that this exonerating circumstance is not admitted; whereas, in the case of new legislation, making use of this derogation should, however, be subject to a Community stand-still procedure, in order to raise, if possible, the level of protection in a uniform manner throughout the Community». All UE Member States received this defense.

[499] VISENTINI E., *L'esimente del rischio di sviluppo come criterio della responsabilità del produttore. (L'esperienza italiana e tedesca e la direttiva comunitaria),* in Resp. civ. prev., 4-5, 2004, p. 1267

[500] BERG O., *La notion du risque de développement en matière de responsabilité du fait des produits défectueux*, JCP, I, 1996, p. 3945 (scientific and thecnological knowledge is a standard formula).

[501] Cour de Justice CJCE, 9 mai 1997, aff. C. 3000-95, Petites Afficher, 17.12.1997, note RICATTE; D. 197, IR p.185.

[502] TASCHNER H.C., *Bergrenzung der Gefendrdungshaftung, durch Hoechstsummen? Festschrift fuer Caemmerer, Tuebingen*, 1983, p. 86.

[503] Case T-13/99, Pfizer Animal Health S.A. v. Council, 2002 WL 31337 European Court of First Instance, Sept. 11, 2002 «*It follows from the Community Courts' interpretation of the precautionary principle that a preventive measure may be taken only if the risk, although the reality and extent thereof have not been 'fully' demonstrated by conclusive scientific evidence, appears nevertheless to be adequately backed up by the scientific data available at the time when the measure was taken*».

[504] This approach is in line with law and economic theory of *deep pocket* within allocation of liability among those who should adopt precautions measures, considering their proximity to adopt them.

he must prevent all measures to prevent possible risks.

The second clause of exemption (regulatory compliance) takes place as regards vehicles and medical products but there is very little case law on this ground of defense[505]. In addition, compliance with standards or trade rules does not preclude manufacturer's liability (1386-10 code civil, art. 105 cod. civ.).

In US States, state-of-art has both a different definition and a different evidential value[506]. For research scope, we consider the state-of-art corresponds to scientific and technological knowledge. If the manufacturer proves that, at the time when he put the product into circulation, this state of knowledge didn't allow the discovery of a defect, the manufacturer will not be held liable. Manufacturer is obliged to be up to date with the scientific developments and advancements and he is considered to have knowledge of an expert in his field.

Some States consider the compliance with start-of-art is a complete defence of manufacturer who is not held liable if product consistent with state-of-art[507], others consider it a no-defectiveness presumption, others state it has not an evidence value[508].

Now, a scientific and technical knowledge, to be real state of art, requires an extremely long time period to get a foothold[509]. An IAR that is placed on the market has a fractured state of arts related to its individual components, but a state of arts does not exist with regard to robot considered as a unitary entity. So, manufacturer could often use this defence to discharge his responsibility. Precautionary could avoid this shortcut in order to ensure the balance between innovative products and consumers' protection leading to reduction of insurance costs of enterprises.

To avoid the effect of development risk, French courts elaborated a theory, such as the *responsabilité contractuelle du fait des choses*, which aims to avoid the loopholes

[505] REPORT FROM THE COMMISSION (2011) TO THE EUROPEAN PARLIAMENT, THE COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE. Fourth report on the application of Council DIRECTIVE 85/374/EEC of 25 July 1985.

[506] GAREY B., *Spradley, Defensive Use of State of the Art Evidence in Strict Products Liability*, 67 Minn. L. Rev. 1982, p. 343.

[507] Arizona statue states the state-of-art is the best technology reasonably available at the time, ARIZ. Rev. Stat. Ann. § 12-683 (1984).

[508] DONALD E., *Stubby, Status and trends in state product liability law: state of the art evidence*, in 14 J. Legis., 1987, p. 261.

[509] The process of scientific and technical knowledge is very long considering that it realizes for speculations and refutations *see* POPPER K.R., *Congetture e confutazioni. Lo sviluppo della conoscenza scientifica*, 1972, pp. 83-84.

of development risk by manufacturer[510]. French courts assume that damages caused by risk of development have an internal source, because they depend on the internal composition of *chose* [511] . The risk of development is *implicitement englobé* in presumption of knowledge charge on trader[512]. Material flaws of building are not a clause excluding this risk, given that the clause is not external[513]. This risk seems to be absorbed by warranty of *vices caches ex* art. 1641 code civil, as well as it is also absorbed by *responsabilité du fait des choses* (1384, al. 1), because it is an internal risk of thing[514]. In summary, this mentioned theory considers that the *obligation de sécurité*, which ensures of achieving a guaranteed result by seller, is a *plein droit* warranty of all damages resulting from use of product[515].

As regards regulatory compliance, it could be a solution for IARs in accordance with new approach announced in TTIP agreements between product liabilities and safety law (*see* chap. III).

1.3. Tort law.

The use of an automated vacuum cleaner could cause injuries to third parties who are not involved in the contract. The owner is held liable for the damages caused by the owned product.

In Italian system, two different situations could occur. The damage is caused by human action during the execution of an activity that contains a probability of damage, and the case in which the injuries are caused by thing directly. In both cases the third-parties have to prove the causation between the dangerous activity or thing and the

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[510] L'arrêt Teffaine du 16.06.1896 s. 1897, 1, p. 1. This notion has been used in Civ. 1[er], 17.01.1995, Bull. Civ. I, n. 43, D. 1995, p. 350 note JOURDAIN P.: «*contractuellement tenu d'assurer la sécurité des élèves qui lui sont confiés, un établissement d'enseignement est responsable des dommages qui leur sont causés, non seulement par sa faute, mais encore par le fait des choses qui il met en œuvre pour l'exécution de son obligation contractuelle*». VINEY G., JOURDAIN P., CARVAL S., Traité de droit civil, 4 éd., LGDJ, Paris, 2013, n. 745-1. They consider the *responsabilitè contractuelle du fait de la chose* ensures the uniformity of rules for victims of damages caused by *fait du chose*, given that the conventional distinction between *contractuelle* and *delictuelle* liability does not give a suitable solution for limiting strict liability application.

[511] JOURDAIN P., *Responsabilité civile*, RTD civ., 1998, p. 387.

[512] GHESTIN J., *Sécurité des consommateurs et responsabilité du fait des produits défectueux*, Colloque des 6 et 7.11.1986, I, dir. GHESTIN J., Paris, 1987, p. 75.

[513] Civ. 3[e], 7.03.1990, Bull. Civ. III, n. 69; conform to non-application of exemption *see* Civ. 1[er], 8.04.1986, JCP 1987. II. 20721 note VIANDIER A. et VIALA G.

[514] OUDOT P., *Le risque de développement contribution au maintien du droit à reparation*, Dijon , 2005, p. 138.

[515] Cass. 1[ère], 22.01.1991 Bull. Civ. I, nr. 30; Cass. Civ. 1[ère], 9.07.1096, consider «*le vice interne du sang, meme indécelable […] ne constitue une cause exonération de leur responsabilité*».

damages reported. Those who operate dangerous activity[516] are not liable, if they demonstrate that all the proper measures to avoid the damage were adopted (art. 2050 c.c.)[517]. The person who has the thing in care is not liable, if he proves that the damage was caused by the "Act of God" (art. 2051 c.c.)[518].

Art. 2051 cod. civ. states that the guardian is held liable of the damages caused by thing which is under his control and direction power, in other words the thing shall be under his *signoria*.

In French system, *responsabilité du fait des choses* (art. 1384, al. 1[519]), is a waste statutory scheme[520] including all *choses* without distinction among hazardous and non-hazardous things[521] (so there are not two articles as in Italy)[522]. Under this article, plaintiff should prove that *inanimé chose* intervened in implementing damage and it had a causal role[523]. The *choses* have to a *role actif,* or *anormal comportment,* or a *vice*. However, if plaintiff shows that *chose* has a causal role, he is free to demonstrate its

[516] An example of robot used in dangerous activities are those used in industrial field such as the professional painting or used in surgery and diagnostic *see* VERUGGIO G., *Euron Roboethics Rodmap*, op.cit., 2007.
[517] Art. 5:101 PETL provides the liability of subject for damages characteristic to the risk. The damage is correlated to the risk caused by the activity *see* GNANI A., *Sistema di responsabilità e prevedibilità del danno*, Torino, 2008, p. 254.
[518] The case of damages to things in care has not been inserted in PETL. In DCFR has been realized the expansion of the operational sphere of the damages caused by immovable art. 3:202 (*see* Von BAR C., CLIVE E., *Principles, Definitions and Model Rules of European Private Law*, DCFR, Munich, IV, 2009, p. 3478). For a comparisons between these two projects *see* WIDMER P., *La responsabilité pour choses et activités dangereuse dans le projet européens*, rapport présenté aux journées stéphanoises des 27 et 28 novembre 2009.
[519] BORGHETTI J.S., *La responsabilité du fait des choses, un régime qui a fait son temps*, RTD civ., 2010, p. 1 ss. «*La préservation d'un espace de liberté au sein duquel les justiciables peuvent agir sans risquer d'engager leur responsabilité, n'est pas un objectif moins important que l'indemnisation des dommages*» *contra* BRUN PH., *De l'intemporalité du principe de responsabilité du fait des choses,* RTD civ., 2010, 487.
[520] L'arrêt du Cass., 4.11.2010 n. 9-65-947, D. 2010, 2772, obs. GALLMEISTER I. has prompted widespread the application of art. 1384, al. 1 regardless of context in which damage has been produced. Therefore, this liability is applied to damages caused by *fait de la chose* and it has residual nature.
[521] Art. 1384, al. 1, does not applied in order to accident of circulation where is applied L. 5 juillet 1985, unless their application to damages suffered by victims *par ricochet* and *au sol par l'évolution d'un aéronef* L. 6131-2 ° l. 6131-4 code des transport.
[522] OVERSTAKE J-F., *La responsabilité de produit dangereux,* RTD civ., p. 486, 1972, n. 3-13 identifies *produits dangereux* base on features of product and not by an external circumstance. When thing is dangerous court seeks whether it is deductible by its nature or features to demand particular information.
[523] Civ. 2^{e}, 17.12.1963, D. 1964, p. 569, note TUNC A.; Civ., 9.06.1939, DH, 1939, 2, p. 283.

type of role[524].To apply art. 1384, al. 1 it is not necessary that thing is or is not operated from humans[525].

The *gardien* is who «au moment de la réalisation du dommage, exerçait en toute indépendance un pouvoir d'usage, de direction et de contrôle sur la chose»[526]. The *gardien*[527] is held liable for injuries caused by thing; there is a presumption of causation[528] against the *gardien*[529], unless this latter demonstrates a *cause étrangère*.

As regards IARs, there are some doubts about the application of these above-mentioned provisions considering their growing autonomy. The first question is related to qualification of thing and consequently to power of control and direction of guardian on it.

On automated *choses* is applied Liability for thing in care, such as «les engins de chantiers les escalators, les ascenseur»[530]. IARs are *sui generis* product but they are already inanimate with regard to their autonomy, so this liability scheme could regulate tortious events.

To deal with this question, some French scholars use a French theory created with regard to complex technology products. These latter have their own dynamism and they could be considered dangerous because of their complex functioning[531]. French doctrine[532] proposed different interpretation of *responsabilité du fait des choses* when *il y a un vice inhérent à la chose et non à son gardien*.

Under this theory the *garde* should be divided in: *garde de la structure* and *garde du comportement* given that the complexity of thing's functioning. An advanced technological product has an internal functioning unknown by consumer; therefore this

[524] NAST V.M. L., *Cause en matière de responsabilité du fait des choses*, JCP, 1, 1941, p. 221.
[525] Civ., 21.02.1930, I, p. 57 note RIPERT G. even if Cour d'Appel de Lyone confirms previous sentence of Cour d'Appel de Besançon under which when thing is actioned by human art. 1382 code civil is applied; Cass., ch. réun., 13.12.1930, DP 1930, 1, p.57 note G. RIPERT.
[526] L'arrêt Franck 3.03.1936, DP 1936 p. 81 note CAPITANNT ensured the elaboration of notion of *garden*. VINEY G., *op. cit.,* 2013, n. 675-1.
[527] Liability is related to *garde de la chose*, Civ. ch. réun., 13 févr. 1930, 1, Jand'heur, D.P. 1930, p. 57, rapport Le Marc'hodour, note RIPET unlike *responsabilité du fait de la chose* which is related to chose.
[528] Civ., 9.06.1939, DH 1939, 2, p.238.
[529] L'arrêt Jand'heurè, Cass. ch. réun., 13.2.1930, DP, 1930 stated the conversion from presumption of negligence to liability one GRYNBAUM L., *Responsabilité du fait des choses inanimées,* Répertoire de droit civil, Dalloz, 2011.
[530] *Idem.,* n. 42.
[531] Versailles, 5.12.1988, D, 1988, R, p. 103 where control cannot be carried out by *gardien du comportement*. *Idem*, n. 693.
[532] GOLDMAN B., *La détermination du gardien responsable,* thèse, Lyon, 1946; *Id., Garde de la structure et garde du comportement*, Mélanges ROUBIER P., Dalloz, II, 1961, p. 51.

latter has not control on it. The *garde de la structure* is up to manufacturer who knows more about functioning of product[533] than owner/consumer, while the *garde du comportement* is up to consumer in accordance of *responsabilité du fait des choses*[534]. In the first case, victim could sue the manufacturer on the basis of product liability if product has not «la sécurité à laquelle on peut légitimement s'attendre» considering «toutes les circonstances et notamment de la présentation du produit, de l'usage qui peut en être raisonnablement attendu et du moment de sa mise en circulation» (art. 1384, al. 1 code civil). Scholars state IARs' manufacturer should adopt detailed warnings about their potential limitations included precaution measures.

This theory aims to protect third parties who should disadvantaged compared to buyer and subcontractors; however this scope has been achieved with product liability laid down by EU, so this theory seems overcome by *responsabilité des produits défectueux* which carries out a distinction between both manufacturer and user liability. This theory has also been criticised because it is hard to understand the source of defect (if it is related to *structure* or *comportment*), also because courts refuse to condemn two guardians *in solidum* (related to contractual and tort liability)[535]. Then, some scholars concern the illusory benefits of this theory, saying «c'est en réalité le propriétaire qui devrai être choisi comme gardien, parce que c'est lui qui est en principe le mieux même de prendre d'avance l'assurance destinée à couvrir les conséquences de l'usage de ses biens»[536]. Although this criticism, this theory has been proposed on IARs[537].

However, there are doubts on control and direction of IARs by guardian. This question is only related to robots having unpredictable behaviour because of their autonomy. Thus, to apply this statutory scheme we need to assess the degree of intelligence of IARs and understand whether is such that robots cannot be under guardian's control.

Italian tort doctrine[538] supposes that IARs could be considered as an animal (better a pet) because it could have similar behaviour. This qualification allows applying the liability for damages caused by animals (art. 2052 cod. civ.) against person that has

[533] L'arrêt Oxygène liquide, Civ. 5.01.1956, D, 1956, Jur. 216.
[534] VINEY G., *op. cit.*, 2013, n. 680.
[535] Cass. civ., 18 juin 1896, S., 1897, 1, p. 17, note ESMEIN A D. 1897, 1, 433, note SALEILLES concl. SARRUT.
[536] VINEY G., *op. cit.*, 2013, n. 675-1,701.
[537] LOISEAU G., BOURGEOIS M., *op. cit.*, 2014.
[538] SANTOSUOSSO A., *Diritto, scienza e nuove tecnologie*, 2011, Padova.

the availability at that moment, unless he demonstrates the Act of God.

In France, the art. 1385 code civ. lays down «que le propriétaire ou l'usager est responsable de son animal soit que l'animal fût sous sa garde, soit qu'il fût égaré ou échappé»; it requires the same conditions of article 1384, 1 al. code civil.

There is a question about this comparison. Even if IARs are able to self-moving, animals are living creatures, with emotions. In fact in France an amendment has been presented to assign feelings to animals[539].

In US, liability for physical injuries caused by use is governed through tort law. At the heart of tort doctrine is the idea that what a person sells has to be subject to certain standard of safety and fault, culpability or negligence are central concept in the law of personal injury. The core of negligence is related to idea that something the defendant did, or did not, was unreasonable in the circumstances. A key element of negligence lays the requirement that up to individuals live the standard of the ordinary prudent person. In particular cases we are prepared to tailor the standard according to specific situations (i.e. the standard are in an emergency standard is not an armchair standard: but a standard of a reasonable person acting in an emergency)[540].

The elements of negligence are duty breach, causation, and damages[541]. To establish a duty, there must be a foreseeable plaintiff and an applicable standard of care. Under the majority view, a plaintiff is foreseeable if he is within the zone of physical danger. A breach occurs when the defendant's conduct falls below the applicable standard of care. The general standard is that of a reasonable person, but not all defendants are held to the same standard. Innkeepers and common carriers, for example, are held to a high standard of care, for which the slightest negligence may qualify as a breach. Children, by contrast, are held to a lower standard.

Also American scholars supposed for IARs a proper liability to manage accidents involving it[542]. They proposed that robot should be treated as domestic

[539] Loi n. 2015-177du 16 février 2015 (Journal Officiel 17 Février 2015; REIGNÉ PH., *Les animaux et le Code civil*, JCP G, act. 242, Libres propos, 2015) has inserted art. 515-14 under which: *«Les animaux sont des êtres vivants doués de sensibilité. Sous réserve des lois qui les protègent, les animaux sont soumis au régime des biens»*.

[540] SHAPO M.S., *op. cit.*, 2003, p. 75.

[541] PROSSER W. L., KEETON W.P., *The Law of Torts,* 5th ed., St. Paul, Minn., 1984.

[542] The behavior of a semi-autonomous machine does not rise to the level of unpredictability one would expect from a wild animal. Its behavior is more like that of a well-schooled canine, which typically does as he is trained – but not always.

animals[543] for legal purposes in disputes about liability. So, the owner of an animal should have a duty of reasonable care in supervising it and in preventing the foreseeable risk of harm from either[544]. By contrast other scholars assume that animals rights and similar theories create defensive institutions, in the sense that they incorporate animals into human society to find defence against disruptive trend of the human society against animals – where in the case of robot is rather the contrary[545].

Another proposal may be to impose non-fault liability by treating the use of robots in some settings as an "abnormally dangerous activity" §520 Restatement (Second) of Torts[546]. In this regard there are similarities with art. 2050 cod. civ.

Hazardous activities theory leads to Italian scholars to state that art. 2050 cod. civ. could be used as regards robots because this norm protects all hazardous activities that are the result of scientific and technological progress. We should interpret it as a general clause including all dangerous activities *tout-court* which have not a specific regulation but are dangerous because of uncertainty of risk causing[547]. This norm is based on precautionary principle and doesn't require the assessment of costs-benefits with regard to adopted measures[548].

[543] IARs «*are more analogous to animals, which act on their own, than to everyday product, which lack meaningful autonomy. These machines are more analogous to domesticated animals, subject to negligence, than to wild animals, subject to strict liability*». *See* SCHAERER E., KELLEY R., NICOLESCU M., *Robot as Animals: A framework for liability and responsibility in human-robot interaction*, RO-MAN, 2009, p. 75.

[544] KELLEY R., SCHAERER E., GOMEZ M., NICOLESCU M., *Liability in Robotics: An international perspective on Robots as Animals*, Advanced Robotics, 2010, p. 24; McFARLAND D., *Guilty robots, happy dogs: the question of alien minds*. Oxford University Press, New York, 2008; CHOPRA S., WHITE L.F., *A Legal theory for autonomous artificial agents.* Ann Arbor. The University of Michigan Press, 2011, pp. 128-130.

[545] TEUBNER G., *Right of non-human? Electronic Agent and Animals as New Actors,* Politics and Law, Max Weber Lecture Series MWP 04, 2007.

[546] The Restatement (Second) of Torts §519 and §520 explains that the doctrine of absolute liability applies to the exercise of ultra-hazardous or abnormally dangerous activities. These activities cannot be made safe by the "exercise of utmost care". Roth v. NorFalco, LLC, 2010 US Dist. Restatement § 519 states: «*One who carries on an abnormally dangerous activity is subject to liability for harm to the person, land or chattels of another resulting from the activity, although he has exercised the utmost care to prevent the harm*».

[547] IZZO U., *La precauzione nella responsabilità civile*, 2004, Padova, p. 644 «*la natura più intima della norma analizzata, permette di affermare con sufficiente chiarezza che la regola - oltre che nel caso di attività che per loro natura o per la natura dei mezzi adoperati esprimano una pericolosità (una situazione di incertezza precauzionale) ricavabile da un'analisi cumulativa e quantitativa dei rischi noti associati alla tipologia dell'attività in questione - dovrebbe trovare prevalente applicazione quando il danno sia espressione di un pericolo legato all'ignoto scientifico-tecnologico*».

[548] *Ibidem.*

Under this aspect, art. 2050 cod. civ. and art. 1384, al. 1 code civil have the same function of general clause, such as the protection of consumers as regards new production activities that could be dangerous for them.

2. The functional approach.

Now, we are going to study civil liability by analysing its individual components on the basis of functional approach, regardless conventional categories.

2.1 Robotic risk and the precautionary principle.

Development of robots leads to questions, as regards to robotic risk that is not individuated easily because of several of these are not known. The argument on robotic risk is included in the concept of *Risikogeselleschaft*[549]. Robotic risk is a massive risk because the robot will become the future global market. The introduction of robots into several fields of society will increase the concern for global robotic risks.

This robotic risk cannot be delimited into time and space, because it is the effect of success of modernity. Robot is a system and its functioning will become very complex in accordance with the increase of its intelligence. The unawareness of robot's functioning leads to exposure of risks unknown. Therefore, the main issue is the unpredictable behavior of a robot and its impact on human health and environment.

In this scenario, you can assess the robotic risk in order to carry out economic, health and social policy, on which some scholars propose to switch from distribution of wealth to a redistribution of risks[550]. However, not every policy on robotic field can bring to zero-risks[551].

Risk related to robots is included into a specific category of risk[552], such as in that one of incertitude risks. These types of risks are unreasonable, although not yet demonstrate scientifically. Therefore, this risk is suspect but still not been identified[553].

[549] BECK U., *Risikogesellschaft. Auf dem Weg in eine andere Moderne, Frankfurt am Mein*, 1986, trad. it. *La società del rischio. Verso una seconda modernità*, Roma, 2000. LUHMANN N., *Soziologie des Risikos*, Berlino, trad.it. Sociologia del rischio, Milano, 1996.

[550] EWALD F., GOLLIER C., DE SADELEER N. *Le principe de précaution*, Paris, 2001, 86.

[551] CALABRESI G., *The Cost of Accidents. A legal and Economic-Analysis*, 1970.

[552] RUGA RIVA G., *Principio di precauzione e diritto penale. Genesi e contenuto della colpa: i contorni dell'incertezza scientifica*, Studi in onore di MARINUCCI G., a cura di DOLCINI E. PALIERO C.E., Teoria della pena. Teoria del reato, II, Milano, 2006, p. 1752 establishes three types of risks: 1) certain and unacceptable risks for which causation is demonstrate scientifically and prevention is applied; 2) remaining and acceptable risks caused by human activities and they are not supported by scientific basis. They are hypothetical risks; 3) incertitude risks.

[553] EWALD F., *Un entretien avec F.E: Après l'ère de la prévoyance et celle de la prévention nous entrons dans l'âge de la précaution*. Le Monde, 1993 states «*celui qui introduit le risque doit le prévoir et qu'en*

This is due to current robotic knowledge that does not allow carrying out an efficient risk assessment.

It is clear that the robotic risk changes in line with the improvement of its intelligence. The robotic risk will increase if the intelligence of robot will increase.

To prevent robotic risk, it is necessary an assessment of risk in order to guide regulation on robotic. The approach based on costs-benefits analysis is adopted by US[554]. EU recurred to the precautionary principle opposed to the prevention principle[555]. However, also EU is going to use the first test as shown in Communication on precautionary principle[556] and in case law *Pfizer*[557]

Prevention approach is applied about a sure scientific knowledge and a certitude risks. By applying that, damages cannot be attributed to individual tortfeasor, but to productive activity[558]. Policy makers use precautionary approach to justify discretionary decisions in situation where scientific knowledge is poor. So, this principle defines a behavioral in order to deal with risks and dangerous of "technologic unknown" when science is lacking in the matter[559]. It becomes a liability principle when it leads to allocation of resources in order to repair injuries[560].

Precautionary is different from cost-benefit analysis. In cost benefit-analysis the

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ne prenant pas suffisamment de précaution, en particulier d'abstention, il peut être déclaré responsable». ID., *Le retour du malin génie, esquisse d'une philosophie de la précaution*, in Le principe de précaution dans la conduite des affaires humaines, sous la direction de GODARI O., éd. Maison des science de l'homme, Paris, INRA, p.116 ss.

[554] Admittedly, these regulatory tools are helpful but imprecise and require the exercise of prudent judgment Executive Order 12866, Regulatory Reviews, 58 Federal Register 51735 (September 30, 1993).

[555] Prevention relates certain and immediately risks while precaution concerns a representable risks in a incertitude situation. This latter has been introduced through Treaty of Lisbon, 13.12.2007 come into force 1.1.2.2009 art. 191, 2: «Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay».

[556] COMMUNICATION FROM THE COMMISSION OF 2.02.2000 ON THE PRECAUTIONARY PRINCIPLE, Brussels, 2002.

[557] Case T-13/99, Pfizer Animal Health S.A. v. Council, 2002 WL 31337 European Court of First Instance, Sept. 11, 2002.

[558] This principle has characterized 1970s. *See* EWALD F., *The return of the crafty genius: an outline of a philosophy of Precaution*, Connecticut Insurance Law Journal, 1999, p. 48.

[559] DESIDERI J.P., *La précaution en droit privé*, D, n. 15, 2000, pp. 238-242.

[560] It arose in Germany *Vorsorgeprinzip*. In France it was criticised by MAZEAUD M., *Responsabilité civile et précaution, dans La responsabilité civile à l'aube du XXIe siècle*, RCA, n. 3, 2001: «*il tend à instaurer une responsabilité au bénéfice du doute à la charge de tous ceux qui n'auront pas adopté une conduite appropriée dans la perspective d'anticiper, de prévenir […] le simples risques susceptible de dommage qui menacent l'avenir de notre civilisation*». ARBOUR M. E., *A proposito della nebulosa. Principio di precauzione – responsabilità civile*, in Liber amicorum per BUSNELLI F. D. Il diritto civile tra principi e regole, Milano, I, 2008, p. 513.

risk is accepted whether the benefits exceed the risks. The uncertainty concerning the risk shall be treated as calculate risk. Precautionary expresses a guideline forwards safety. However, these two different interpretations have been combined by EU legislator as follows:

> «4. The precautionary principle should be considered within a structured approach to the analysis of risk which comprises three elements: risk assessment, risk management, risk communication. The precautionary principle is particularly relevant to the management of risk. The precautionary principle, which is essentially used by decision-makers in the management of risk, should not be confused with the element of caution that scientists apply in their assessment of scientific data. Recourse to the precautionary principle presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified, and that scientific evaluation does not allow the risk to be determined with sufficient certainty». (Communication from the EU Commission).

A precautionary risk assessment will be conduct in a precaution vision. This combination reduces the effects of risk assessment. This procedure does not consider the uncertainty of the risk, in fact in this evaluating an uncertain risk is considered as risk certain. In this way, the assessment of risk does not represent the reality[561].

The application of this principle is supported by Verruggio who emphasizes, «problems of the delegation and accountability to and within technology are daily life problems for everyone of us […] crucial aspects of our security, health, saving, and so on to machines. Professionals are advised to apply, in performing sensitive technologies, the precautionary principle»[562].

However, the application of precautionary to robot could lead to some issues. Some scholars concern that precautionary could cause an excessive protectionism because the risk is individuated before taking place[563]. A hard application of this

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[561] COMANDE G., *Gli Strumenti della precauzione: nuovi rischi, assicurazione e responsabilità*, Milano 2006, p. 73: «*Un'applicazione dell'analisi costi benefici non rielaborata alla luce del principio di precauzione è incapace di incorporare un'analisi qualitativa e non solo quantitativa del dato scientifico porterebbe ad un'attività produttiva che potrebbe rilevarsi presto causa di gravi e irreparabili danni alla salute umana*». STOCZKIEWICZ M., *Trading Away Citizen and Environmental Safeguards*, European Voice, 2013. She argues that strict scientific risk assessment and economic cost-benefit analysis requirements could undermine precaution principle implementation for human health and environmental regulatory purposes.

[562] VERUGGIO G., *Euron Roboethics Roadmap*., op. cit., 2006.

[563] PAGALLO U., *The laws of Robots, Crimes, contracts and Torts Law*, Governance and Technology Series 10, Netherlands, 2013 «*since the need of proving of absence of risks before taking action, rather than providing the existence of such risks, implies that inactivity would continue until a no-evidence hypothesis is falsified*».

principle could lead to an excessive protectionism, so it could stop the innovation of robotic evolution. Then only in military field the precautionary can be justified because in this field there is the alarm of catastrophic risks[564].

By contrary, the excessive protectionism of precautionary depends on how this principle is applied[565]. So, for instance policy makers shall demand if it is reasonable deny some activities, or judges shall demand if manufacturer could avoid uncertain (but probable risks) through suitable measures. The answer depends on possibility to reduce the implementation of the risk to the activity, or on the type and intensity of the risk[566].

2.2. The interplay of civil liability rules according to the sequence: tortious event/causation/damage).

Our study follows considering the elements composing civil liability function: HE*D*C= - D[567] in which: «d'un point de vue juridique, on enseigne traditionnellement que la responsabilité civile repose sur la réunion de trois conditions: le fait générateur (FG), le dommage (D) et le lien de causalité (LC)»[568].

We start to identify particular issues raised in this matter: shortage of scientific knowledge; multiplicity of causes; understanding where cause has been originated given that several components are involved and so it could be caused by different independent causes able to provoke damage.

Tortious event. Robots will have a larger application in different sectors, in particular in automotive and health sector. Their introduction within society raises some questions because of their interaction with humans thanks to their progressive evolution about their cognitive capabilities. In the next chapter we will study some of these probable harmful events which could be provoked by robot cars.

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564 LINA L. P., BEKC G., ABNEY K., *Robots in War: Issues of Risk and Ethics*, Ethics and Robotics CAPURRO R. and NAGENBORG M. (eds.), AKA Verlag Heidelberg, 2009, p. 65.

565 COMMUNICATION FROM THE COMMISSION OF 2 February 2000 ON THE PRECAUTIONARY PRINCIPLE [COM (2000)] one of purposes «is to avoid unwarranted recourse to the precautionary principle, which in certain cases could serve as a justification for disguised protectionism» art. 2, 5.

566 COMANDÈ G., *Gli Strumenti della precauzione: nuovi rischi*, op. cit., 2006, p. 65.

567 VERGES E., *Les liens entre la connaissance scientifique et la responsabilité civile: preuve et conditions de la responsabilité civile*, in Preuve scientifique, preuve juridique: la preuve à l'épreuve, LARCIER, (dir.) E. TRUILHE-MARENGO, 2011. He states : «*cette formule est plus proche de la mise en œuvre de la responsabilité civile, car les trois conditions précédemment mentionnées sont cumulatives. Si l'une d'elles fait défaut, la responsabilité ne peut être engagée. La formule suivante exprime cette défaillance lorsque le fait générateur fait défaut. Le fait générateur n'existe pas, donc: FG = 0. En équation, cela donne: 0 x D x LC = 0*».

568 *Idem*, p. 127.

From these harmful events, the major concern is on non-pecuniary and pecuniary damages to the plaintiff's person; or to person of another when harm to the other interferes with an interest of the plaintiff protected by tort law; or the plaintiff's property other than the defective product itself[569].

Robots could cause an increase of personal injuries considering that, i.e., surgical robot interacting with patient who is in a state of misery. She/he could have a trauma from this interaction, the effects of which could take place after some time, as happened with "da Vinci" system that is not an autonomous robot but only a remote control product whose degree of intelligence is poor[570].

Then, long-term damages are important as in the case of medicines which can lead to this above mentioned effects with regard to its nature or physical reaction[571].

The massive advent of IARs could also raise new types of personal and physical injuries, as happened for, i.e., *préjudice spécifique de contamination* concerning infected blood and asbestos.

In order to compensate these damages, Italian system requires «il risarcimento del danno per l'inadempimento o per il ritardo deve comprendere così la perdita subita dal creditore come il mancato guadagno, in quanto ne siano conseguenza immediata e diretta» art. 1223 cod. civ. (taken over by art. 2056 cod. civ.) as well as French system where «les dommages-intérets ne doivent comprendre que ce qui est la suite immédiate et directe du fait dommageable» (art. 1151 code civil).

In US, victims can demand compensatory and also punitive damages whether they demonstrate that tortfeasor acted with malice or gross negligence[572]; or identify punitive damages with regard to breach of safety standard[573] or to inadequate testing or

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569 *See* § 21. Definition of "Harm to People or Property": Recovery for Economic Loss For purposes of the Restatement, harm to people or property includes economic loss if caused by harm.

570 [Online] *New concerns on Robotic Surgeries*, http://well.blogs.nytimes.com/2013/09/09/new-concerns-on-robotic.

571 PITET L., *Responsabilité du fait des produits sagesse et force du lien de causalité*, Gaz. Pal., 2004, p. 869.

572 OWEN D.G., *Product liability law*, op. cit., 2008, p. 1172; SCHLUETER L.L., REDDEN K.R., *Punitive Damages* (3rd ed.). Charlottesville, VA: Michie Butterworth.§ 3.14, 1995; BENATTI F., *La circolazione dei danni punitivi: due modelli a confronto*, in Corr. giur., 2, 2012, p. 263; BUSNELLI F.D., *Deterrenza, responsabilità civile, fatto illecito, danni punitivi*, in Europa e diritto privato, fasc. 4, 2009, pp. 909-946; RICCIO A., *I danni punitivi non sono, dunque, in contrasto con l'ordine pubblico interno*, in Contr. impr., 4-5, 2009, pp. 854- 881. On statutory reforms, that improves standard of proof, in term of "preponderance of evidence" and "clear and convincing" *see* Pacific Mutual Life Insurance Co. v. Haslip 499 U.S. 1 (1991).

573 Rosendim v. Avco Lycoming. Santa Clara S. Ct. 1971 (an executive jet blows up).

quality control or to failure of warm[574].

Causation[575]. Robot is a complex system created by many traders. There are two questions, such as causation and the identification of effective tortfeasor.

The burden of proof of causation is more accessible when there is a limited number of causes and where the causation bases on the reasonable likelihood that the fact of robot causes damages.

In a pre-industrial society, the proof of causation was less complicated than today, because there was a direct perception of causation Instead, this perception does not exist in industrial society because of complexity of the method of production and the creation of new injuries (like those arising from pollution). This leads to a conversation from individual liability to allocation of damages on productive activity, included the advent of solidarity in civil liability[576].

Robots are the result of the scientific and technological progress. The actions of robots are unpredictable because their actions are the sum of several components. There is not the certitude in terms of causation between an action and an effect. The assessment of action's robot shall be carry out under a probabilistic reasoning through the current technological and scientific knowledge when tortious event occurs.

Robots give raise the same issues raised by other products of technological progress. To ensure the evaluating of causation, Courts used the proof for presumptions as long as they are serious, precise and concordant[577]. In this way, Courts interpreted existing norms on civil liability by developing causal presumption in order to facilitate the burden of proof to victim[578].

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[574] PONZANELLI G., *I punitive damages, il caso texano e il diritto italiano,* in Riv. dir. civ., II, 1997.
[575] The shift based on different function of civil liability aims to compensation of damages leading to probabilistic causation. PONZANELLI G., *La responsabilità civile, Profili di diritto comparato,* Bologna, 1992, p. 60.
[576] COMANDÈ G., *Gli Strumenti della precauzione: nuovi rischi,* op. cit., 2006, p. 67: «*in questa logica si è consumato il passaggio al secondo e al terzo scenario segnalato: una più il paradigma dell'immediata percezione della causalità […] ma il paradigma causale della conoscenza e del controllo dei rischi con conseguente responsabilità per la loro materializzazione (il paradigma del rischio esternalizzato). l'espansione del raggio operativo della responsabilità civile che e consegue è immediata e senza limiti […]. Il carattere normativo dell'attribuzione della responsabilità per il rischio a cui si espongono terzi è evidente e di difficile riscontro empirico* […]».
[577] Cass. 25.05.1964, n. 1070 in FI, 1965, I c. 2098; MARTORANO F., *Sulla responsabilità del fabbricante per la messa in commercio di prodotti dannosi (a proposito di una sentenza della Cassazione)*, in FI, V, C. 1966, p. 31.
[578] LE TOURNEAU PH., *Droit de la responsabilité civile et des contrats. Regime d'indemnisation,* 10 éd., n. 1711, 2015, p. 699. He establishes a series of hypothesis where causation between harmful event and damage is presumed, among these art. 1384, al. 1er c.c. (implied presumption of causation).

In particular, the causation in-fact is uncertain[579]. There are several causes of damage and it is not possible a division of damages among multiple sources of risks. Consequently, plaintiff is not able to reduce the damage to a specific tortfeasor.

In this scenario, the distinction between cause in fact and legal causation is not always convenient. Therefore, these two causation periods – factual and legal – should be interpreted in a different way. In case of incertitude - caused by complexity of causes and the difficult to understand their origin – it is not easy to identify the causation in fact, thus as legal causation. This difficult require to circumscribe the extension of civil liability through the identification of precondition of civil liability [580]. These preconditions allow dealing with the complexity of functioning robot.

To guide this operation, precautionary principle may be helpful. It aims to protect health before and independently to achieve of knowledge able to exclude or affirm the existence of damages[581].

The application of this principle to cause-in-fact could lead to incertitude results for victims, because it may cause an increase of causes linked to injuries[582]. Instead, the application of precautionary to legal cause could help to select the duty of prevention that manufacturers have. This allows understanding if manufacturer could represent the risk of damage and to prevent it through adequate measures. This approach gives a fundamental role to concept of "preventable risk"[583].

Probability of occurred harmful event - when it can be reasonable conceivable - enables to avoid or limited damages by manufacturer. This interpretation leads to different results.

As regards to juridical consequences, there is a reversal of burden of proof. Manufacturer shall prove that robots are not dangerous for health of consumers. European Commission confirms this reversal of burden of proof. It says that: «where

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[579] STEIN A., PORAT A., *Tort Liability under Uncertainty.* Oxford, University Press, 2001. They study the allocation of civil liability in case of uncertainty.

[580] *See* COMANDÈ G., *Gli Strumenti della precauzione,* op. cit., 2006, p. 67. CARNEVALI U., *Dei fatti illeciti*: Art. 2043, Art. 96 c.p.c, in GABRIELLI E. (diretto da) Commentario del Codice Civile, Torino, 2011, p. 410; COMANDÈ G., *Gli Strumenti della precauzione,* op. cit., 2006, p. 67.

[581] PUCELLA R., *L'incerta causalità nella prospettiva del civilista,* in Il nesso d causalità. Profili giuridici e scientifici, a cura di PUCELLA-DE SANTIS, Padova, 2007, p. 93.

[582] In this terms COMANDÈ G., *Gli Strumenti della precauzione,* op. cit., 2006, p. 67 «*In un quadro in cui si applica il principio di precauzione, la dimostrazione del nesso di causalità materiale non dà, di per se, adito a responsi certi*».

[583] On this reconstruction, see IZZO U., *La precauzione*, op. cit., 2004, p. 40.

such a prior approval procedure[584] does not exist, it may be for the user, a private individual, a consumer association, citizens or the public authorities to demonstrate the nature of a danger and the level of risk posed by a product or process. Action taken under the head of the precautionary principle must in certain cases include a clause reversing the burden of proof and placing it on the producer, manufacturer or importer». However, Commission states that this «obligation cannot be systematically entertained as a general principle. This possibility should be examined on a case-by-case basis when a measure is adopted under the precautionary principle[585], pending supplementary scientific data, so as to give professionals who have an economic interest in the production and/or marketing of the procedure or product in question the opportunity to finance the necessary research on a voluntary basis»[586]. Commission considers that the application of precautionary principle lead to a reversal of the burden in some cases[587].

Then, both the precaution interpretation of norm and civil liability lead to a balance of compensation and prevention function of civil liability. Robot manufacturers are encouraged to improve their knowledge with the aim of not being liable. Damaged obtains the compensation for injuries suffered.

Finally, a precautionary rules is created, in fact «si disegna una regola precauzionalmente di necessità transitoria giacché con l'aumentare delle conoscenze scientifiche l'attribuzione causale […] cambierà (la effettiva ricostruzione eziologica della stessa a cui consegue una diversa attribuzione del danno) spostando gli equilibri

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[584] *Ibidem* says that «*Il principio regolativo della autorizzazione preventiva - in base al quale compete al soggetto passivo dell'attività regolamentare di provare, adducendo le necessarie evidenze scientifiche, la sicurezza della sostanza che intende immettere sul mercato - risulta così operante in settori ben individuati, come per esempio quelli delle sostanze medicinali per uso umano, degli antiparassitari e degli additivi alimentari*».

[585] *Ibidem*, p. 40 «*Ma negli altri casi, ovvero nella più parte dei settori regolamentati da Bruxelles, ove questo tipo di approccio regolamentare farebbe collassare la libera iniziativa economica e genererebbe enormi costi transattivi, imponendo di verificare preventivamente e caso per caso la bontà delle allegazioni dei richiedenti, l'onere della prova scientifica della pericolosità grava in capo a chi (autorità pubblica, associazione di tutela dei consumatori, etc.) abbia motivo di ritenere che il prodotto o la sostanza già immessa sul mercato (o l'attività esercitata) in un dato settore debba essere assoggettata a limiti più stringenti (fino all'ipotesi estrema dell'adozione di un provvedimento inibitorio) in ragione della sua ritenuta pericolosità*».

[586] COMMUNICATION FROM THE COMMISSION OF 2.02.2000 ON THE PRECAUTIONARY PRINCIPLE [COM(2000)].

[587] *Contra* FOSTER C., *Scientific Evidence and the Precautionary Principle in International Courts and Tribunals*, Salmon Lecture, 2010, p. 69: «*where quantitative evidence is not available, the standard of proof for the government shifts from causation to correlation. In this process, scientific experts are to facilitate greater understanding of the multiple "dimensions of mixed questions of fact and law that frequently characterize scientific disputes." Furthermore, regulatory decisions remain open, non-final and subject to continuous reassessment pending new scientific developments*».

attributivi del rischio avverato con il trasformarsi dello stesso da rischio potenziale a rischio avverato».[588]

In this way, causation evolves in line with precautionary principles. Causation is assessed between damages and the failure to adopt prevention measures, in view of precautionary principle. This is the point of conjunction with traditional categories and scientific and technological progress.

Many manufacturers built a robot. To deal with the multiplicity of tortfeasors, the *obbligatio in solidum* (joint and several liabilities) is adopted[589]. So, a person subjecting to solidary liability may recover a contribution from any other person liable towards the victim in respect of the same damage. This right is without prejudice to any contract among the responsibles determining the allocation of the loss or to any statutory provision or to any right to recover by reason of subrogation or on the basis of unjust enrichment[590].

The jointly and severally liable requires an indivisible damage, otherwise every author responds to their damage. There is a *fictio iuris* with regard to the origin of the damage which is considered caused by all co-authors[591]. Individual author is held liable (presumption of causation[592]).

This *fictio iuris* does not consider the effective causation in respect of individual co-authors in order to compensate victim[593]. The cause-in-fat is not proven. Instead, legal causation replaces and precedes the factual causation.

However, if this *fictio iuris* facilitates the compensation in favor of victims, it

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[588] COMANDÈ G., *Gli Strumenti della precauzione*, op. cit., 2006, p. 72.

[589] In France *see* Civ., 11.07.1892, D, 184. 1. 561, note LEVILLAIN; Civ. 2ème, 2 juillet 1969, Gazz. Pal. 1969, 2.311; CHABAS F., *Remarque sur l'obligation in solidum*, RERTD Civ., 1967, p. 113 ; CORGAS-BERNARD C., *La pluralité de responsables en droit français et dans d'autres ordres juridiques nationaux*, Recueil des travaux du GRERCA, IRJS éditions, 2012, p. 19 ss. The *obbligatio in solidum* is not inherent to causation, but it gives to victims a guarantee. Every co-author is sorts of caution each other, *ex* art. 2 l. 1985. GROUTEL H., *La pluralité d'auteurs dans un accident de la circulation*, Dalloz, chron., 1987, p. 86. BUSNELLI F.D., *L'obbligazione soggettivamente complessa. Profili sistematici*, Milano, 1974, p.140 ss.

[590] This principle has been adopted in PETL, art. 9:102, paragraph 2: «Subject to paragraph (3) of this Article, the amount of the contribution shall be what is considered just in the light of the relative responsibility for the damage of the persons liable, having regard to their respective degrees of fault and to any other matters which are relevant to establish or reduce their liability. A contribution may amount to full indemnification. If it is not possible to determine the relative responsibility of the persons liable they are to be treated as equally responsible». PETL, art. 3:103. Les Principes européens du droit de la responsabilité civile, textes et commentaires, O. MORETEAU (dir.) Soc. législ. Comp., 2011, p. 203.

[591] QUEZEL-AMBRUNAZ V.C., *op. cit*., says of «*fiction de la causalité alternative et de ses bornes*».

[592] BRUN PH., *Les présomptions en droit de la responsabilité civile*, th. Grenoble, 1993, p. 90 ss. in doctrine some scholars state that it is «*responsabilité collective*».

[593] MEURISSE R., *Le décline de l'obligation in solidum*, D, chron., 1962, p. 243. MIGNOT M., *Les obligations solidaires et les obligations in solidum en droit privé français*, Dalloz, 2002.

does not solve the allocation of liability among manufacturers. Manufacturers shall prove causation with the aim to shared liability among them.

To deal with the shared of liability among manufacturers, a French doctrine created a method to build an advanced technological system. This system is composed by several components and each component has a black box, which records the functioning of an individual component. Then, the burden of proof is regulated through a contract.

They consider a technological system composed by a limited number of component produced by different manufacturers[594]. Manufacturers also create a black box for every component. The operations of every component are recorded (*enregistrement des traces*) and the operations are analysed by an analyser. This analyser is identified by manufacturers in a contract in which manufacturers may map out a recording procedure and identify a third party. This third-party should pick out and analyse data in accordance with principles of evidence established by law.

They image a global system - that corresponds to the technological system – and a series of individual technological systems – that correspond to single components -. To enable a coordinate functioning of these systems, they created three elements. The first element is a «contrats informatique complexes». The second element is a «cahier des charges dans les contrats informatique complexes», where «comportement attend des composantes et diffèrent typologie des disfonctionnement» are written. Finally, the third element is a «convention de prévue dont il y a la constitution des processus d'obtention de preuves e le choix volontaire de leur voleur ajoutent un niveau de prévisibilité dans la relation contractuelle»[595].

The creation of this project aims to ensure «l'extraction et l'analyse de log – que peuvent être réalisé par un tiers; l'intégrité des données; la conservation du log; la description des processus de collecte; l'enregistrement et l'extraction d'analyse des log doit être décrite techniquement dans la convention de preuve»[596].

They regulate causation in advance. They consider two causations, in vertically

[594] GOSSLER G., LE METAYER D., RACLET J.B., *Causality Analysis in Contract Violation*, in RV, LNCS, Springer-Verlag, 2010, p. 271.
[595] STEER S., CRAIPEAU N., LE METAYER D., MAAREK M., POTET M.L., VIET TRIEMTONG V., *Définitions des responsabilités pour les dysfonctionnements de logiciels: cadre contractuel et outil di mise en œuvre*, in VERGES E., editor, Actes du colloque Droit, sciences et techniques: quelles responsabilités, LITEC, collection Colloques et Débats, 2011, p. 135.
[596] GOSSLER G., LE METAYER D., RACLET J.B. *op. cit.*, 2010.

and in horizontal direction. Vertical causation refers to relation between global system and individual components. Horizontal causation refers to the relation between individual components. As regards vertical causation, they identify three causation notions, such as weak, necessary and sufficient causality where the first one «is exact if the suffixes are sufficiently long to contain an interaction between the considered components». Instead, «the necessary and sufficient causality depend on the satisfaction of a contract and/or a guarantee by some prefix»[597].

In case of failure, two observers - used for every component - include a Boolean flag. This allows understanding what the causes of failure are. In addition, the contract that regulates the burden of proof among manufacturer aims to avoid the excessive costs and time of a process. This idea is original, however it requires supporting many costs to be realised. In addition, the proof related to dynamic of facts shall be respected the principles about the implementation of the proof.

Jointly and severally liable theory is not considered in US system, where Restatement (Third) of Torts §17 states: « […] (b) the manner and extent of the reduction under Subsection (a) and the apportionment of plaintiff's recovery among multiple defendants are governed by generally applicable rules apportioning responsibility». This option does not allow facilitating consumer who, instead, in continental system once he proves the causation between harmful events and damage this latter is up to defendants. These latter should litigate among themselves to divide the liability.

However, the liability between manufacturers is shared based on market share liability. In accordance with this theory, manufacturers respond on basis of their quote of market. This theory raises some issues, i.e. who shall sue other tortfeasors, who shall respond in case of failure by some tortfeasors. Then, consumer could have some questions on quantity of product put into circulation[598].

Now, solidarity principle solves the question related to compensation of victim. However, the division of liability among manufacturers may be deal with precautionary. Based on precaution logic, damage may be shared between manufacturers in proportion to prevention measures that manufacturers should adopt. This solution ensures both prevention function and the financing in innovation.

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[597] VINEY G., JOURDAIN P., *op. cit.*, 2013, n. 277.
[598] Sindell v. Abbott Labs., 26 cal. 3d 588, 607 P. 2d 924, 163 (Cal. 1980).

The contributory conduct of victim. In robotic field, contributory conduct or activity of the victim has an important role, because of interactivity between robots and consumers and their influence on IAR's performs.

So, we demand how victim's conduct could influence civil liability judgement. It is obvious this question shows up in particular, with semi-autonomous robots, i.e. the current robot cars.

Principles of European Tort law state: «(1) Liability can be excluded or reduced to such extent as is considered just having regard to the victim's contributory fault and to any other matters which would be relevant to establish or reduce liability of the victim if he were the tortfeasor» (art. 8:101 PETL). This article is limited to strict liability.

In Italy, art. 2055 cod. civ. establishes a jointly and severally liability among tortfeasors: and art. 1227 cod. civ. (taken over by art. 2056 cod. civ) lays down a diminution of compensation in case of contributory conduct of victim: «Se il fatto colposo del creditore ha concorso a cagionare il danno, il risarcimento è diminuito secondo la gravità della colpa e l'entità delle conseguenze che ne sono derivate».

The same situation is in France[599] where art. 1147 code civil states debtor is not held liable when «l'inexécution provient d'une cause étrangère qui ne peut lui etre imputée», (also applied to art. 1384, al. 1, 4, 5[600]). This is because «plus la faute de la victime est grave plus son indemnité est diminuée on fait une compensation des fautes, l'idée qui explique la diminution de l'indemnité par suite de la faute de la victime este […] sanctionner la conduite de celui qui a manqué au devoir de veiller à sa propre sécurité»[601]. In France l'arrêt Desmarque required that the conduct of victim shall be characterized by the same feature of force majeure. «L'effet de la faute de la victime est en principe d'exonérer partiellement le défendeur de sa responsabilité, ce qui se traduit par un partage de responsabilité, sauf en présence d'une faute intentionnelle où *l'exonération pourrait être totale*»[602].

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[599] VINEY G., JOURDAIN P., *op. cit.*, 2013, n. 426-1, there is an exemption for victims of accident *ex* art. 3-6 Loi Badinter.

[600] *Ibidem*, n. 383

[601] STARCK B., *La pluralitè des causes de dommage (la vie brève d'une fausse équation: causalité partielle = responsabilité partielle)*, JCP, I, 1970, n. 39-40.

[602] SABARD O., *Les causes d'exonération en droit français et dans d'autres ordres juridiques nationaux,* Travaux issus des premiers séminaires Droits nationaux et projets européens en matière de responsabilité civile organisés par le GRERCA, 2010.

In US Restatement (Third) of Tort states §17:« (a) A plaintiff's recovery of damages for harm caused by a product defect may be reduced if the conduct of the plaintiff combines with the product defect to cause the harm and the plaintiff's conduct fails to conform to generally applicable rules establishing appropriate standards of care. […]». Consumer is held liable if he uses a conduct contrary to the product's function or he was distracted during using of product. Therefore, he does not use the product in a foreseeable manner. When these elements are shown as proximate cause of injuries, they will influence the final determination of liability.

The contributory conduct of victim has not a uniform application in US States. Only four States and the District of Columbia recognize the Pure Contributory Negligence Rule. In this case, a damaged party cannot recover any damages if it is even one percent fault. The jurisdictions, which employ the Pure Contributory Negligence Rule, include Alabama, District of Columbia, Maryland, North Carolina, and Virginia. Thirteen states recognize the Pure Comparative Fault Rule, which allows that a damaged party may recover even if it is 99 percent at fault, although the recovery is reduced by the damaged party's degree of fault». These States include Alaska, Arizona, California, Florida, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, New York, Rhode Island, South Dakota, and Washington[603].

[603] Coats v. Penrod Drilling Corporation and Anr - US Court of Appeals (5th Circuit) (Politz CJ and 15 other judges) - 61 F 3d 1113 (5th Cir) 1995.

CHAPTER V
ROBOTIC CIVIL LIABILITY IN CONTEXT: THE CASE OF SMART CARS.

TABLE OF CONTENTS:

The current chapter studies civil liability with regard to one robotic field, such as smart cars. I would first like that circulation of car is both dangerous and useful activity. In particular it is dangerous because it leads to harmful implications even if driver's behaviour is compliance with duty of diligence and cars are not defective.

On basis of chapter III, we can say it cannot be ensured the safety absolutely, by contrast a car with optimal-non-perfect-safety[604].

In relation to semiautonomous car there is a combination between robotic and human driver. This interaction is not defined, because it is still not clear the kind of attention required to drivers. In addition, it is not clear if driver should have the same level of attention while driving or there is a distinction in relation to different steps of driving (for example overtaking manoeuvre). This uncertainty has the effect on the application of liability schemes, such as the standard of negligence required to human driver.

Fully autonomous robots give raise several issues because the only driver will be the car. This situation will lead to fully liability of manufacturers on the bases of current liability category unless a new statutory scheme will be adopted.

1. The law of civil liability and insurance applied to road traffic accidents: the traditional framework.

Before dealing with liability law to road traffic accident we anticipate that drivers are obliged to conclude insurance in order to mitigate the damages caused by a car crash.

1.1. Italian law

[604] OWEN D.G., *Product Liability Law*, 2008, p. 1134.

The referenced norm of civil liability applied to road traffic is the art. 2054 cod. civ.[605] contained into general part of the code which excludes both unforeseeable and intentional accident.

Art. 2054 cod. civ. states: «il conducente di un veicolo senza guida di rotaie è obbligato a risarcire il danno prodotto a persone o a cose dalla circolazione del veicolo, se non prova di aver fatto tutto il possibili per evitare il danno». The liable could be the car's owner, tenant for life and the user, who are jointly and severally liable with owner. This jointly and severally liability aims to protect victims who can identify parties responsible, easily.

Originally, Italian doctrine interpreted this norm as liability based on driver's fault by refusing a statutory strict liability scheme. This interpretation complicated the compensation of victims, so the burden of proof of the driver's fault[606] was reversed. Consequently the proof of driver's negligence is supposed in absence of evidence on the contrary[607], such as i.e. the conduct of driver has been caused by Act of God.

In this way, the negligence theory becomes object of a fault presumption, based

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[605] Art. 2054 – reproducing previous provisions included into art. 79, r.d. 31.12.1923, n. 3043 that regulates circulation on public road and public areas, then transfused in art. 120 r.d.l. 2.12.1928 n. 3179 and after in art. 120, r.d. 8.12.1933, n. 11740 Testo Unico delle disposizioni per la tutela delle strade e per la circolazione – did not adopt substantial amendments. BRASIELLO T. (1959). *I limiti della responsabilità per danni,* Milano, p. 83.

[606] Originally art. 2054 c.c. was interpreted as liability based on driver's fault *see* BARBERO D., *Criteri di nascita e criteri di propagazione della responsabilità per fatto illecito*, in RDC, 1960, p. 580; PERETTI G., DOMENICO R, *La responsabilità nella circolazione,* Torino, 1959, p. 178; BRASIELLO T., *op. cit*., 1959, 80; POGLIANI M., *Responsabilità e risarcimento da illecito civile*, Milano, 1969, p. 189, DE CUPIS A., *Dei fatti illeciti*, in Commentario del codice civile a cura di SCIALOJA-BRANCA, Bologna-Roma, 1971, p. 100. Doctrine and courts interpreted «*l'obbligo di compiere tutto il possibile per evitare il sinistro*» as an aggravation of duty of diligence justified by harmfulness of the vehicle's use. Obligation *ex delicto* based on defendant's negligent behavior and it spreads to persons who is a qualification position regarding tortfeasor *ex* art. 2047, 2048, 2050 co. 3 or regarding the source of compensable prejudices art. 2050, 2054 c.c. Driver has to comply with provisions of route code or behavioral of common prudence; to adopt necessary emergency manoeuvres and to provide other drivers' negligent. Art. 2054 c.c. seemed to confer importance to definition of *colpa lievissima*, understood as diligence to its furthest extreme that is receivable by defendant. DE CUPIS A., *op. cit.*, 1971, p.183; CIGOLINI F., *La responsabilità nella circolazione stradale*, Milano, 1963, p. 790. To pretend a maximum diligence standard by driver (included every measure related to avoid accident), a yardstick of behavior has been introduced. Therefore, it is possible to pretend by driver a diligent behavior and not an effort of prudence FORCHIELLI P., *Colpa (diritto civile)*, in EG, VI, 1988, 4. Finally, art. 2054 states an hypothesis of aggravate liability based on fault. BIANCA C.M., *La responsabilità*, in Diritto civile. Milano, 1994, p. 687. The reconstruction of theories about art. 2054 c.c. is taken from FORTUNATO G., *Assicurazione e responsabilità nella circolazione stradale: problematiche generali e questioni applicative,* Milano, 2005.

[607] Evidence could be directly through the prove of driver's no-fault behavior or conform with rules of Highway code or indirectly through evidence of interference of a causal factor imputable to victim of crash car or third party, *see* Cass. 17.4.1997, n. 3309, AGCSS, 1997, 692.

on danger of the circulation[608]. Only driver may avoid accident because he is able to control the vehicle. This approach leads to improvement of behavioural duties of driving into Highway Code and consequently driver has to ensure safety while driving.

Nowadays, some courts adopt a different approach. By studying judgments on liability of road traffic, the driver's liability is not based on fault. It requires the evaluating of accident's procedure and the imputation of its implications of the accident depends on causal relevance of drivers' fact with regard to injuries[609]. This approach is justified because of hazardous nature of circulation of vehicles. In fact car's owner or driver are held liable regardless their negligent behaviour[610]. Hence, the art. 2054 cod. civ. is a specific rule of art. 2050 cod. civ.[611].

In case of collision among cars the art. 2054, 2 co. lays down that « […] si presume, fino a prova contraria, che ciascuno dei conducenti abbia concorso ugualmente a produrre il danno subito dai singoli veicoli». The Italian legislator states that in case of many drivers, their conducts are equal unless evidence on the contrary is given.

There are different cases of car crash involving different driver's behaviour, such as emergency manoeuvres, where these latters shall be carried out prudently, according to the circumstances and evaluate on the basis of a prognostic analysis *ex ante*[612] tortious event. The factor of risk could be announced from whether conditions, or other drivers' reckless conduct, or pedestrians' behaviour under which driver should adopt adequate emergency measures[613].

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[608] SALVI C., *Responsabilità extracontrattuale: diritto vigente* in ED, XXXIX, p.1247; CORSARO L. (1989). *Responsabilità civile*, EG., XXVI, 1988, p. 32.

[609] BORDON R., ROSSI S., TRAMONTANO L., *La nuova responsabilità civile. Causalità, Responsabilità oggettiva, Lavoro,* UTET, 2010, p. 633.

[610] FRANZONI M., *L'illecito*, in Trattato della responsabilità civile diretto da FRANZONI, 2 ed., Milano, 2010, p. 649 ss.; BONA M., *La responsabilità civile per i danni da circolazione di veicoli,* 2010, Milano.

[611] IZZO U., *La precauzione nella responsabilità civile*, op. cit., 2004, p. 651. «*La prima [art.2054] è una norma tecnologicamente tipica, è rivolta ad un soggetto ben identificato ("il conducente") ed individua un'attività specifica ("la conduzione di un veicolo senza guida di rotaie"), focalizzandosi così su un'attività individualmente rischiosa, ritenuta, però, in base ad una valutazione normativa, socialmente pericolosa (l'art. 2054, primo comma, c.c.). La seconda norma, l'art. 2050 c.c., assume invece le vesti di una clausola generale, nel senso che la valutazione normativa in essa espressa è tecnologicamente atipica, rivolgendosi ad una gamma indefinita di attività, etichettate pericolose tout-court, che il giudice è chiamato ad individuare[…]*».

[612] Cass. 5.5.2000, n. 5671, Giust. Civ. Mass., 2000, 942.

[613] Cass. 10.10.1968, n. 3197, Riv. Giur. Circ. 1969, 233, Cass. 10.03.1972 n. 686, Giust. Civ. 1972, I, 2042; Cass. 16.12.1968 n. 4040, Riv. Giur. Circ., 1969, 341.

Act of God is the exonerating evidence [614] that is characterized by unpredictability and inevitability. The Act of God excludes the liability for manufacturing defect, in fact the art. 2054, co. 4 lays down that: «In ogni caso, le persone indicate dai commi precedenti sono reponsabili dei danni derivati da vizi di costruzione o da difetto di manutenzione del veicolo», unless driver demonstrates that the failure would not have been avoided through normal controls[615].

This provision facilitates defendant's burden of proof. However, it does not exclude the manufacturer's liability. The fourth paragraph contains the liability of driver (and others) to third parties and refers to product liability indirectly [616].

B. *Insurance law*. Circulation of vehicles is a dangerous activity that could cause damages against third parties. To protect these latter, drivers are obliged to stipulate an insurance coverage. This duty was introduced through l. 990/1969 "Assicurazione obbligatoria della responsabilità civile derivante dalla circolazione dei veicoli a motore e dei natanti" that was transposed into d.lgs. n. 209/2005 (Code of Insurance). Under this law, car's owner is obliged to conclude an insurance agreement, which corresponds to minimum requirements *ex* art. 2054 cod. civ.

In 2006, d.P.R. 18 luglio 2006 n. 254 entitled «Regolamento recante disciplina del risarcimento diretto dei danni derivanti dalla circolazione stradale, a norma dell'articolo 150 del decreto legislativo 7 settembre 2005, n. 209» coordinates the application of direct compensation (risarcimento diretto). This decree establishes that «il destinatario della richiesta di risarcimento viene individuato nell'impresa di assicurazione che ha stipulato il contratto relativo al veicolo utilizzato» (art. 148.) In case of accident the art.149 lays down that «in caso di sinistro tra due autoveicoli identificati ed assicurati per la responsabilità civile obbligatoria, […], i danneggiati devono rivolgere la richiesta di risarcimento all'impresa di assicurazione che ha stipulato il contratto relativo al veicolo utilizzato». Finally, the victim can demand the compensation to insurance company of driver who is liable (art. 144 cod. ass. priv.).

In this way, there are two principles in Italian insurance system. Who caused the accident is obliged to pay damages and the indirect compensation (*risarcimento diretto*).

[614] COTTINO G., *Caso fortuito e forza maggiore*, in ED, VI, 1960, p. 383.
[615] Cass. 24.7.1971, n. 2465, Resp. civ. prev., 1972, 402.
[616] ALPA G., *Costruzione di autoveicoli, clausole di esonero e responsabilità dell'impresa. Per una diversa lettura dell'art. 2054, ultimo comma, codice civile*, in Giur.it., I, 1975, p. 751; CARNEVALI U., *La responsabilità del produttore*, Milano, 1974, p. 42.

Our insurance system has the advantage to provide the mechanism of experience rating, such as the bonus/malus system. The liable supports both the costs of the damage suffered for their negligence and the increase of the insurance premium. This leads to reduction of subsidies given to the categories that are alleged dangerous[617].

However, this system raises some issues. It encourages moral hazard behavior intended to overestimate the damage and, therefore, the compensation. This situation takes place because of the contractor and insurance company. Contractor of insurance considers that insurance coverage is a requirement for the car circulation, while the premium allows the transfer of the risk on the insurance. The insurance company considers that the amount of compensation required by the damaged is not realistic, because the damaged is not its insured. This system encourages counterproductive behaviors, because the damaged will bloat the amount of damage. Instead, insurance company will believe that the compensation claimed is excessive. These behaviors lead to the solution of the litigation[618].

1.2. French law.

Loi sur les accidents de la circulation du 5 juillet 1985 (Loi Banditer)[619] states a strict liability. It is a combination of civil liability and automatic compensation and it covers personal injuries while other types of injuries are regulated by common rules[620].

This law creates a compensation system of the victims on the basis of insurance (art. 211-2 Code des assurances) that is compulsory and it covers the liability of the guardian and the driver towards anyone injured. This system functions thanks to

[617] BUZZACCHI L. SIRI M., *Efficienza ed equità nell'assicurazione r.c.a.: ri-regolamentare per liberalizzare?*, in Mercato, concorrenza, regole, 2002, 413.

[618] These observations are of PARDOLESI P., *La disciplina del risarcimento diretto dei danni da circolazione stradale*, Danno e resp., 2007, 3, 249: «*Le conseguenze negative - sotto il profilo dell'efficienza - paiono inevitabili. Tale impostazione riduce gli incentivi alla concorrenza tra le imprese in quanto, in primo luogo, l'interesse ad intervenire sulla qualità del servizio è fortemente ridotto dalla consapevolezza che i benefici offerti verrebbero goduti dai clienti di altri imprese piuttosto che dai propri*».

[619] Before Law of 1985, *responsabilité du fait des choses* (art. 1384, al. 1) was applicable to crash accident. In 1964, a commission was nominated to deal with liability for crash cars, but its proposals were criticized. In 1981, a new commission was nominated, but only Cassation, with arrêt DESMARES 21.07.1982 leads to legislator to adopt law of 1985.

[620] For autonomy of Loi Badinter *see* Trib. inst. Fréjus 2 décembre 1985 (Gaz. Pal. 1er mars 1986, 14 et note F. C.); Trib. Gr. Inst. Nancy, 20 janvier 1986 (Gaz. Pal. 13 mars1986, somm., JCP. 1986, II, 20599 et note F. Chabas), *contra* Dijon, 25 septembre 1985 (Gaz. Pal. 1985, 2, 602): application de l'article 1384, alinéa 1er pour les dommages matériels (eux seuls?) d'un cycliste; Amiens, 24 octobre 1985 (Gaz. Pal. 11 mars 1986, 26, et note F.C.): article 1384, alinéa 1er et article 3 de la loi Chambéry 12 novembre 1985 (Gaz. Pal. 1985, 2, 766; D. 1986, 201 et note F. CHABAS); Trib. Inst. Antibes 24 janvier 1986 (Gaz. Pal. 1er mars 1986, somm. 14).

compulsory insurance on motorized land vehicles (*véhicules terrestres à moteur* - VTM). If the compensation is not possible, a compensation fund supplements the first system.

This system moves away from civil liability principles with the aim to speed up the compensation procedure, so all victims of road traffic accidents are compensate unlike the driver suffering injuries. This system requires three elements, such as a car crash, *véhicules terrestres à moteur* and the involvement of car.

There is not a definition of crash car; however courts assume that the accident is an unexpected and casual event. This notion is large and it excludes voluntary accidents.

Drivers are those who control the vehicle at the moment of accident from beginning to end and they are held liable even if the vehicle is stationary or it is towed and the victim could be another driver or a pedestrian. In case of plurality of drivers, every one of them can demand the compensation against others, and their negligent contributory could reduce or exclude the compensation. This law shall apply « […] même lorsqu'elles sont transportées en vertu d'un contrat, aux victimes d'un accident de la circulation dans lequel est impliqué un véhicule terrestre à moteur ainsi que ses remorques ou semi-remorques, à l'exception des chemins de fer et des tramways circulant sur des voies qui leur sont propre».

The involvement of a car requires two situations, such as the collision or the contact among vehicles[621] and its sense is larger than the sense of the causation because the contact is sufficient to create the harmful event.

However, to identify causation courts established some presumptions when damages take place at accident time, in particular the involvement of vehicle would indicate the causation between car crash and damage, unless the evidence on the contrary given by driver. But the questions occur when many vehicles are involved in a road traffic accident and a chain reaction has been caused (accident complex). Courts[622]

[621] Cass. 2e civ., 23.03.1993, Dalloz, 1994, p. 229 (liability for every driver involved in crash accident when its car meets other cars). Cass. 2e civ. 2, 25.01.1995, D, 27 (it is necessary driver is involved in accident, while VTM can be stopped or acting).
[622] Cass. 11.07.2002, Bull. civ. II, n. 160 on a chain accident among five cars causing damage to a passenger. Cour d'appel states «*les différentes séquences de l'évènement accidentel étaient parfaitement divisibles et cet événement ne devait pas être appréhendé dans sa globalité*». Court of Cassation, on the contrary, states liability of all vehicles : «*tous les véhicules étaient impliqués dans l'accident complexe*».

decide that all involved vehicles are liable, unless the evidence on the contrary[623].

Art. 2 states «Les victimes, y compris les conducteurs, ne peuvent se voir opposer la force majeure ou le fait d'un tiers par le conducteur ou le gardien d'un véhicule mentionné à l'article 1[e]». It excludes clauses of exemptions (also the contribution of third parties) unless the accident is caused by victim's fault (*faute volontaire d'une exceptionnelle gravité).*

The victim can be the driver or other people. In the first case «la faute commise par le conducteur du véhicule terrestre à moteur a pour effet de limiter ou d'exclure l'indemnisation des dommages qu'il a subis» (art. 4). Courts can decide to exclude the compensation in favor of driver when the driver's fault is particularly serious, for instance when driver is under the influence of alcohol or drugs at the accident time (even if this state did not cause the accident)[624].

If the accident has been caused by drivers' grave fault, the compensation in favor of driver does not take place. Grave fault means the consciousness of risks related to a specific behaviour[625]: «les victimes, hormis les conducteurs de véhicules terrestres à moteur, sont indemnisées des dommages résultant des atteintes à leur personne qu'elles ont subis, sans que puisse leur être opposée leur propre faute à l'exception de leur faute inexcusable si elle a été la cause exclusive de l'accident» (art. 3, 1 al.).

Finally, in the case of plurality of cars involving in a road traffic accident, Courts recognize to every driver the right of action against others involving in car crash and if the driver is guilty, his compensation will be reduced or excluded.

1.3. U.S. law.

In American legal system drivers are held liable for injuries caused by their car. Theories of negligence or strict liability, including no-fault statutes, are applied to car crash.

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[623] Cass., 2 civ., 17.06.2010, n. 09-67338, Resp. civ. ass., 2010, com. 283, obs. GROUTEL H. D., 2011, 35, obs. BRUN PH. states that: «*constitue un accident complexe les collisions successives intervenues dans un même laps de temps et dans un enchaînement continu*». Instead Cass., 2ème, 17.02.2011, n. 10-14658, Resp. civ. ass., 2011, com. 176, obs. GROUTEL. H. concerns: «*l'accident complexe est écarté en cas d'enchainement discontinu de collisions*».

[624] Cass., Ass. Plén., 6.04.2007 pourvoi n. 05-81.350, arrêt n. 555.

[625] French Courts followed a different evolution in this case. Firstly, they consider *faute inexcusable* as cause of accident: «*la faute volontaire d'une exceptionnelle gravité exposant sans raison valable son auteur à un danger dont il aurait dû avoir conscience*» Cass. civ. 2ème, 20 juill. 1987, Bull., n°160; Cass., Ass. plén., 10.11.1995, Dalloz, 1995, p. 633.

A. *Liability law*. Under the theory of negligence, the standard of reasonableness is used to assess the driver's behaviour, in particular to understand whether driver could reasonably have avoided damages. Driver has a duty of care and he is held liable if he is in breach of this duty.

Based on this theory, plaintiff has to prove the duty of care; the breach of the duty of care; the cause of harm; physical harm and proximate cause.

Instead, under no-fault theory – concerning car-crash litigation and insurance - tort claims are abolished. Victims cannot sue the driver unless their damages exceed a threshold. Twelve States are using this theory (see *infra* §B).

As regards to strict liability, drivers are held liable regardless of their negligence whether their activity is qualified as «ultra-hazardous». This statutory scheme is primarily on the existence of an infringement under the law. This type of activity leads to an increased awareness about risks involved by parties.

This theory is in §§519-524A Restatement (Second) of Torts (1977), where Section 519 states:

> «[...] one who carries on an ultra-hazardous activity is liable to another whose person, land or chattels the actor should recognize as likely to be harmed by the unpreventable miscarriage of the activity for harm resulting thereto from that which makes the activity ultra-hazardous, although the utmost care is exercised to prevent the harm.

Section 520 defines ultra-hazardous activity as follows:

> «An activity is ultra-hazardous if it (a) necessarily involves a risk of serious harm to the person, land or chattels of others which cannot be eliminated by the exercise of utmost care, and (b) is not a matter of common usage, (c) inability to eliminate the risk by the exercise of reasonable care; (d) extent to which the activity is not a matter of common usage; (e) inappropriateness of the activity to the place where it is carried on; and (f) extent to which its value to the community is outweighed by its dangerous attributes».

A defect of a car could cause car accident. In this case driver can sue manufacturer when there is a defect of manufacturing/design/warning[626]. Thus, driver shall prove that a car has: an error of fitting, i.e. of pistons, or a poor quality of tire

[626] With regard to product liability of car manufacturer, see GRAHAM J.D., *Product Liability and Moto Vehicle Safety*, in The Liability Maze, HUBNER e LITAN (eds.), Washington, 1991, p. 120-190; NADER R. and PAGE J.A., *Automobile-Design Liability and Compliance With Federal Standards*, 64. Geo. Wash. L. Rev. 415, 1996.

rubber[627]; a defect of design that shall be evaluated through the analysis methods (consumer's expectations or risk-utility test)[628]; or the car has not useful warning in order to avoid predictable risks[629]. In addition, driver does not know the presence of defect and he uses vehicle in an appropriate way.

In particular, with regard to design defect courts use the consumer expectations test or risk-utility test. The first allows identifying the defect whether the product is unreasonably dangerous based on consumer expectations on that category of products. Under the second test, a product is defective if the benefits are greater than costs. In other words, in case of car crash if the steering system is broken and it provokes the accident, courts evaluate benefits – in terms, for example, of reduction of car crash – than costs supported for an alternative design.

In relation to warning defect, manufacturers shall inform consumers with instructions about the driving of a robot car. Then, they shall educate driver to use it. In particular, manufacturer of semiautonomous vehicles shall teach consumers how robotic system interacts with them.

As mentioned above (see *supra* chap. III), in this system there is a specific link between safety and liability product. Therefore, FMVSS (Federal Motor Vehicle Safety Standards) play a fundamental role to establish manufacturer liability. When federal standards contain the express or implied preemption clause, the product complies with these are safe even if the state regulation contains a higher safety level[630]. For other standards - that do not contain these above-mentioned clauses -, art. 49 U.S.C. §30102 (a) (9) considers them as minimum safety level. Manufacturers are held liable in case of manufacturing/design/warning defects; if plaintiff proves that the defendant could comply with standards that would ensure a higher level of safety.

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[627] In this case is difficult that manufacturer is held liable if he conforms with standards, considering that ALI states a strict liability. There is not a judgment of feasible alternative; *see* Delvecchio v. General Motors Corp., 625 N.E. 2*d* 1022 (III App. Ct. 1993).

[628] Camacho v. Honda Motor Co., 741 P.2d 1240, 1987; Holloway v. Gen. Motors Corp., Chevrolet Div., 250 N.W.2d 736, 738 (Mich. 1977).

[629] Superior Indos Int'l Inc v. Faulk, 695 So2d376 (Fla5th DCA 1997) where manufacturer had to compensate injuries caused by a warning defect of a lift block which could provoke abnormal reaction while steering.

[630] O'REILLY J.T., *Federal Preemption of State and Local Law*, Chicago, 2006, p. 196.

B. *Insurance law.* In US, there is not the unitary system of insurance. Three types of insurance can be individuate, such as pure no-fault system and (threshold) partial no-fault (or hybrid no fault, or modified no-fault) and no-fault systems[631].

In a pure no-fault system, the victim cannot claim compensation to driver. He can claim compensation to his insurance company[632]. The no-fault insurance is based on an automatic compensation, the amount of which is fixed *ex ante* car crash. The insured knows the amount of compensation in advance. This system has some advantages and some disadvantages. Firstly, the prize becomes the payment for a service received. The insured will be encouraged to search the insurance company that provides the best quality/price relation. Secondly, the insurance company knows the history of vehicle, so it will be able to determine the premiums. Then, the insurance company may develop contracts that discourage opportunistic behaviors. This system is also able to contain the costs because the mechanism of civil liability does not occur. Finally, the no-fault system is fairer, because each insured pays a premium corresponding to compensation that can receive and therefore the owner of a vehicle, having a small value, supports a cost for a less insurance[633].

However, this system has some disadvantages, such as the failure of deterrent effect[634], which, although attenuated, continues to exist in third party systems – where they do not support the consequences of the damages done to other drivers and people transported -. In addition, this system influences the drivers' behavior[635]. Drivers could reduce their carefully while driving. Finally, the reduction of the costs of the compensation depends on the recognition of a lower compensation than that one known in the context of civil liability[636].

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[631] SCHWARTZ G.T., *Auto no-fault, and First-Party Insurance: Advantages and Problems*, 73 S. Cal. L. Rev., 2000, 612. HOLMES E.M., *Holmes'Appleman on Insurance*, 2 ed., vol. 25, Automobile Insurance, San Francisco, 2004, §154.1.

[632] In Québec, Manitoba, Michigan, New jersey, Pennsylvania, Hawaii, Kansas, Kentucky, Massachusetts, Minnesota, North Dakota and Utah.

[633] AGCM, *Indagine conoscitiva sul settore assicurazione autoveicoli*, IC19, 17 aprile 2003, 182 ss., available at http://< www.agcm.it.

[634] SHAVELL, *Foundations of economic analysis of law*, Cambridge, Mass., 2004, 261 ss. PACCES A.M., *Il ruolo economico della responsabilità giuridica*, in Economia per il diritto, a cura di CIOCCA e MUSU, Torino, 2006, 159, 169 ss.

[635] LOUGHRAN D.S., *The effect of no-fault automobile insurance on driver behaviours and automobile accidents in the United States*, Santa Monica CA, 2001, 6.

[636] Ibidem, 184; PARDOLESI P., *La disciplina del risarcimento diretto dei danni da circolazione stradale*, op. cit., 2007.

The (threshold) partial no-fault system presents a threshold. The driver shall stipulate a compulsory car insurance first party for personal injuries (PIP) added to insurance covering damages caused to third parties and things. In addition, if damage is above a minimum size, victim can claim compensation[637].

The no-fault system[638] enables drivers choosing between two insurance systems. The first is a no-fault system that has the lowest premiums. If driver opts for this insurance coverage, he shall buy personal protection insurance (PPI). The second is a modified current instance with the highest premium where the claim compensation is not limited. This second system provides a mandatory insurance covering bodily injury and driver. In addition, driver shall acquire insurance covering tort maintenance and personal injury insurance (PIP)[639].

2. Applying the existing liability schemes to road accidents involving AVs: real scenarios.

The application of above-mentioned laws on robot car leads to reflect on different level of autonomy. As regards fully autonomous car, largest number of accidents will depend on system error. Instead, with regard to semiautonomous car – characterized by the coexistence between human and driving system - the human behavior will be relevant in car crash.

Conventional car robot has different automated systems, which do not create a self-driving car, so driver knows how his car will operate. These systems assist the driver but they do not replace him, so driver is still liable for accident.

In semiautonomous robot car, driver's behavior and software's behaviour are evaluated in case of car crash. It is necessary to study if a traffic road has been caused by driver's behavior, or by a defect of the system, or by both.

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[637] AGCM, *Indagine conoscitiva,* op. cit., *p.* 185 nota 291, «*a causa degli incrementi nei premi verificatisi dopo l'introduzione dei meccanismi di no fault modificato, diversi Stati (Colorado, Florida, Hawaii, Kansas, Massachussets, Michigan, New York, North Dakota, Utah, Nevada, Georgia e Connetticut) che avevano adottato tali sistemi negli anni '70, sono poi tornati alla responsabilità civile. In alcuni Stati (New Jersey, Pennsylvania e Kentucky) è lasciata agli automobilisti la scelta tra un no fault modificato e la responsabilità civile (cd. sistema auto choice). Tale sistema misto presenta numerosi problemi, in particolare nel coordinamento tra i diversi regimi, quando in un sinistro si trovano coinvolti guidatori no fault e RCA, né sembra aver prodotto risultati apprezzabili dal punto di vista del controllo dei costi*».

[638] AA.VV., *The Economics and Politics of Choice No-Fault Insurance,* edited by EDWARD L., LASCHER E.L, POWERS M.R., Boston , 2001, p. 3 ss.

[639] CARROL S.J., ABRAHAMSE A.F., *The Effects of a Proposed No-Fault Plan on the Costs of Auto Insurance in California*: An Updated Analysis, IP-146-1, 1996, p. 32.

Therefore, the above-mentioned considerations about the driver's liability can be reproduced on driver of a robot car with some specifications. In addition, Product Liability is applied in case of accident caused by defect of driving system.

The increase of driving system's actions leads to the decrease of human error while driving. As regards semiautonomous car, current traffic road liability applies on human error.

The *Loi Banditer* is a compensation system where the only contact - that causes injuries - is sufficient to ensure compensation to victims. The analysis of driver's behavior will not be difficult, in this way. The issue shows up when law requires the proof of driver's negligence or it establishes a presumption of fault. Art. 2054 cod. civ. covers damages caused to victims who are not conductors and driver is also liable for manufacturing defect. In this case, there is a problem with regard to assessment of behavior of driver. The standard of driver's diligence is based on behavioral duty indicated in Highway Code. However, the behavior of the driver of a semiautonomous car will be different from the behavior required for conventional vehicle. In these two cases, the standard of diligence will be different because of the interaction between driver and driving system. Therefore, it is necessary indicate some rules of driving which included how driver has to behave while driving a semiautonomous vehicle.

In American system, the non-fault theory does not raise particular questions given that it operates as a compensation system for accidents that are less serious. Under strict liability theory, robot car's activity is qualified as an ultra-hazardous activity. Moreover, the application of this theory does not raise issues. Therefore, victim could sue car's driver who is liable regardless his negligence.

However, the increase of functions of driving system will cause an increase of car crash provoked by this system. Therefore, the liability transfers from driver to driving system, and consequently to manufacturer. In these cases, manufacturer is held liable for injuries caused by manufacturing/design/warning defect.

First, different traders, such as the vehicle manufacturing, the individual component manufacturing, the software programmer, the designer and the infrastructure manufacturer, create AVs. This multiplicity leads to a plurality of responsible if a defective car causes an accident. Generally, only the car manufacturer is held liable to final product while other traders are liable if their component is defective. However, this approach is inadequate for smart cars, because the cause of accident will be had to identify, so the plaintiff’s interest will be to sue all traders involved in the manufacturing of robot car.

For seeking the cause of accident – understanding the events surrounding the incident – some States adopted black boxes, which are inserting into vehicle. These boxes give relevant clues about car crash[640]. (See chap. IV)

Second, semiautonomous robot car has alert systems – which indicate to driver when and how he shall act -. Therefore, the most of defects of smart cars refers to alert systems. In particular, there will be an increase of design defect because the manufacturer will not provide all situations when putting car into circulation. In other words, there will always be a better feasible alternative design than those selected by manufacturer. The two tests - used to evaluate the design defect – present some issues on AVs. The consumer expectations test is not reliable because consumer does not know what to expect by a robot car, so it could have unrealistic prospects about vehicles.

The second test (costs–benefits) could lead to the same issues. The costs related to feasible alternative design will be less expensive compared to benefits ensured by this design. In addition, after car crash, better alternative design will be identify easily and its cost will be less compared to costs of the accident[641]. Some scholars consider the possibility to determine a standard of benefits-costs in civil liability judgment, but it is difficult about robot car[642].

In addition, among these defects, it is difficult to insert the failure to update of the software because it is not clear if driver or manufacturer should make the update.

Then, there is the possibility that car manufacturers could use a defense against car’s consumers. This defense is the express assumption of risk of a dangerous product or the reasonably assumption of the risk by consumers. This defense is relevant when plaintiff choices between different products and he opts for the product that presents the risk. However, this defense is not credible on AVs because manufacturer should inform

[640] TROP J., *A black boxes for car crash*, NY Times, 2013, in http://www.nytimes.com/2013/07/22/business/black-boxes-in-cars-a-question-of-privacy.html.
[641] MARCHANT G.E., LINDOR R.A., *The coming collision between autonomous vehicles and the liability system*. Santa Clara Law Review, 52(4), 2012.
[642] KALRA N., ANDERSON J., WACHS M., op. cit., 2008, p.35.

consumer of all probable risks of a product. It is not possible, as regards AVs manufacturer because they do not know all risks of these latter.

Some American scholars state that manufacturers are held liable with regard AVs[643], because of their position, which enable them to control malfunctioning system. Then, this liability leads to improvement about attention of manufacturer on safety of product[644]. These could cause a block of activity of manufacturer who will be discouraged to finance on new technology because of the costs. In this respect, legislation could ensure immunity to manufacturers[645] or federal standards could limit manufacturer's liability through preemption clauses[646].

Finally, current insurance liability is sensible to AVs, because it insures the compensation of victims. However, the effects of AVs - such as the reduction of accidents and liability of manufacturers – lead to new forms of car insurance. Some scholars propose a no-fault system combined to first-party insurance paid by drivers to cover their own damages[647]. Others state that Swedish model of traffic insurance is a promising model for compensation of victims of automated car accidents upon which further research are advised[648].

Now, we can imagine some future scenarios in relation to AV that invades the lane and it causes the impact with another AV by provoking injuries to third parties

2.1. The first scenario: the careless driver despite the robotic alert.

Driver received the alert to take control of car by robotic system. Driver does not take control of car because of the wear of the brakes.

USA. To evaluate if driver has been negligent some court use Learner Hand theory (B <PL)[649] where the cost of precautions are compared with the probability of

[643] MARCHANT G.E., LINDOR R.A., *op. cit*., 2012, p.1326; KALRA N., *op. cit.*, 2008, p. 20.

[644] MELE D.M., *The Quasi-Autonomous Car as an Assistive Device for Blind Drivers: Overcoming Liability and Regulatory Barriers*, 28 SYRACUSE J. SCI. & TECH. L., 2013, 26, 27.

[645] CALO R., *Open Robotics*, op.cit., p. 601 ss.

[646] WALLACH W., *From Robots to Techno Sapiens: Ethics, Law and Public Policy* in the Development of Robotics and Neurotechnologies, 3 Law, Innovation & Tech., 2011, 185, 194. Geier v. American Honda Motor Co., 529 US 861 (2000) (Federal regulation on installation of air bag contains an implied preemption); Williamson v. Mazda Motor di Am., Inc., 131 S. Ct. 1131 (2011).

[647] KALRA N., *op. cit.*, 2008, p. 21.

[648] Robolaw, op. cit., 2014, p. 215.

[649] Learned Hand formula is used in negligence cases. The Learned Hand formula is an algebraic formula ($B = PL$), according to which liability turns on the relation between investment in precaution (B) and the product of the probability (P) and magnitude (L) of harm resulting from the accident. If PL exceeds B, then the defendant should be liable. If B equals or exceeds PL, then the defendant should not be held liable.

damage multiplied for cost of injuries supported by victim. When «the cost of an accident - the monetary cost of harm, *L*, times its probability of occurring, *P* - exceeds the costs of prevention, *B*, then the accident should be prevented. When *B* exceeds *PL*, however, the accident should not be avoided. Society's net wealth or welfare is maximized by preventing only those accidents where *B* is less than *PL*»[650]. Therefore,

If: $B>PL$ driver is not negligent (1)

If: $B<PL$ driver is negligent (2)

(1) The cost of precaution measures is higher than the costs of result between percentage of damage and costs of injuries.

(2) The cost of precaution measures is lower than the costs of result between percentage of damage and costs of injuries.

ITALY. Driver has been negligent because he could avoid the accident if he changed his brakes. In this case, we apply art. 2054, co. 4, cod. civ. which held liable driver based on causality between harmful event and damage. This paragraph states a strict liability that requires the proof of causation[651].

FRANCE. This situation meets an immediate solution in France, where the *indemnisation* system requires the involvement of a car and it aims to compensate damage of victim. Therefore, if there is the implication of car, driver will have to compensate victim.

2.2. The second scenario: the missed robotic alert.

1. Driving system has a design defect and driver could have avoided car crash.

To understand who is liable, we analyze both system's malfunctioning and driver's behavior based on fault comparative.

USA. To evaluate the malfunctioning of the driving system, product liability law is applied. Software has a design defect. The driver could argue that manufacturer could have used an alternative design of software that could have avoided the accident.

Instead, manufacturer could argue that design of car is comply with standards established in state regulation. In relation to robot car, there are not federal standards and we cannot use the doctrine of preemption. This is the first issue already noted in

[650] COLE D.H., *Uncertainty, Insurance, and the Learned Hand Formula* (with P.Z. GROSSMAN, R. CEARLEY), Law, Probability, and Risk 5, 2006, pp. 1-18.

[651] ALPA G., BESSONE M., ZENO ZENCOVICH V., *I fatti illeciti*, in Trattato RESCIGNO, XIV, Torino, 1995.

matter of car safety. The creation of federal regulation could solve this question.

Therefore, the victim could comment that manufacturer could use a foreseeable alternative design. At this point, courts could recut to consumer expectations test or costs-benefits analysis.

The consumer expectations test leads to unrealistic result because consumer may only carry out their expectations alleging to advertise of robot car. Robot car is a special product and consumers do not know their real functioning. The costs-benefits test raises the following question. The complexity of driverless cars does not allow proving an alternative designs, easily.

ITALY/FRANCE. In Italy, in case of car defect the driver is held liable by virtue art. 2054, co.4. Driver is liable against the victim. However, driver can sue manufacturer of car on the bases of product liability.

Manufacturer could argue that the smart car conformed to the state-of-art when it was putted into circulation. This defense will be assessed based on precautionary. When product was putted onto market, the risk was reasonableness linked to damage, or the manufacturer could reasonableness adopt measure to prevent damage.

The state of art should correspond to technical regulation. Manufacturer of smart cars, before of put car in circulation, should obtain the certification of conformity or a declaration of conformity. The conformity of product to technical regulation represents a presumption of safety of product. However, plaintiff may prove that product is not safe based on standards.

Then, we assess the behavior of driver. Two scenarios could occur.

Driver proves that he intervened while driving. His car was passing another car, but after this maneuver, the car invaded opposite lane and driver intervened to ensure a regulate return into the lane. However, the driver’s intervention caused the impact with passed car. Alternatively, driver proves that he did not intervene to prevent accident because the time and the space were too short to avoid the invasion of opposite lane.

The second scenario is the following. Driver was distracted while driving because of his belief to drive distractedly based on advertising of robot car safety, which created a false belief.

These scenarios are assessed on the bases of negligence theory in US. In Italy, there is a presumption of fault *ex* art. 2054, 1 co., codice civile. In France, driver is considered liable because its drive is involved in accident.

2. Driving system does not alert driver because he has not update the system.

This situation raises some issues, such as to understand who should make this operation. Manufacturer had to update the system through car dealers. This operation can become a contractual obligation for protecting driver through contractual scheme.

2.3 The third scenario: driving when the data of the automotive system have been hacked

This is a particular scenario for US and Italy, while in France the misconduct of a third is not a problem on compensation because driver shall be paid victim and the misconduct of a third does not reduce the liability of driver. This argued also reproduces with regard to *force majeure* and negligence of victim. In addition, in this case the *Loi Godfrain* n. 88-19 of 5 January 1988 on computer fraud is not applied[652].

In US and Italy, it will be important the safety of car, in particular the safety measures on software to ensure privacy.

-Regulation on privacy safety could be realized by EU and US

-The application of comparative fault theory takes place.

These examples help us to identify some questions as regards introduction robot car.

France has a juridical system in which there are no problems about compensation of victim, because legislator requires the implication of car (that is not causation) in order to compensate the victim. The interference of third's activity or the fault of victim does not reduce the compensation in favor of victim.

Italy presents the article 2054 cod. civ. which covers the dangerous consequences derived from driving. The implications caused by circulation of semiautonomous robot car are not different from the implications of conventional cars circulation. However, you need to identify the standard of diligence required to driver of semiautonomous car. Highway Code contains the norms of conduct of driver that do not consider the driver's behavior while driving a robot car.

2.4. The fourth scenario: collision among AVs causing damages to third parties.

[652] This law has been integrated into art. 321 code penal.

This forth scenario is developed through a probable juridical reasoning.

A. Driver did not intervene to stop car although he received notification in this sense.

While driving, driver was speaking on the phone because he was convinced that car replaced him during driving.

- Why did driver think that?

a) Driver was convinced that a semiautonomous car could be driven without any careful while driving.

- Why does driver have this belief?

a) When driver bought car, seller gives him warnings about the use of car; so, driver knew that the robot car has a combined driving between both human and system driving.

b) At the time of purchase, driver received an instruction manual, in which the information about the functioning car is understandable and clear.

- Could driver drive the robot car?

a) Driver has not a full ability to drive, because he was drunk.

- Might the drunk driver take the car?

a) There are not prohibitions in this respect in Highway Code.

b) Seller/manufacturer has not informed driver that a drunken man cannot drive.

Those who have a diminished ability could not drive a semiautonomous car. This standard of diligence could be inserted in Highways Code in order to identify the rules for driving a robot car.

- Is a warning defect there?

a) There is a warning defect because manufacturer, who knows the risks of a semiautonomous car, should have informed consumer about this predictable risk. (Product liability).

b) Driver cannot consider negligent, because his expectations on robot car formed on the bases of its advertising. Driver bought smart car because he has a diminished ability.

c) Seller/manufacturer has informed driver that a drunken man cannot drive.

B) AV receives false information by another AV.

- Why did AV receive false information?

a) The other AV has been hacked.

- Why?

a) Manufacturer does not ensure the protection structure of software and he did not take precautions measures.

b) Driving system is compliance with regulation on privacy, but hacker violates it.

b) The communication between AVs was not linear because of unpredictable environment condition. At this point it is important identify the relation between driver and driving system by indicating the correspondent duty of driver. Driver's behaviors have to follow an important norm such as the supervision of driver while driving. This rule gives driver a superior position that consists in the fact that "driver has the last maneuver".

A similar reasoning cannot be reproduced with regard to fully autonomous robot, where there will not be the coexistence between driver and driving system. When that moment will arrive, different issues will raise than those ones related to semi-autonomous car.

The above exposition shows that semiautonomous cars lead to some issues related to compensation of damages caused by defective driving system and damages suffering by driver.

As regards to first case, we reflect on Product Liability. The question is the difficult to demonstrate the defect of product by driver.

Before the massive advent of AVs, it is necessary regulate the semiautonomous car. In this case, if an accident occurs because of defect of system driving, the insurance coverage could solve the problem. The first insurance system is a no-fault system for car manufacturers. The third-party insurance aims to cover personal injuries suffered by victim. The second insurance coverage is compulsory first party insurance for personal injuries (PIP) suffering by drivers. This last solution is justified from the acceptation of risks by driver. He decides to assume the risk through the acquisition of semi-autonomous car[653].

When there will be the massive advent of AVs, a compensation fund could be the solution. Car manufacturer could finance this fund. They contribute in proportion to benefits received from the use of AVs. These benefits may be calculate based on the number of robot cars put into circulation, or the number of car crash in which the car of a manufacturer have been involved. This mechanism should also ensure a different compensation in favor of victim. For this scope, it is necessary to identify different criteria that reflect different aspects of victims. For instance, compensation should consider the entity of injuries, or the implication of injuries on social relationships.

[653] IZZO U., *Analisi economico - comportamentale della responsabilità sciistica (parte prima).* L. 24-12-2003, n. 363, DR, 2011, 5, 549 *says: «nella responsabilità sciistica chi decide l'acquisto della copertura assicurativa è anche colui che, su un piano puramente elettivo, decide di intraprendere l'attività che determina il sorgere del rischio dedotto nella polizza […]» «Non è affatto peregrino immaginare che costui sarebbe propenso ad utilizzare lo strumento assicurativo per garantirsi dall'intero rischio (e non solo da quella porzione di rischio connessa all'eventuale lesione colposamente cagionata ad altri nell'esercizio dell'attività sciatoria), acquistando una buona copertura assicurativa first party legata all'infortunio sciistico a prescindere da ogni profilo di responsabilità civile connesso al sinistro»* (*see* note 62).

CONCLUSION.

Robotics is the effect of modernity and scientific and technological progress. The development of robotics is justified by benefits in terms of social progress and well-being for the community. The question is to understand how much we are willing to sacrifice our own interests in favor of the benefits of robotics development.

Robotics is characterized by a variety of applications. Everything and every activity seems to be robotic, included the human body. Robotics covers many areas of society and in every sector robotic raises ethical, social and legal questions.

The juridical implications of robotics arouse interest from both sides of the Atlantic, the EU and the USA.

The fact that robotics is developing at this moment - when EU and US are adopting a new attitude with regard to the regulatory process – is more relevant. The Transatlantic Trade and Investment Partnership ("TTIP") is a trade through which the EU and US are planning the development of consumer market, investments and jobs. It ensures greater regulatory convergence through the elimination of trade barriers. This new approach could considerably reduce costs and extraterritorial distortions of the market.

In addition, the automotive industry is in the wake of this new Regulatory approach.

The unification process is justified by the need to ensure consumer protection, health and the environment between the US and the EU. The unification of the regulatory process requires a combination of principles and tools used by the EU and the US in their respective regulatory processes. One gap is inherent to the principles used by the two States in the risk regulation. It reveals the application of a reasonable precautionary principle that is the result of reading the costs-benefits analysis under a precautionary perspective. This element is central in this process of unification because the interest of the States will be to achieve a balance between protecting consumers' safety and health and innovation directed to the increase the collective benefits.

In order to achieve this homogenization, EU and the USA are working to ensure the unification of autonomous car regulatory. EU is working through Guidelines and the Green Paper in order to ensure the safety of smart cars. Instead, the US has launched a process that moves from below: some individual States have enacted legislation to regulate the AVs. While, the regulatory agency has developed recommendations followed by States in order to develop local regulations.

Regulations on safety play a vital role in the liability judgment. Safety regulations do not exclude the tortfeasor’s liability, since they have to comply with the standards established by regulatory agencies. The compliance detected as rebuttable presumption. In fact, the judicial assessment aims to assess the conduct in a precautionary perspective. The precautionary principle stands on the border between risk and prevention measures in order to deal with scientific uncertainty.

The application of the Product Liability reflects the absence of regulatory. Its absence complicates the assessment of the predictability of the product safety. In particular, the application of Product Liability on smart cars generates difficulties to ensure compensation in favor of the victims. This scenario could become more complex when there will be a massive advent of AVs. Therefore, there will be the necessity to establish a compensation fund. Auto manufacturers could finance the fund and this latter could guarantee the compensation of victims based on subjective criteria that takes account the peculiarities of injuries suffered by damaged. While producers should finance the compensation fund based on objective criteria, which take into account the number of cars put in circulation or the number of litigation involving the producers of the cars.

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