THE LAW IN THE AGE OF ARTIFICIAL INTELLIGENCE AND ROBOTICS: A CASE STUDY OF ATLAS FROM A TORT LAW PERSPECTIVE

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Abstract: The law in the age of artificial intelligence and robotics faces many challenges to which our current legal systems may not yet have the proper tools to tackle them with. In recent years, we have seen the development of technologies which just ten or twenty years ago we wouldn't have thought were even yet possible. From advanced AI-powered language models such as ChatGPT to driverless autonomous vehicles such as Tesla's, it is undeniable that the science of intelligent machines advances at a pace that far outmatches that of its legal counterpart. The present study will seek to analyse both current and future regulatory proposals regarding the use of autonomous humanoid robots from a Tort Law perspective, both through the Spanish and European regulatory frameworks, in order to establish efficient legal solutions that offer satisfactory outcomes both for manufacturers and consumers.

Keywords: Artificial Intelligence, Robotics, Humanoid Robots, Tort Law, Non-contractual Liability, Vicarious Liability, High-risk AI systems, Machine Learning, Deep Learning

Título: El Derecho en la era de la Inteligencia Artificial y la Robótica: Un estudio del caso de Atlas desde una perspectiva del Derecho de daños.

Resumen: El Derecho en la era de la inteligencia artificial y la robótica enfrenta muchos desafíos para los cuales nuestros sistemas legales actuales tal vez aún no tengan las herramientas adecuadas para abordarlos. En los últimos años hemos visto el desarrollo de tecnologías que hace apenas diez o veinte años ni siquiera hubiéramos pensado que fueran posibles. Desde modelos de lenguaje avanzados impulsados por IA, como ChatGPT, hasta vehículos autónomos sin conductor como el de Tesla, es innegable que la ciencia de las máquinas inteligentes avanza a un ritmo que supera con creces el de su contraparte legal. El presente estudio buscará analizar las propuestas regulatorias actuales y futuras sobre el uso de robots humanoides autónomos desde una perspectiva del Derecho de Daños, tanto a través del marco regulatorio español como europeo, con el fin de establecer soluciones jurídicas eficientes que ofrezcan resultados satisfactorios tanto para los fabricantes como para los consumidores. consumidores.

Palabras clave: Inteligencia Artificial, Robótica, Robots humanoides, Derecho de daños, Responsabilidad extracontractual, Responsabilidad vicaria, Sistemas de IA de alto riesgo, Aprendizaje automático, Aprendizaje profundo

Títol: El Dret a l'era de la Intel·ligència Artificial i la Robòtica: Un estudi del cas de l'Atlas des d'una perspectiva del Dret de danys.

Resum: La llei a l'era de la intel·ligència artificial i la robòtica s'enfronta a molts reptes als quals els nostres sistemes legals actuals potser encara no disposen de les eines adequades per afrontar-los. En els darrers anys hem assistit al desenvolupament de tecnologies que fa només deu o vint anys no ens pensàvem que encara fossin possibles. Des de models de llenguatge avançats amb intel·ligència artificial com ChatGPT fins a vehicles autònoms sense conductor com el de Tesla, és innegable que la ciència de les màquines intel·ligents avança a un ritme que supera amb escreix el del seu homòleg legal. El present estudi pretén analitzar les propostes normatives actuals i futures sobre l'ús de robots humanoides autònoms des de la perspectiva de la Llei de danys, tant a través del marc normatiu espanyol com europeu, per tal d'establir solucions legals eficients que ofereixin resultats satisfactoris tant per als fabricants com per als consumidors.

Paraules clau: Intel·ligència Artificial, Robòtica, Robots Humanoides, Dret de danys, Responsabilitat extracontractual, Responsabilitat vicària, Sistemes d'IA d'alt risc, Aprenentatge automàtic, Aprenentatge profund

Summary

I. INTRODUCTION

In 1950, Russian-born and later American scientist and science fiction writer Isaac ASIMOV (1920-1992)[1], in his famous novel "*I, Robot*", imagined an artificial being which acts and looks just as a human being, but without being an actual human being. He called this being a "robot", an artificial person capable of thinking beyond what their creators had intended for them and developed a series of laws regarding the behaviour of such beings.

And although an artificial person was a thing of science fiction and fantasy in Asimov's time, recent breakthroughs, and innovations in the fields of artificial intelligence and robotics have made such a being a real possibility within the near future. It is therefore imperative that our legal systems, as regulators of individual behaviour and society as a whole, adapt accordingly to this new reality, offering regulatory solutions that accomplish satisfactory outcomes both for consumers as well as users and producers.

The objective of the present thesis is therefore twofold: on the one hand, (i) to establish whether our current legal instruments for liability are suited to tackle the legal issues arising from human interaction with autonomous humanoid robots and, on the other hand, (ii) to propose new ways to regulate such interactions beyond our current legislation. Given the limited scope of the present thesis, I shall centre my study around one particular case of autonomous intelligent robots: humanoid robots capable of acting completely without direct human supervision, in an autonomous manner. And even though such robots are mostly still far from being commercially available to the public, there are several examples of such machines currently in development. One such example of these, and the one that I shall base my thesis on, is the Atlas robot currently being developed by *Boston Dynamics*.

1. THE AUTONOMOUS ROBOTS OF THE FUTURE (I): THE ATLAS

Atlas is one of the most advanced robots, perhaps even the most advanced robot in existence at the present time[2]. It is either controlled remotely or autonomous, and capable of sensing its environment and acting accordingly, without the need for any human control or supervision. Even though it is not yet fully intelligent, as although it can create its own behaviour based on learning and trial and error it does not have full

[1] Isaac Asimov (January 2, 1920 – April 6, 1992) was an American writer and professor of biochemistry at Boston University. During his lifetime, Asimov was considered one of the "Big Three" science fiction writers, along with Robert A. Heinlein and Arthur C. Clarke, and he wrote more than 500 books. (Source: Wikipedia)

[2] See BIBA (2020), DICKSON (2021), AMADEO (2023) and NELSON (2023), among others.

intelligence nor conscience, it is the nearest existing thing to such an intelligent machine as the one which is the object of this thesis. Therefore, Atlas will serve as the ideal focus of the present study.

2. The autonomous robots of the future (II): A hypothetical practical case

As autonomous humanoid robots are still far from being commercially available, let us imagine a near future where the improved versions of Atlas have become a staple of most homes in the European Union, being as common as our cars or our laptops are today. In this not-so-distant future, the successor versions of Atlas would fulfil the role of electronic servants or helpers, performing a series of tasks we nowadays perform ourselves: caretakers, cleaners, and assistants. This Atlas would be, for our purposes, autonomous but limited in its intelligence, capable of learning through trial and error and of performing complex tasks, but with no real will or consciousness of its own, and the property of a human or legal person, similar to any other electronic or smart device today.

This robot would then interact with humans on an almost constant manner and would in many cases act without any real human supervision or control. In particular, and for the purposes of the present thesis, I shall centre around a very particular case: a situation where the users or owners of Atlas have left their children or other vulnerable people temporarily under its care to go on a date or plan of their own. This would allow for Atlas to cause harm, through action or inaction of its own, and would therefore pose a series of legal challenges we must solve: *How do we determine liability for actions or omissions committed by an autonomous robot? Who would be liable? Would the manufacturer be always liable, or can its users be made liable as well? How would said liability be constructed? Are there any other legal means of solving liability for damages caused by autonomous non-human third parties?* These and several other questions I shall try to answer in the following sections.

3. The relevant law to the case

Artificial intelligence and robotics can be regulated from many dimensions and perspectives, and from multiple systems of liability and national and international regulations. The issue of autonomous humanoid robots, which work with a great deal of very sensitive data from vulnerable individuals, and which interact with them physically on an almost constant manner, poses a series of legal challenges on several areas of Tort Law that might go beyond the classical: issues ranging from data protection to the fundamental rights to honour, privacy and one's own image, as well as the issues of defective product and negligent use, and possible criminal responsibility, among others.

Therefore, and for simplifying purposes, it is the author's intention to make clear that the present thesis will focus on Tort Law in the European Union, especially Tort Law as established by the Spanish Civil Code and the Spanish jurisprudence, and in particular on liability for actions or inactions committed by such robots through *vicarious liability*. This will be developed in more detail in Section 3 of the present thesis.

4. THE METHODOLOGY

In order to solve the many legal challenges posed by autonomous humanoid robots, the present thesis will make use of the following methodology:

(i) On the one hand, the use of both regulation and relevant jurisprudence and case-law of the Spanish legal system and courts, as well as the European Union.
(ii) On the other hand, the use of legal texts and authors who have worked both on the issues of artificial intelligence and robotics, as well as extra contractual liability of autonomous robots as well as similar cases of non-responsible third agents.

5. ORDER OF CONTENTS

Finally, the present thesis will follow the following structure: firstly, I shall begin by presenting both robots as well as artificial intelligence and what we understand as an autonomous intelligent robot (**Section 2**), then I will analyse the legal solutions offered to us regarding non-contractual liability for the use of intelligent robots (**Section 3**), and then I will proceed to offer future regulatory solutions regarding those aspects where I have deemed that current legislation is lacking, both with existing EU proposals as well as my own (**Section 4**). Last, but not least, I will summarize the main conclusions of the present thesis (**Section 5**).

II. STATE-OF-THE-ART, CONCEPTS AND CURRENT INNOVATIONS IN THE FIELDS OF ARTIFICIAL INTELLIGENCE AND ROBOTICS

1. CURRENT STATE-OF-THE-ART IN THE FIELD OF ARTIFICIAL INTELLIGENCE APPLIED TO ROBOTICS

Since the dawn of time humans have dreamt of artificial beings with intelligence rivalling their own[3]. And even though such beings are still far from being a reality, the field of artificial intelligence applied to robotics, and specially the field of humanoid autonomous robots, has seen a true blossoming in all directions in recent years[4].

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[3] The history of artificial intelligence applied to robotics is not as recent as one may think. The concept of artificial intelligence itself can be traced back to the ancient Greeks, who already came up with the idea of artificial beings with intelligence, such as Daedalus and his artificial humans with which he tried to control the winds. However, the formal study and development of intelligent machines would not start until much later. SMITH et al. (2006), and most scientific literature, situate such a beginning with John MCCARTHY, who first coined the term artificial intelligence in 1956 in a conference of the same name at Dartmouth College. Not long after, more practical applications for AI would soon emerge, such as playing chess, as first proposed by Claude SHANNON in 1960.

[4] See BIBA (2020), SCHROER (2022) and NELSON (2023), among others.

Although still limited in scope and implementation, humanoid robots are increasing in number, complexity, and abundance. In 2005 *ASIMO*[5] (see Figure 1), the first modern robot capable of interacting with human beings in a human-like manner was first introduced, and since then the field has seen multiple successively more complex robots being developed. Their great deal of versatility, given their human-like capabilities, make them increasingly useful in all manner of areas and sectors. The field began with interactive speech platforms, such as the current *Sophia* from *Hanson Robotics*[6] or *Ameca* from *Engineered Arts*[7], but has rapidly expanded onto a diverse range of areas and fields.

Figure 1. ASIMO robot.
Source: Honda

As technology improved, humanoid robots have increasingly become capable of more physical tasks, such as caretaking with *Beomni* by *Beyond Imagination*[8] or activities ranging from healthcare to education through *Nao* by *Softbank Robotics*[9]. The great complexity that human-like movements and behaviour require has meant that progress has not been as fast-forward as with other simpler robots, such as industrial robots, and that commercial implementation is still limited, most humanoid robots still being mostly used in research.

However, the commercial potential of such robots in the future, with their great deal of capabilities once technical limitations have been surpassed, is almost limitless[10]. Humanoid robots in practice will be able to do almost anything a human being can do, and there is no robot currently in development with greater such potential than *Atlas* by *Boston Dynamics*[11].

[5] ASIMO (Advanced Step in Innovative Mobility) is a humanoid robot created by Honda in 2000. It ceased production in 2018, after more than 18 years in service and more than 100 units being built. (Source: Wikipedia)

[6] Sophia is a social humanoid robot developed by the Hong Kong-based company Hanson Robotics in 2016. Sophia is marketed as a "social robot" that can mimic social behaviour and human speech. (Source: Wikipedia)

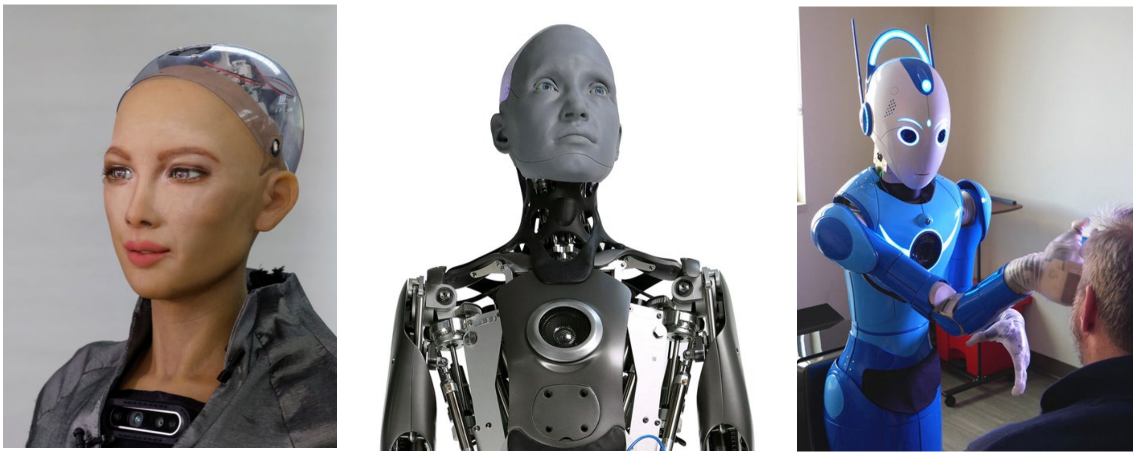
[7] Ameca is primarily designed as a platform for further developing robotics technologies involving human-robot interaction. It utilizes embedded microphones, binocular eye mounted cameras, a chest camera and facial recognition software to interact with the public, by either GPT-3 or human telepresence. (Source: Wikipedia)

[8] Beomni is a caretaking humanoid robot powered by its own artificial intelligence or through teleoperators. (Source: Beyond Imagination)

[9] Nao is an autonomous, programmable humanoid robot intended for education and research, formerly developed by Aldebaran Robotics, a French robotics company rebranded as SoftBank Robotics in 2015. (Source: Wikipedia)

[10] See DICKSON (2021) and TIMOSHENKO (2023), among others.

[11] See BISWAS (2018), DICKSON (2021) and AMADEO (2023), among others.



Figures 2, 3 and 4. Sophia, Ameca and Beonmi robots.
Sources: Hanson Robotics, Engineered Arts and Beyond Imagination

2. BOSTON DYNAMICS AND THE ATLAS SERIES OF ROBOTS

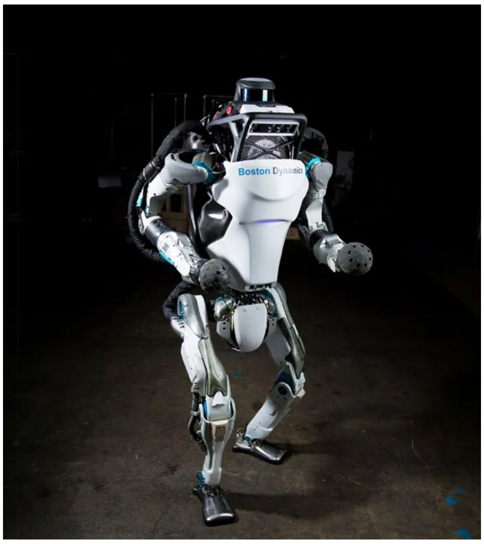


Figure 5. Atlas robot.
Source: Boston Dynamics

Atlas is a bipedal humanoid robot (see Figure 5) primarily developed by American robotics company Boston Dynamics, with funding and oversight from the US *Defense Advanced Research Projects Agency* (DARPA), first introduced in 2013. Atlas is based on the principles set by PETMAN[12]; another humanoid robot also developed by Boston Dynamics. It has four hydraulic extremities, it is made of aerospace grade aluminium and titanium, has a maximum height of 1.8 meters and weighs 150 kilograms. It is designed with two vision systems: a laser telemeter and stereo cameras, both controlled by its aboard computer.

As for its capabilities, Boston Dynamics affirms that "*an advanced control system and state-of-the-art hardware give the robot the power and balance to demonstrate human-level agility*"[13]. Atlas is capable of multiple tasks, both in rescue and recovery missions, as well as in-home assistance. In the 2015 *DARPA competence of robotics*, Atlas successfully completed the eight tasks of the competition: (i) driving a utility vehicle, (ii) traveling on foot through rubble, (iii) taking aside debris blocking an entrance, (iv) opening doors, (v) going up staircases and

[12] PETMAN (Protection Ensemble Test Mannequin) is a bipedal device constructed for testing chemical protection suits. It is the first anthropomorphic robot that moves dynamically like a person. (Source: Wikipedia)

[13] Statement as stated by Boston Dynamics on the Atlas page of the products section of their website.

walkways, (vi) using a tool to break a concrete panel, (vii) locating and closing a gas valve and (viii) connecting a hose to a water pipe[14].

Unlike other mobile robots developed by Boston Dynamics, such as its cousins *Spot*[15] and *Stretch*[16], Atlas is not yet commercially available, being defined by its developers as a "*research platform*". However, a humanoid robot designed for human-like tasks has unlimited potential for all manner of tasks and functions. In the future, it is quite possible that commercially available versions of Atlas will appear for a multitude of functions, such as in-home assistance as well as work in dangerous or perilous tasks. Therefore, the possible applications of Atlas are broad, quite possibly encompassing many of the tasks human beings are physically able to perform.

Atlas can either be teleoperated by a human operator or make its own decisions based on its own AI system integrated into its aboard computers. The exact way in which these systems work is proprietary information to which we do not have access. However, we do know[17] that they most probably work through either (i) simple carefully designed programming and traditional algorithms[18] or (ii) reinforcement learning[19], which is a subset of machine learning[20]. Unlike in the past, where programmers had to devise all possible rules from the start, this kind of AI is capable of creating its own code by analysing vast amounts of data and spotting meaningful correlations. Programmers do not need to give these AIs all possible rules, they just have to create an algorithm with the relevant variables and train it with data collected from thousands of other AIs or humans themselves[21].

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[14] These results were made public in 2015 on DARPA's Robot Challenge competition website (Team IHMCR).

[15] Spot is an agile four-legged mobile robot that navigates terrain with unprecedented mobility, allowing you to automate routine inspection tasks and data capture safely, accurately, and frequently. (Source: Boston Dynamics)

[16] Stretch is a flexible autonomous mobile robot that automates case handling tasks for more efficient warehouse operations. It is designed as an extensible mobile arm which can hold weight of up to 50 kg, with a fixed base from which it operates. (Source: Boston Dynamics)

[17] See ROBBINS (2016), GROSS (2019), CARROLL (2020), SLOMINSKI (2021), GOLDMAN (2022) and BASTIAN (2022), among others.

[18] In mathematics and computer science, an algorithm is a finite sequence of rigorous instructions, typically used to solve a class of specific problems or to perform a computation. Algorithms are used as specifications for performing calculations and data processing. (Source: Wikipedia)

[19] Reinforcement learning (RL) is an area of machine learning concerned with how intelligent agents ought to take actions in an environment in order to maximize the notion of cumulative reward. Reinforcement learning is one of three basic machine learning paradigms, alongside supervised learning and unsupervised learning. Reinforcement learning differs from supervised learning in not needing labelled input/output pairs to be presented, and in not needing sub-optimal actions to be explicitly corrected. (Source: Wikipedia)

[20] Machine learning (ML) is a computer science field devoted to understanding and building methods that let machines "learn" – that is, methods that leverage data to improve computer performance on some set of tasks. Machine learning algorithms build a model based on sample data, known as training data, in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as in medicine, speech recognition, agriculture, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks. (Source: Wikipedia)

[21] It must be noted that applying AI to robotics is still a challenge, as robot AIs require vast amounts of data for training that cannot be easily obtained from the real world. See PEREZ et al. (2017, p. 41).

Therefore, Atlas' decisions are either the result of direct programming, or of its initial algorithm and the data fed to train it, as well as the inputs it receives afterwards. The classification of Atlas is relevant with regards to the applicable legislation, and therefore in the following section I will offer both a robotic and AI classification for Atlas.

3. CONCEPTUAL FRAMEWORK: HUMANOID ROBOTS AND CLASSIFICATION

a) Robotics and classification

The term robot comes from the Czech "*robota*", which means "servitude" or "forced labour". It was first introduced by Czech playwright and novelist Karel CAPEK (1880-1938) in his 1920 play "*R.U.R., or Rossum's Universal Robots*".

ISO 8373:2012 and the Robotic Industries Association (RIA) define it as a "*reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks*." However, a more modern definition would be "*any piece of equipment that has three or more degrees of movement or freedom.*"[22]

Robots can be classified in many ways, and it is not the purpose of the present thesis to enter into such detail, but merely offer a proper classification for Atlas. Generally, robots can be classified as either fixed or mobile, and as either autonomous or non-autonomous[23], although generally several degrees of autonomy are observed (see Section 2.3.3). Within mobile robots, we can find industrial, autonomous mobile robots and humanoid robots[24]. Atlas can be classified as a humanoid mobile robot, and either autonomous or not autonomous (it can either be teleoperated or be autonomous through its own integrated AI).

b) Artificial intelligence and classification

As mentioned in Section 2.1, the term artificial intelligence was first coined by John McCarthy in his 1956 conference "*Dartmouth Summer Research Project on Artificial Intelligence.*" MCCARTHY (1956) defined artificial intelligence as "*the science and engineering of making intelligent machines*".

Scientific literature agrees that a proper definition of AI has never been fully developed[25]. However, we can find some definitions proposed by different authors and authorities. RUSSELL and NORVIG (2009), in their textbook "*Artificial Intelligence: A*

[22] In mechanics, degrees of freedom (DOF) are the number of independent variables that define the possible positions or motions of a mechanical system in space. DOF measurements assume that the mechanism is both rigid and unconstrained, whether it operates in two-dimensional or three-dimensional space. The number of degrees of freedom is equal to the total number of independent displacements or aspects of motion. The term is widely used to define the motion capabilities of robots, including humanoid robots. In this context, the term generally refers to the number of joints or axes of motion on the robot. (Source: Tech Target)

[23] See SACHI and KUMAR (2020, p. 227-230).

[24] See SACHI and KUMAR (2020, p. 227-230).

[25] See RUSSELL and NORVIG (2009, p. 19).

Modern Approach"[26], define the field of artificial intelligence as "*concerned with not only understanding but also building intelligent entities – machines that can compute how to act effectively and safely in a wide variety of novel situations*."

The European Commission, on its *Communication on AI*[27], proposed the following definition: "*Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g., voice assistants, image analysis software, search engines, speech, and face recognition systems) or AI can be embedded in hardware devices (e.g., advanced robots, autonomous cars, drones or Internet of Things applications).*"

Finally, the proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on Artificial Intelligence (*Artificial Intelligence Act*, see Section 4.1)[28] defined AI as any "*software that is developed with one or more of the techniques and approaches listed in Annex I and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with;*"

Artificial intelligence can be classified in many ways, but most authors[29] agree on three main types: (i) artificial narrow intelligence (ANI) or weak AI, (ii) artificial general intelligence (AGI) or strong AI and (iii) artificial super intelligence (ASI). The three types can be understood as stages of development in intelligence, with weak AI being able to merely perform a set of predefined tasks, general AI being able to think for itself and reach human level intelligence, and artificial super intelligence being beyond our current comprehension.

Most currently developed AIs fall within the first category and are therefore devoid of any real thinking ability. However, even weak AI is able to produce outcomes beyond its initial programming through machine learning and deep learning[30], both abilities of artificial intelligence that, as previously mentioned, Atlas can use to display autonomous behaviour.

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[26] See RUSSELL and NORVIG (2009, p. 19).

[27] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on Artificial Intelligence for Europe (COM/2018/237).

[28] Title I on Scope and Definitions of AI, Article 3(1).

[29] See ADAMS et al. (2012, pp. 25-26), BOSTROM (2014, p. 1) and POHL (2015, p. 2), among others.

[30] Deep learning (DL) is part of a broader family of machine learning methods, which is based on artificial neural networks with representation learning. Learning can be supervised, semi-supervised or unsupervised. Deep-learning architectures such as deep neural networks, deep belief networks, deep reinforcement learning, recurrent neural networks, convolutional neural networks and transformers have been applied to fields including computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, climate science, material inspection and board game programs, where they have produced results comparable to and in some cases surpassing human expert performance. (Source: Wikipedia)

c) Levels of autonomy and classification

SHERIDAN and VERPLANK (1978), from the Massachusetts Institute of Technology (MIT), were among the first to establish a full classification of robot or computer autonomy in their research paper "*Human and Computer Control of Undersea Operators*" (see Figure 6). In their study, they established ten levels of autonomy, from the human doing the whole job or task the computer has then to implement (level 1), to the computer being able to decide what it does and whether it tells the human it has done it (level 10).

Table 2. Levels of Decision Making Automation (Sheridan & Verplank, 1978)

Level of Automation	Description
1.	The computer offers no assistance; the human must make all decisions and actions
2.	The computer offers no assistance; the human must make all decisions and actions
3.	The computer offers a complete set of decision/action alternatives, or
4.	Narrows the selection down to a few, or
5.	Suggests one alternative
6.	Executes that suggestion if the human operator approves, or
7.	Allows the human a restricted time to veto before automatic execution, or
8.	Executes automatically, then necessarily informs the human, and
9.	Informs the human only if asked, or
10.	Informs the human only if it, the computer, decides to

Figure 6. Levels of automation. Sheridan and Verplank, 1978.

Other systems of autonomy classification have also been proposed. The *Society of Automobile Engineers* has created its own classification of driving automation (see Figure 7), from no driving automation (level 0) to full driving automation (level 5), and the *Norwegian Forum for Autonomous Ships* has proposed its own set of levels of autonomy for autonomous ships, from decision support (level 1) to fully autonomous (level 4).

Table 1-2. Summary of SAE International driving automation levels.[4]

Level and Name	Description
Level 0 (L0) No Driving Automation	The human driver does all the driving.
Level 1 (L1) Driver Assistance	Vehicle is controlled by the driver, but some driving assist features may be included that can assist the human driver with either steering or braking/accelerating, but not both simultaneously.
Level 2 (L2) Partial Driving Automation	Vehicle has combined automated functions, like speed control and steering simultaneously, but the driver must remain engaged with the driving task and monitor the environment at all times.
Level 3 (L3) Conditional Driving Automation	An automated driving system on the vehicle can itself perform all aspects of the driving task under some circumstances. Driver is still a necessity, but is not required to monitor the environment when the system is engaged. The driver is expected to be takeover-ready to take control of the vehicle at all times with notice.
Level 4 (L4) High Driving Automation	The vehicle can perform all driving functions under certain conditions. A user may have the option to control the vehicle.
Level 5 (L5) Full Driving Automation	The vehicle can perform all driving functions under all conditions. The human occupants never need to be involved in the driving task.

Figure 7. Levels of vehicle automation. Society of Automobile Engineers (SAE)

All systems share an increasing set of levels, from the inexistence of autonomy to full autonomy, and all establish full autonomy as the greatest level. Such full autonomy is generally understood as (1) the robot being capable of deciding for itself what it does and (2) not needing a human to decide or even know what it does. Full autonomy is therefore understood as a robot which is able to decide for itself what it does, without need for any human intervention, whether this be active or passive. The philosophical nature of such level of autonomy, as well as a more detailed study, are both beyond the scope of the present thesis.

However, we can determine that the intelligence this study would be concerned with would not be full autonomy as the Atlas robot would still have to execute the instructed commands given by its human user, but rather near full automation, where the robot has to fulfil the commands as set by its user but can diverge in so long as it follows its directive. The exact classification of such an intelligence merits a thesis of its own, but for the purposes of the present thesis our future Atlas robot would be able to act autonomously within the confines of the directives given by its users and the base programming as set by its programmer.

4. PRACTICAL APPLICATIONS OF HUMANOID AUTONOMOUS ROBOTS AND ATLAS

As mentioned in the last section, Atlas is not yet commercially available. In fact, there are very few examples of humanoid robots currently available to the public, and these are yet very limited both in degrees of freedom and level of autonomy (e.g., *TALOS* by *PAL Robotics*[31] or *Kime* from *Macco Robotics*[32]). These are usually fixed semi mobile robots or teleoperated robots, with a fairly limited scope of action. Atlas diverges from these robots in the sense that it is fully mobile, and the most agile robot currently being developed. This gives it the greatest potential to be the future of autonomous intelligent robots.

The applications of Atlas and other similar humanoid autonomous robots, just to name a few, would be:

(i) In-home assistance, such as caring for the elderly and children, and helping with everyday tasks such as grocery shopping or cleaning.
(ii) Dangerous tasks, such as search and rescue missions, security, policing, military purposes, mining, and resource extraction.
(iii) Space exploration, such as maintenance of the *International Space Station (ISS)* and surveying of other terrestrial bodies.

In the future it is plausible to think that not only will there be a human workforce, but a robotic workforce as well, intended for those tasks and purposes which humans will not wish to do, or will find more suited for machines. In our case, we will centre on

[31] Launched in 2017, TALOS is a bipedal humanoid robot developed by PAL Robotics. The humanoid robot was created keeping in mind the load of heavy industry tools, being able to incur the load of 6 kgs with each arm fully extended. TALOS' EtherCAT communication network allows to run control loops at 2 kHz, and up to 5 kHz, which enables TALOS to have highly reactive and dynamic motions. (Source: PAL Robotics)

[32] Kime is a humanoid bartering kiosk capable of preparing and serving multiple food and beverage products uninterrupted. It has been showcased in multiple venues, such as the Mobile World Congress. Kime can offer up to 12 different products per kiosk and prepare 2 beverages every 6 seconds. (Source: Macco Robotics)

the case of humanoid robots used for in-home assistance, with our focus being Atlas in particular.

5. FUTURE POTENTIAL AND COMMERCIALIZATION OF HUMANOID ROBOTS

Finally, to establish the commercial potential and level of implementation of humanoid autonomous robots, and therefore the need for proper regulation, we must study the data. The limited scope of the present thesis does not allow for a deep quantitative study, and therefore the present section will be limited to the most relevant data.

As stated by the Humanoid Robot Market Size Growth Report 2032 by Precedence Research (see Figure 8), the global humanoid robot market size was valuated at USD 1.62 billion in 2022 and is projected to be valuated at around USD 28.66 billion by 2032[33].

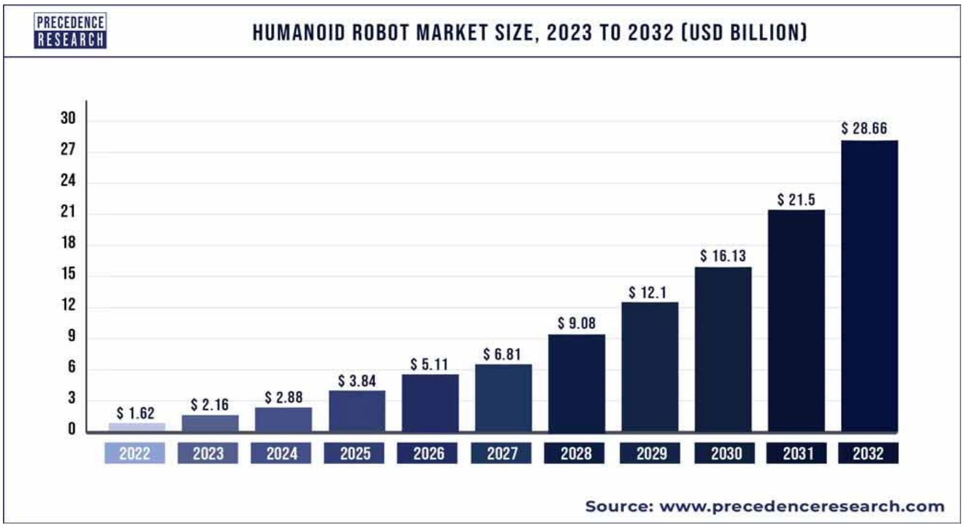

Figure 8. Humanoid robot market size expectations (2022-2032). Precedence research.

The main obstacle at the present time for the full commercialization of humanoid robots, and commercial robots in general, are the elevated costs, both of production as well as development and commercialization. However, American bank Goldman Sachs believes humanoid robots could be economically viable in factory settings between 2025 and 2028, and in consumer applications between 2030 and 2035[34].

Goldman Sachs Research estimates a USD 6 billion market in “people-sized-and-shaped” robots is achievable in the next 10 to 15 years, which would be able to fill 4% of projected US manufacturing labour shortage by 2030 and 2% of global elderly care demand by 2035.

In fact, Goldman Sachs Research is even more ambitious, and projects that “*Should the hurdles of product design, use case, technology, affordability and wide public acceptance be completely overcome, we envision a market of up to US$154bn by 2035 in a blue-sky scenario (close to that of the global EV market and one-third of the global*

[33] Figures as stated by the *Humanoid Robot Market Growth Report for 2032*. (Source: Precedence Research)

[34] Figures and statements as stated by *Humanoid Robots: Sooner Than You Might Think. The investment case for humanoid robots. Goldman Sachs Research report 2022*. (Source: Goldman Sachs)

smartphone market as of 2021), which suggests labor shortage issues such as for manufacturing and elderly care can be solved to a large extent."

Therefore, we can see how with current trends the market for human robots is forecasted to increase by almost 18 times in the next ten years, reaching a market size of between USD 6 billion and up to USD 154 billion by 2035. Forecasts are of course subject to future changes and conditions but offer us a glimpse of how relevant this industry will most probably become in the following years and decades, and the importance of establishing proper regulation.

III. SOLUTIONS TO AUTONOMOUS HUMANOID ROBOTS FROM A TORT LAW PERSPECTIVE IN SPAIN AND THE EUROPEAN UNION

While Sections 1 and 2 have introduced the topic of humanoid intelligent robots such as Atlas and the several legal problems their commercial use and interaction with humans may pose, the present section will deal with how the current regulatory environment could tackle such problems, while Section 4 will offer possible future solutions to the problem.

The study of autonomous intelligent robots from a Tort Law perspective presents several challenges both because of the multiple possible agents involved in their production and use (the manufacturer of the robot, the programmer of the AI, and the final users of the robot), as well as the issues raised by the level of autonomy such robots would present. Thus, the present section will centre around the most challenging issues the commercial use of humanoid intelligent robots in the future could pose:

(i) Liability of the manufacturer for defective product (Section 1)
(ii) Liability of the programmer for defective software (Section 1)
(iii) Liability of the user for damage caused to third parties (Section 2)

1. LIABILITY OF THE MANUFACTURER OR THE PROGRAMMER FOR DEFECTIVE PRODUCT OR SOFTWARE

Since the approval in 1985 of Council Directive 85/374/EEC of 25 July 1985 for liability for damages caused by defective products (onwards, the Directive), most issues raised by damages caused by robots and such machines in the European Union have been solved through the solution of the *liability of the manufacturer for defective product*.

Such a solution requires, as Article 135 of the Revised Text of the Spanish General Law for the Defence of Consumers (onwards, TRLGDCU) establishes, the fulfilment of three elements: (i) the classification of the robot as a product under Article 136 TRLGDCU's scope, (ii) the objective condition of harm caused by a defect attributable to the manufacturer, and (iii) the elements of causation and harm of Article 1902 of the Spanish Civil Code (onwards, SCC). Such a type of liability has been studied in detail by other authors for several types of robots[35], such as surgery robots (e.g., *Intuitive*

[35] See GARCIA-MICÓ (2014), SIMÓN MARCO (2017) and NAVARRO MICHEL (2020), among others.

Surgical's Da Vinci[36]) or autonomous vehicles (e.g., *Tesla*'s Autopilot[37]), and will therefore not be the focus of the present section.

However, new advancements in the fields of both robotics as well as artificial intelligence have proven that such regulation has become insufficient to solve all legal issues raised by the use of intelligent robots and machines. Intelligent robots such as Atlas and non-physical AIs such as *ChatGPT*[38] have proven that even when such products are not defective, attending to the definition of defect as given by the Directive and the TRLGDCU, they can still cause damages for which neither the manufacturer nor the programmer can be made liable[39].

This issue has not gone unnoticed by European institutions, which in 2017 approved Resolution 2015/2013 of the European Parliament with recommendations to the Commission on rules regarding civil Law for robotics, as well as Resolution 2020/2014 of the European Parliament with recommendations to the Commission on a civil liability regime for artificial intelligence. These resolutions although recommendatory in nature, offer some insight on how such issues may be solved, and later influenced the approval of two recent proposals: the Proposal for a regulation of the European Parliament and of the Council laying down harmonised rules on Artificial Intelligence (known as *Artificial Intelligence Act*), as well as the Proposal for a Directive of the European Parliament and of the Council on adapting non-contractual civil liability rules to Artificial Intelligence (the *AI Liability Directive*).

Both will be developed in more detail in Section 4 of the present thesis, as they are not yet in force in the European Union, and present challenges of their own. Therefore, the focus of the present section will be the third and less discussed type of liability regarding the use of intelligent robots: *liability of the user for damage caused to third parties*, making use of the current regulation, jurisprudence, and doctrine in force in the EU and particularly in Spain, tackling in particular the issue of negligence or fault regarding autonomous robots.

2. LIABILITY OF THE USER FOR DAMAGE CAUSED TO THIRD PARTIES

a) Elements of non-contractual liability in the Spanish Civil Code of 1889

Once we have focused our research on non-contractual liability for damage caused to third parties within the Spanish regulatory framework, our starting point must be Article 1902 SCC, which states the following:

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[36] The Da Vinci Surgical System is a robotic surgical system that uses a minimally invasive surgical approach. The system is manufactured by the company Intuitive Surgical. The system is used for prostatectomies, and increasingly for cardiac valve repair, and for renal and gynaecologic surgical procedures. (Source: Wikipedia)

[37] Tesla Autopilot is a suite of advanced driver-assistance system (ADAS) features offered by Tesla that amounts to SAE International Level 2 vehicle automation. The car still requires constant supervision. (Source: Wikipedia)

[38] ChatGPT is an artificial intelligence chatbot developed by OpenAI and released in November 2022. It is built on top of OpenAI's GPT-3.5 and GPT-4 foundational large language models (LLMs) and has been fine-tuned (an approach to transfer learning) using both supervised and reinforcement learning techniques. (Source: Wikipedia)

[39] This is not merely the author's viewpoint, but also a fact recognized by the Directorate-General for Internal Policies in its Study for the JURI Committee on European Civil Law Rules in Robotics (2016).

> ***Article 1902.***
> *Whoever by action or omission causes damage to another, intervening fault or negligence, is obliged to repair the damage caused.*

Therefore, non-contractual liability requires four elements: (i) an action or omission, (ii) which causes damage, (iii) with a causal connection, (iv) intervening fault or negligence[40].

b) A return to the practical case of Atlas as a caretaker

i. Action or omission

As mentioned in the Introduction (See Section 1.1), in the near future we imagined our Atlas robot would be a helper and caretaker at home. This robot would be autonomous to make its own decisions within the limitations of its users' directives and would act as the manufacturer and programmer intended. It is undeniable that such a scenario would allow for both actions and omissions by the Atlas robot on any human beings under its care, such as children or elders; or on any humans interacting with it, such as its users or third parties.

ii. Damage caused

Said interaction by the future Atlas robot with any human beings under its charge, both through physical actions or mere omissions, would have the potential to cause harm to said humans. For example, as in our case, the robot could not be careful enough in its grip and harm the children, or not see an action by the children as dangerous enough and let them harm themselves through inaction. Such actions would not be considered as defective as long as they were the product of the user's directives and the robot's own ability to learn from its environment and adapt its behaviour.

iii. Causal connection

Between the action or inaction of the Atlas robot and the damage caused by said action there must exist a causal connection. This connection would exist in so far as the damage produced by the robot is the result of its actions. The issue turns more complex once we must connect the damage and the robot's action or inaction to its human user's or user's action or inaction. The causal path would be as follows (see Figure 9):

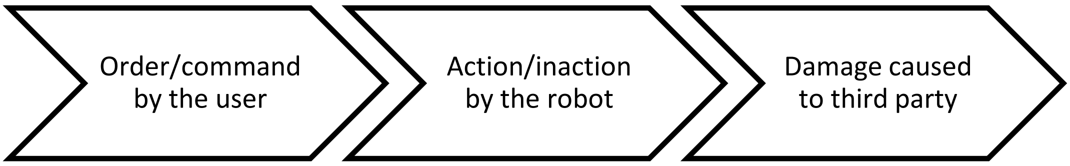

Figure 9. Order of causation for damages caused by an autonomous Atlas

[40] VICENTE DOMINGO (2013, pp. 71-89) and PEÑA LÓPEZ (2013, pp. 12960-13002) understand the damage as the most essential element of the four, being in fact the first prerequisite of any possible liability.

iv. Intervening fault or negligence

Robots, as inanimate objects, no matter how complex, have no conception of good or evil, or intentions in themselves. They follow the orders given by their users within the confines of what their programming and artificial intelligence allow, at most being able to learn new actions through trial and error (see Section 2.2).

Fault or negligence cannot lie within the robot itself, at least not as long as robots have no will of their own or a capacity to act with malice or negligence themselves[41]. Therefore, fault or negligence must lie within the human agent or legal person behind said robot or machine, be that their user or users, or their manufacturers or programmers through product liability[42]. Having established that in this scenario the robot would not be defective either in its programming nor in its manufacturing, the present issue then is to establish how negligence of the user and owner in its instructions can possibly be sustained as cause for liability through current legislation.

c) Liability for another's act: vicarious liability

As we have established, Atlas, in so far as not able to be negligent nor have a will of its own, cannot be made liable for harm caused by its actions or omissions. Having also set aside the manufacturer and the programmer, we must therefore establish how its human users could be made liable for its actions. Both doctrine and jurisprudence offer us several ways we could form such a solution, but it is the liability for another's act (*vicarious liability*) which in my opinion offers the most consistent basis for a solution to the problem.

Although the general rule in Tort Law is to be made liable for one's own negligent actions or inactions (Art. 1902 SCC), there also exists the possibility of being liable for another's actions in so far as those actions fall within our own scope of control (Art. 1903 SCC)[43]. This is what we know as liability for another's act, or vicarious liability as it is often referred to, which in essence is merely the liability for one's own acts through another's[44]. It is an exception to the general rule of personal liability for one's own acts and establishes a legal presumption (*iuris tantum*) of culpability of those agents explicitly mentioned in the article itself[45]. This is established by Article 1903 SCC, which affirms that:

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[41] More complex AIs with wills of their own, such as Artificial General Intelligences (AGIs), are still far from being a reality, and would be banned under the EU's proposed regulation, see Section 4.

[42] GÓMEZ CALLE (1995, p. 95) understands that to respond for damages according to Article 1902 SCC, one must be "civilly imputable", which for the purposes of non-contractual liability implies having "sufficient capacity for discernment to understand the scope of their actions and foresee their possible consequences, as well as also being in a position to act in accordance with said understanding to avoid the expected damage."

[43] NAVARRO MICHEL (1998, p. 22) understands that there is a disassociation between the author of the action or inaction and the liable party.

[44] ALONSO SOTO (1977, p. 396) and DIEZ-PICAZO (1999, p. 364) among others, argue that Article 1903 SCC sets out a liability for one's own acts through the acts of another.

[45] See GÓMEZ CALLE (1990, p. 218), DIEZ-PICAZO and GULLON (1992, p. 625) and MORENO DE TORO (1994, p. 45), among others.

Article 1903.
The obligation imposed by the previous article is enforceable not only for one's own acts or omissions, but also for those of those persons for whom one must respond.
Parents are responsible for damages caused by children under their guardianship.
Guardians are responsible for damages caused by minors who are under their authority and live in their company.
The curators with full powers of representation are curators of the damages caused by the person to whom they provide support, as long as they live with them.
The owners or directors of an establishment or company are equally so with respect to the damages caused by their dependant in the service of the branches in which they were employed, or on the occasion of their duties.
The persons or entities that are owners of a non-higher education educational Center will be liable for damages caused by their underage students during the periods of time in which they are under the control or surveillance of the Center's teaching staff, developing school or extracurricular and complementary activities.
The responsibility that this article deals with will cease when the persons mentioned in it prove that they used all the diligence of a good father of a family to prevent the damage.

For simplifying reasons, we will centre on parents, guardians and curators, as our practical example revolves around humanoid intelligent robots that help and assist at home with caretaking and other such related tasks, also known as *culpa in vigilando*. The reasons why I chose to look at this specific type of liability and not at other currently existing liability regimes for non-human actors such as animals (Art. 1905 SCC), would be (i) because autonomous humanoid robots have capabilities to cause harm more similar to those of humans than non-human actors, (ii) because as technology improves and robots become progressively more intelligent and advanced, simplified liability regimes would not suffice to determine liability[46] and (iii) because unlike liability regimes for animals, vicarious liability does allow for a greater degree of autonomy on the dependent agent's part[47], in this case, the robot's.

d) Culpa in vigilando: How to build the case of vicarious liability for damages caused by humanoid autonomous robots

The several types of liability that article 1903 SCC develops are mainly three: (i) *culpa in eligendo*, (ii) *culpa in vigilando*, and (iii) *culpa in educando*. In our case, we will centre around the second case of *culpa in vigilando*, with respect to parents, guardians and curators, as it is the case which applies under harm caused by children under a parent's care[48].

Culpa in vigilando or "fault in supervising" is the liability that can be attributed to the superior of a dependent relationship by actions or inactions committed by its dependent agent because of an omission of the superior's duty of control and

[46] Article 1905 SCC establishes a stricter liability regime for animal owners, being always liable in the case their animals cause harm as long as there is no *force majeure* or fault of the victims themselves involved.

[47] Article 1905 SCC does not allow for an animal's level of autonomy to play any role in determining liability.

[48] *Culpa in eligendo* would apply to the case of business owners for harm caused by their employees, and *culpa in educando* to the harm caused or suffered by children under a school or education center's care. They could be used for harm caused by autonomous robots in working or education environments, but in my opinion, they would not be suitable liability regimes for other cases. *Culpa in vigilando* offers us a more versatile liability regime.

vigilance[49]. The Spanish Supreme Court (onwards, SSC) understands that "*the person to whom the culpa in vigilando is attributed to has the right of direction, control, intervention or vigilance on the activity deployed by the other agent*"[50]. The court understands that such liability encompasses all those situations when a person to which the culpa in vigilando is attributed to has a certain level of authority or control on the activity of another agent, when it exists a "*causal connection between two people characterized by the capacity of one of them to give orders or instructions to the other*"[51].

In this way, the SCC understands that such liability requires four elements: (i) dependency between the author of the damage and the entity on which it depends, (ii) a causal connection between the action or inaction of the author and the omission of the duty of control by the superior entity, (iii) the absence of due diligence on the superior's duty to establish effective and sufficient means of vigilance or control and (iv) the level of control that can and should be exercised in each case.

i. Dependency between the author of the damage and the entity on which it depends

Both doctrine and jurisprudence understand that the starting point of *culpa in vigilando* is the existence of a relationship of dependence between the agent performing the action and the other agent[52]. This is perhaps the most essential element and is characterized by a hierarchical or authority relationship between both agents, not being necessary a formal or strict dependency between the two[53].

In the case of Atlas, the dependency relationship between the robot and the users (in this case, the owners of the robot) is clear. The main issue one could raise is whether Atlas can be considered a dependent agent under which culpa in vigilando would apply, as it is not a person *per se*. Such issue however could be solved if we assimilate the robot's position to that of a child's, who cannot legally respond for damages on its own. In this way, we can see how an autonomous robot may be similar to such agents in so far as they are a non-responsible agent, and therefore could be assimilated to them.

ii. Causal connection between the action or inaction of the author and the omission of the duty of control by the superior entity

Once dependency has been established, we must analyse whether there exists a causal nexus between the action or inaction of the robot and the omission on the duty of supervision of its user giving the commands. In the case of the Atlas robot, in so far as its actions are the result of the orders given by its user, there is a causal connection

[49] STS of March 24th, 1979 (C2), and STS of March 11th, 2000 (FJ2).

[50] STS of December 30th, 1992 (FJ4), STS of March 17th, 2009 (FJ2), and STS of June 1st, 2010 (FJ5).

[51] STS of December 10th, 1992 (FJ2), STS of December 30th, 1992 (FJ4), and STS of March 17th, 2009 (FJ2).

[52] STS of May 14th, 2010 (FJ3).

[53] STS of April 3rd, 2006 (FJ3), and STS of May 6th, 2009 (FJ3).

between the two. Even if the robot is able to adapt and change its behaviour, it would do so within the scope of its main commands and would therefore act within said scope control or supervision.

iii. Absence of due diligence on the superior's duty to establish effective and sufficient means of vigilance or control

Given that the robot is not fully intelligent nor conscious, it is the agent giving the commands which must ensure the necessary due diligence in the form and content of their directives[54]. In the case of the Atlas robot, a superior entity may be absolved of liability in so far as they gave commands that were sufficiently precise and encompassed sufficient situations as to give the robot enough direction and scope of action to exercise its duties effectively. Therefore, in the case that we accepted such an assumption, then the matter would be to establish whether the victim could then be made liable for their own negligence for the damages suffered, or whether we should establish a strict vicarious liability regime for autonomous robots, where the mere proof of damages caused and the existence of causal connection, could be enough to constitute liability of the user giving the commands.

In order to prevent unfairness, such a solution could be graded according to the level of autonomy or self-learning capability of the robot in question: *the greater the robot's capability of self-learning is, the lower the user's liability should be, and so forth*[55]. A graphic representation of such a scheme of liability would be as follows (see Figure 10):

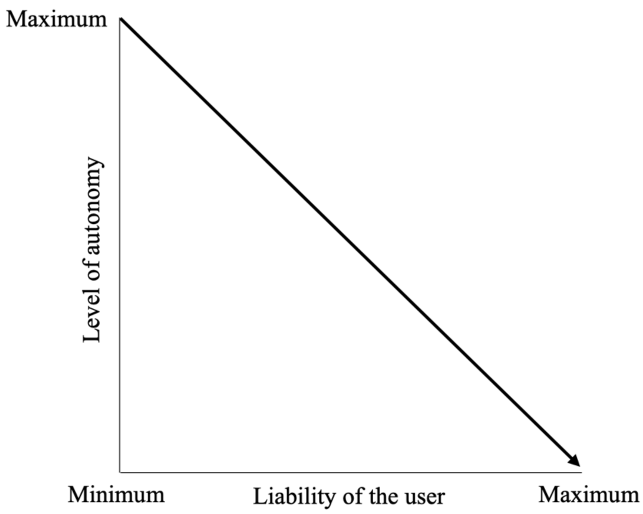

Figure 10. Levels of autonomy in relation to liability of the user

[54] The SSC affirms that even if the dependent agent is not liable, the superior still is. STS of June 30th, 1995 (FJ2).

[55] Such a proposal is succinctly mentioned by the Directorate-General for Internal Policies in its Study for the JURI Committee on European civil law rules in robotics (2016). However, it still raises several issues that must be solved: How should such a level of self-learning be measured? Should judges be left to establish it themselves or should strict classifications be made in order to simplify the process? Such questions have no easy answer, but a possible solution could be to establish a basic framework and classification of autonomy to guide judges in their decisions, even forming specialized sections of judges within each judiciary level or institution.

In any case, the level of due diligence that can be expected from the user or agent must be adapted on a case-to-case basis, depending on the level of autonomy and self-learning capabilities of the robot in question.

iv. The level of control that can and should be exercised in the case of autonomous robots capable of adapting their own behaviour

Once we have established dependency, the causal connection, and the absence of due diligence on the user or user's part when giving its orders or commands, we must establish the level of control or supervision that should be expected from said agents. As discussed in the above section, the level of control expected must vary according to the robot's autonomy and capacity for self-learning.

However, we must make an important distinction between (i) control understood as orders or commands given to the robot, and (ii) supervision understood as visual or physical control of the robot while performing its duties. Through this distinction, the level and manner of control that could be expected of the superior agent would vary depending on whether they are absent and have merely given commands (our case) or whether they are within the robot's area of action and could intervene in the scene. Both jurisprudence and doctrine, in the cases of parents supervising their children, have varying views for both situations[56].

The SSC has established that the responsibility of parents for the damages caused by their children requires a rigorous level of due diligence on the parents' part to evade any kind of responsibility[57]. The SSC considers in fact the parents' responsibility over the children's damaging acts an almost objective responsibility, requiring them to prove that they exercised the necessary and sufficient level of vigilance or control to prevent the act, and that not being present when such acts were committed is no excuse to evade liability[58].

In fact, the requirement of the SCC on the parents' part is such that cases where parents were able to prove their due diligence are rare, ensuring that the victim is almost always compensated for the harm caused[59]. Some authors go so far as to affirm that

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[56] STS of June 17th, 1980 (C1), STS of May 16th, 2000 (FJ2) and STS of March 8th, 2006 (FJ5), among others.

[57] STS of June 17th, 1980 (C1), and STS of September 22nd, 1984 (C2).

[58] The SSC has repeatedly established that: "It is the doctrine of this Chamber that the responsibility declared in article 1903, although it follows a precept that is based on responsibility due to fault or negligence, it does not mention such information of guilt, and for that it has been argued that it contemplates a liability for risk or quasi-objective liability, justifying itself by the transgression of the duty of vigilance that it is expected of parents on the children subject to their authority with presumption of guilt on the one who holds it and the insertion of that objective nuance in said responsibility, which comes to obey risk criteria in no lesser proportion than the subjective ones of guilt, without being allowed to rely on the fact that the conduct of the minor, due to their young age and immaturity, cannot be classified as liable, since the responsibility stems from the guardian's own fault due to omission of their duty of vigilance." STS of March 8th, 2006 (FJ5), STS of March 14th, 1978 (RJ 1978, 815), STS of March 24th, 1979 (C2), STS of March 10th, 1983 (C3), STS of January 22nd, 1991 (FJ2), STS of January 7th, 1992 (FJ2), STS of June 30th, 1995 (FJ2), STS of May 16th, 2000 (FJ2), and STS of November 10th, 2006 (FJ3).

[59] STS of December 29th, 1962 (RJ 1962, 5141), and STS of March 8th, 2006 (FJ5), among others.

fault has almost disappeared as an element of the precept[60]. The SSC understands that such responsibility of the parents arises from their parental authority as derived from art. 154 SCC. In the case of Atlas, such authority would be derived by the property rights over the robot itself.

As for the conduct of the robot and how its users could exercise sufficient vigilance and control, the fact that proof of due diligence is highly restrictive for children does not necessarily imply that such would be the case for autonomous robots. The responsibility of the users would vary according to the manner of the instructions or commands given, their level of precision and consideration of all factors involved. Users would still be made liable for their own actions in so far as they did not fulfil their duties of vigilance and control[61], but in this case their actions would be their commands, which would have to be precise and clear enough. Unlike children, an autonomous robot would always try to follow instructions to the letter or as near as possible, and it would therefore be harder for the parents to evade responsibility.

However, it is also possible that with enough training and learning, the robot could be able to act in ways completely unpredictable for the parents or understand orders or commands more broadly or more restrictively than they were intended[62], in a manner unpredictable or sufficiently hard to predict for the parents to evade responsibility[63].

For example, if the parents gave the robot the command to "*Look after the children at home*", and if the children were somehow able to escape their home into their garden, the robot could then either not pursue if it understood that they had to remain at home or expand the concept of home to the garden itself. In each case, the level of vigilance and control that could be demanded of the parents would vary depending on the level of sophistication of the robot itself and its ability to interpret commands, as well as the level of precision and contents of the commands themselves[64].

In any case, from both our assimilation of the relevant case-law on parental liability for damages caused by their children, as well as the analysis of said case-law as applied under the particularities of autonomous robots such as Atlas, it is clear that parents could and would most probably be made liable for their robot's actions or

[60] DIEZ-PICAZO (1979, p. 733) is of the opinion that in practice the fault element has almost disappeared.

[61] This is reflected in numerous rulings by the SSC such as STS of March 14th, 1978 (RJ 1978, 815), STS of January 22nd, 1991 (FJ2), or STS of January 7th, 1992 (FJ2), among others.

[62] FRANKLIN et al. (2022, pp. 276-284) and other authors have argued that foreseeability could play a major role in how to determine liability by actions or omissions committed by autonomous robots.

[63] GRIFFIN (2017) explains the famous case of the two Facebook chat bots, Alice and Bob, who had to be shut down after they developed their own language that could only be understood by them. Although it was a simple case of the language used by the chatbots degenerating because of incorrect parameters set by the researchers, it is not unreasonable to consider the possibility of commands being interpreted in unpredictable ways.

[64] On predictability and the causal connection, the SSC affirms that "It should be noted that physical causation is not enough, but rather it is necessary for there to be an action or omission attributable to the person who is claimed to be responsible -or for whom one must answer- determinant, exclusively or in conjunction with other causes, always with certainty, or in a judgment of qualified probability, according to the concurrent circumstances -among them the entity of the risk-, of the harmful result produced." STS of January 26th, 2007 (FJ3).

inactions while in charge of their children, in so far as they did not exercise the sufficient level of vigilance and control. In such cases, the courts would most likely assimilate the position of the robot to that of a child, with the particularities that such agents would present, such as the level of autonomy displayed and the foreseeability of their actions within their commands.

e) Going even further than the robot itself: Culpa in vigilando in vigilado

Once we have established how the user could be made liable for the robot's actions or inactions, we can go further and study the following scenario: the case where it is the person itself under the robot's care, the children, who causes harm to a third party. Would then the parents and users still be liable for the robot's inaction and the children's action?

In short and following the same process as we did in the above section, they could indeed be made liable. This hypothetical scenario would play as follows (see Figure 11):

Figure 11. Order of causation in the case of two non-responsible third parties

As we can see, the structure would be similar to that of *culpa in vigilando*, with the further complication of two dependent agents in subsequent order of causality instead of one. Such cases would present the complication of establishing the causal connection between the action of the first dependent agent, the inaction of the robot and the command of the user but would not need a different solution than before[65].

IV. FUTURE REGULATORY PROPOSALS IN THE EUROPEAN UNION FOR ARTIFICIAL INTELLIGENCE APPLIED TO ROBOTICS

Once we have established how our current regulation tackles with the legal issues raised by the use of humanoid intelligent robots from a Tort Law perspective, I will dedicate this section to future solutions to the problem from a double perspective: (i) how recent proposals from the European Union regarding AI and robotics address the problem of liability[66] and (ii) alternative liability regimes for autonomous robots as presented by both EU institutions and other authors. My own proposal on the matter will be developed in the Conclusions (see Section 5).

[65] In this case, unpredictability could play an even major role, as the user would not only have had to predict the robot's behaviour when giving the commands, but also the dependent person's own response to said behaviour.

[66] Regarding the EU proposals, it is not the objective of the present thesis to offer a detailed analysis but rather a study of the most relevant aspects with regards to liability for autonomous robots such as Atlas.

1. Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act)

The matter of artificial intelligence and its possible risks has been at the forefront of the public debate in the European Union in recent years. This fact has not gone unnoticed by European institutions, who have enacted a series of resolutions and guidelines or recommendations to address the issue and the rising concerns. Among these, and following the advice given by the High-level Expert Group on Artificial Intelligence[67], in 2021 the European Commission proposed a first draft of the Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on Artificial Intelligence and amending certain union legislative acts (onwards, Artificial Intelligence Act).

The Artificial Intelligence Act was then brought to the European Council and later to the European Parliament, where it is currently being discussed. The Act is structured around eight titles and broadly offers regulation and guidelines on six main issues: (i) scope and definitions of AI, (ii) prohibited artificial intelligence practices, (iii) high-risk and low or minimal risk AI systems, (iv) transparency obligations for certain AI systems, (v) measures in support of innovation and (vi) governance and implementation. For the purposes of the present thesis, I will centre only on issues first to third (*scope and definitions of AI, prohibited artificial intelligence practices and high-risk and low or minimal risk AI systems*)[68].

a) Scope and definitions of AI

Title I defines artificial intelligence as the subject matter of the regulation[69] and establishes the scope and application to providers and users of the placing on the market of services and products which make use of AI systems[70]. The definition of AI system in the legal framework aims to be as technology neutral and future proof as possible, taking into account the fast technological and market developments related to AI.

[67] The High-level Expert Group on Artificial Intelligence was appointed by the European Commission to provide advice on its artificial intelligence strategy. (Source: European Commission)

[68] The reasons for this are that for the purposes of liability regarding autonomous robots as developed by the AI Liability Directive (see Section 4.2), these are the most relevant aspects we must consider.

[69] Article 3.1 defines AI as "software that is developed with one or more of the techniques and approaches listed in Annex I and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with;" The techniques and approaches listed by Annex I referred to in Art. 3.1 are "(a) Machine learning approaches, including supervised, unsupervised and reinforcement learning, using a wide variety of methods including deep learning; (b) Logic-and knowledge-based approaches, including knowledge representation, inductive (logic) programming, knowledge bases, inference and deductive engines, (symbolic) reasoning and expert systems; (c) Statistical approaches, Bayesian estimation, search and optimization methods." Atlas would fall within category (a).

[70] Article 2 defines the scope of application as applying to "(a) providers placing on the market or putting into service AI systems in the Union, irrespective of whether those providers are established within the Union or in a third country; (b) users of AI systems located within the Union; (c) providers and users of AI systems that are located in a third country, where the output produced by the system is used in the Union."

Given that the future Atlas robot we envision would imply the commercialization of a product or service with a built-in system of artificial intelligence within the European Union, it would fall within the scope and definition of AI of said regulation.

b) Prohibited artificial intelligence practices

Title II establishes a list of prohibited AIs following a risk-based approach, differentiating between those AIs that (i) create an unacceptable risk, (ii) a high risk and (iii) a low or minimal risk. The list of prohibited AI systems encompasses all those AIs capable of posing an unacceptable risk to fundamental rights, such as (a) through the manipulation of behaviour of people through subliminal techniques, (b) through exploiting vulnerabilities of specific vulnerable groups, (c) through the placing of systems of social evaluation by public authorities and (d) the use of 'real time' remote biometric identification systems in public spaces for the purpose of law enforcement, which is also prohibited unless certain limited exceptions apply[71].

Returning to our case with the future Atlas robot, as long as it is not able to manipulate behaviour nor use real time biometric identification systems in public spaces for law enforcement purposes, it would not fall within the classification of the prohibited AIs.[72]

c) High-risk and low or minimal risk AI systems

Finally, Title III contains specific rules for AI systems that create a high risk to the health, safety or fundamental rights of people within the EU. The use of such high-risk systems would then be subject to certain prerequisites, such as an exa-ante conformity assessment. Title III sets a classification of rules and identifies two main categories of high-risk AI systems: (i) AI systems intended to be used as safety components and (ii) other stand-alone AI systems with mainly fundamental rights implications[73]. Then, it outlines the legal requirements for data protection of such systems, as well as the set of obligations on both providers and users.

High-risk systems are then expected to comply with certain requirements[74]: (a) risk management services, (b) data and data governance, (c) technical documentation, (d) record-keeping, (e) transparency and provision of information to users, (f) human oversight, and (g) accuracy, robustness and cybersecurity. In our case, our main concern would be on the one hand whether our Atlas robot would fall within the high-risk AI systems classification and, if it would, how would human oversight be implemented.

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[71] However, the Commission notes that such issues of data protection would mostly be covered by the existing data protection regulation. Such regulation would be Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation or GDPR) (Text with EEA relevance).

[72] It must be noted that Atlas, as an autonomous robot interacting with vulnerable groups, may need to comply with even more strict safety standards, such as regulation regarding vulnerable consumers such as elders.

[73] Articles 6 and 7.

[74] Articles 9, 10, 11, 12, 13, 14 and 15.

On the matter of the classification, Article 6 establishes that an AI system shall be considered high-risk when either (i) the AI system is intended to be used as a safety component of a product, or is itself a product, covered by the Union harmonisation legislation listed in Annex II[75], and the product whose safety component is the AI system, or the AI system itself as a product, is required to undergo a third-party conformity assessment with a view to the placing on the market or putting into service of that product; or (ii) the AI system can be classified as an explicitly high-risk AI system listed in Annex III[76].

Therefore, Atlas will be considered a high-risk system as long as it is either (a) an AI system intended to be used as a safety component of a product or itself a product, covered under harmonized legislation listed in Annex II, or (b) an AI system listed as an explicitly high-risk system in Annex III[77]. Therefore, the Atlas, as an autonomous robot capable of caring for children or other vulnerable groups such as elders autonomously through the use of biometric identification systems, which would in turn pose several issues regarding fundamental rights of said natural person, would fall within the explicit high-risk AI system classification as established by Annex III[78].

And, on the matter of the human supervision, Article 14 lays down two main ways through which human oversight may be ensured: (1) identified and built, when technically feasible, into the high-risk AI system by the provider before it is placed on the market or put into service; and (2) identified by the provider before placing the high-risk AI system on the market or putting it into service and that are appropriate to be implemented by the user.

These measures, as established by the precept, shall enable the individuals to whom human oversight is assigned to not only fully understand the capacities and limitations of said high-risk systems, but also remain aware of the possible tendency to over-rely on its outputs, be able to correctly interpret them and be able to not use said outputs, or even stop or interrupt the system at any moment altogether. This poses a

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[75] Annex II of the proposal lays down a list of specific EU regulation regarding certain goods with fundamental rights implications, such as machinery, safety components, aviation, motor vehicles, medical devices and protective systems, among others.

[76] Annex III of the proposal sets out a list of explicitly high-risk AI systems, which include (1) biometric identification systems, (2) management and operation of critical infrastructure, (3) education and vocational training, (4) employment, workers management and access to self-employment, (5) access to and enjoyment of essential private and public services and benefits, (6) law enforcement, (7) migration, asylum and border control, and (8) administration of justice and democratic processes.

[77] It must be noted that Article 7.1 allows for the possibility of expanding the list of explicit high-risk AI systems of Annex III, establishing that "The Commission is empowered to adopt delegated acts in accordance with Article 73 to update the list in Annex III by adding high-risk AI systems where both of the following conditions are fulfilled: (a) the AI systems are intended to be used in any of the areas listed in points 1 to 8 of Annex III; (b) the AI systems pose a risk of harm to the health and safety, or a risk of adverse impact on fundamental rights, that is, in respect of its severity and probability of occurrence, equivalent to or greater than the risk of harm or of adverse impact posed by the high-risk AI systems already referred to in Annex III." As development and implementation of such technologies progresses, it is probable that the Commission will expand the list.

[78] Annex III.1(a) defines such biometric identification and categorization of natural persons as "AI systems intended to be used for the 'real-time' and 'post' remote biometric identification of natural persons." This distinguishes such biometric identification systems from prohibited AI biometric identification systems, which would be intended for public spaces with law enforcement purposes. In our case, as long as Atlas is able to use biometric identification and categorization of natural persons, it would be classified as a high-risk system.

legal challenge when it comes to high-risk AI systems taking care of vulnerable people or groups without physical human oversight, such as was our practical case with Atlas.

However, such a challenge could be overcome through either (i) built-in monitoring systems that allow providers to control and even remotely interrupt operations of any defective robot or (ii) similarly built-in monitoring and control systems that allow users to not only control and interrupt the system physically but also remotely. A safe word or simple verbal code could also be implemented as an emergency interrupt system for vulnerable groups such as children or elders who may be left at the care of robots with such AI systems.

2. Proposal for a Directive of the European Parliament and of the Council on adapting non-contractual civil liability rules to Artificial Intelligence (AI Liability Directive)

Complementing the above-mentioned Artificial Intelligence Act, in September 2022 the European Commission proposed the Proposal for a Directive of the European Parliament and of the Council on adapting non-contractual civil liability rules to Artificial Intelligence (onwards, AI Liability Directive), which aims to establish a harmonized regime for consumer liability claims for damages caused by AI products and services.

The AI Liability Directive is composed of 9 articles which mainly outline common liability rules on two issues: (i) the disclosure of evidence on high-risk artificial intelligence systems to enable a claimant to substantiate a non-contractual fault-based civil law claim for damages[79]; and (ii) the burden of proof in the case of non-contractual fault-based civil law claims brought before national courts for damages caused by an AI system[80].

On the first matter, the Directive mainly establishes an obligation towards the states to provide national courts with sufficient means to ensure that claimants have access to evidence regarding high-risk systems which are suspected of having caused damage. And, on the second matter, the Directive establishes a presumption of fault on the defendant of such AI systems subject to certain conditions[81]. On this matter, for high-risk systems Article 4.2 establishes a series of requirements which upon failure to comply by the provider or user, would imply the fault of the defendant.

These requirements are the following: (a) the AI system is a system which makes use of techniques involving the training of models with data and which was not developed on the basis of training, validation and testing data sets that meet the quality

[79] Article 3 lays down the conditions and means through which member states must empower national courts to be able to disclose the relevant evidence on high-risk AI systems suspected of having committed damages.

[80] Article 4 lays down a presumption of fault of the defendant similar to that of Article 1903 SCC of vicarious liability. This seems to imply a preference by the Commission for an objective or semi-objective liability regime for such AI systems and high-risk systems.

[81] Article 4.1 lays these conditions as "(a) the claimant has demonstrated or the court has presumed pursuant to Article 3(5), the fault of the defendant, or of a person for whose behaviour the defendant is responsible, consisting in the non-compliance with a duty of care laid down in Union or national law directly intended to protect against the damage that occurred; (b) it can be considered reasonably likely, based on the circumstances of the case, that the fault has influenced the output produced by the AI system or the failure of the AI system to produce an output; (c) the claimant has demonstrated that the output produced by the AI system or the failure of the AI system to produce an output gave rise to the damage."

criteria[82], (b) the AI system was not designed and developed in a way that meets the transparency requirements[83], (c) the AI system was not designed and developed in a way that allows for an effective oversight by natural persons during the period in which the AI system is in use[84], (d) the AI system was not designed and developed so as to achieve, in the light of its intended purpose, an appropriate level of accuracy, robustness and cybersecurity[85], or (e) the necessary corrective actions were not immediately taken to bring the AI system in conformity with the obligations[86].

Finally, Article 4.3 establishes, for the case of users as defendants, that their fault for not having fulfilled their duty of care will be presumed when either (1) the user did not comply with their obligations to use or monitor the AI system in accordance with the accompanying instructions or, where appropriate, suspend or interrupt its use[87], or (2) exposed the AI system to input data under their control which is not relevant in view of the system's intended purpose[88].

For our case of Atlas, given that we classified its AI system as a high-risk system according to Article 6 of the Artificial Intelligence Act, both articles 3 and 4 of the AI Liability Directive would apply. This implies that, once the Directive goes into effect and is transposed into the national legal frameworks, there would be four main consequences: (i) all claims brought against the users of said robot would work under a presumption of fault in so far as conditions of Article 4.1 are met, (ii) users would be obliged to disclose all relevant evidence as requested by the claimant about their Atlas robot's AI specifications in so far as it is a high-risk system as pursuant to Article 3, (iii) the failure to comply with such obligation would imply a presumption of non-compliance with a relevant duty of care, and (iv) users would be presumed to not have fulfilled the necessary duties of care when either they did not comply with their obligations to use or monitor the AI system, or exposed the AI system to input data under their control which was not relevant.

This would mean that EU institutions have chosen a quasi-objective liability regime for high-risk AI systems, in so far as liability would only require harm and causation except in the cases where the user proves to have fulfilled the necessary duties of care. What this implies for Atlas would be that, once such regulation goes into effect, the vicarious liability regime that I developed in Section 3.2 would be perfectly

[82] Referred to in Article 10.2 to 4 of the AI Act.

[83] As laid down in Article 13 of the AI Act.

[84] Pursuant to Article 14 of the AI Act.

[85] Pursuant to Article 15 and Article 16, point (a), of the AI Act.

[86] As laid down in Title III, Chapter 2 of the AI Act or to withdraw or recall the system, as appropriate, pursuant to Article 16, point (g), and Article 21 of the AI Act.

[87] Pursuant to Article 29 of the AI Act.

[88] Pursuant to Article 29.3 of the AI Act, which affirms that "Without prejudice to paragraph 1, to the extent the user exercises control over the input data, that user shall ensure that input data is relevant in view of the intended purpose of the high-risk AI system." These inputs can be assimilated to the commands given by the user to the Atlas robot in our practical case.

compatible with this new regime, simply requiring that the case fall under the high-risk AI definition, on a case-by-case basis.

3. ALTERNATIVE REGULATORY PROPOSALS FOR AUTONOMOUS HUMANOID ROBOTS

a) The proposal of general and specific insurance schemes for robot owners

Among the several options available to us on the matter of how to tackle liability for damages caused by actions or omissions of AI systems, and in particular of autonomous robots, one such solution proposed by several authors are both general and case-specific insurance schemes for robot owners. The idea, as proposed for example by BERTOLINI et al. (2016)[89], would be to establish insurance contracts for robot owners so that in so far as damage is produced and it can be attributed to actions or omissions by said robots, their owners or users would be made liable and would have to respond for any damages caused[90].

These contracts would work in a similar way to insurance for motor vehicles, establishing a monthly payment to be made by the user or owner in accordance with a risk assessment of their AI system or autonomous robot, although it must be noted that such risk assessments may be complex to determine, and may lead to certain types of robots not being insured, or having to pay superior risk premiums[91]. These payments would then be used to repair any damages caused by said robots in so far as effective damage could be proved and the causal connection between the action or inaction of the robot and the damage be established.

[89] BERTOLINI (2016, p. 296) and BERTOLINI et al. (2016, pp. 387-388). GARCIA-MICÓ (2021, p. 103) also proposes this idea as "One potential solution might be the creation of a specific insurance scheme, that turns into a way of revisiting institutions of contract law to assess how the risks and costs posed by emerging technologies can be internalized. This would involve not a general civil liability insurance, but a case-specific insurance."

[90] The Committee on Legal Affairs of the European Parliament, on its Draft Report with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), also arrives to this same conclusion, stating on its principles 29 and 30 that "29. Points out that a possible solution to the complexity of allocating responsibility for damage caused by increasingly autonomous robots could be an obligatory insurance scheme, as is already the case, for instance, with cars; notes, nevertheless, that unlike the insurance system for road traffic, where the insurance covers human acts and failures, an insurance system for robotics could be based on the obligation of the producer to take out an insurance for the autonomous robots it produces;" and "30. Considers that, as is the case with the insurance of motor vehicles, such an insurance system could be supplemented by a fund in order to ensure that reparation can be made for damage in cases where no insurance cover exists; calls on the insurance industry to develop new products that are in line with the advances in robotics;".

[91] BERTOLINI et al. (2016, p. 388) notes that "the complexity and novelty of robots (i.e. autonomous) causes the identification of the damages they may bring about in a real life environment to be extremely complex, diversified and hard to foretell and hence managed. The same kind of technical malfunctioning may indeed determine very different outcomes once the device is used in different and *ex ante* unrestrained environments (like in the case of a robotic prosthesis). The complexity and to some extent opacity – if not inadequateness – of the legal framework further adds upon such considerations, causing the assessment of the risk pertaining to each party involved (be it the producer or user) to be even more complex. Indeed, in some cases, it is not even clear which party may be held liable, hence, ultimately, who should have an interest to acquire insurance coverage. Overall, this may result either in the (i) refusal to insure some kinds of robotic devices, or (ii) the use of existing contracts, which however may prove inadequate, or (iii) the charging of higher premiums, ultimately delaying the diffusion of robots as well as impairing the proliferation of a supply side of the economy (industry for the production of robots)."

This insurance would even allow for the possibility of a public fund to supplement those cases where insurance does not exist, or by implementing an obligatory minimum insurance for all robot owners, given the inherent risk autonomous robots may pose to human health, safety and fundamental rights[92]. The benefits of such a proposal would mainly be (i) the simpler allocation of responsibility for damages caused by autonomous robots, in so far as it would not require judges to establish the case of vicarious liability through the elements of Article 1903 of the SCC[93], as well as (ii) the ensurance of reparation for any damages caused.

However, it must be noted that such liability schemes would in practice presume fault on the part of the defendant for any damages caused by their autonomous robots and would not consider any aspects regarding the level of autonomy and predictability of the robot, nor of due diligence on the part of the user or owner when exercising control and giving commands. It would simplify the process and ensure reparation, but at the cost of not allowing for a greater degree of a possible proof of due diligence on the defendant's side. Further regulation on this aspect should be added, such an exception clause to the insurance where users or owners would not have to respond for damages even if insured in so far as they acted with due diligence.

b) The proposal for an electronic personhood and a legal status for AI

Finally, and once we have established liability solutions to advanced AI systems through both current legislation, future EU proposals and possible general robot insurance schemes, we must turn to the last proposition: *an electronic personhood and legal status for AI*. Such a proposal was already discussed by the European Parliament during the debates surrounding the Draft Report on EU Civil Law Rules in Robotics proposed by rapporteur Mady Delvaux and the JURI Committee (the Committee on Legal Affairs) on May 31st of 2016[94].

This proposal was one of many such initiatives that the committee discussed and offered as possible solutions to the question of liability for actions or omissions committed by autonomous robots and advanced artificial intelligence systems but was not developed in detail and rather simply mentioned as a possible solution that the Commission should consider when implementing future regulation regarding this issue.

The proposal caused differing opinions among parliamentary members[95], and ended with the approval on February 16th, 2017, of a motion for a resolution by the

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[92] HOLDER et al. (2016, pp. 387, 570) also proposes this idea for robot-assisted surgery and driverless cars.

[93] This would also allow for a unified liability system for autonomous robots for all European member states. However, this could also be accomplished through the guidelines as established by the AI Liability Directive.

[94] In particular, on principle 31 Section f) the rapporteur called on the Commission to "explore the implications of all possible legal solutions, such as: f) creating a specific legal status for robots, so that at least the most sophisticated autonomous robots could be established as having the status of electronic persons with specific rights and obligations, including that of making good any damage they may cause, and applying electronic personality to cases where robots make smart autonomous decisions or otherwise interact with third parties independently;"

[95] Several MPs showed their opposition to the idea during the February 15th debate, such as rapporteur of the Committee on Industry, Research and Energy Kaja Kallas who affirmed that "We cannot, however, have active and empowered individuals if we shift all the responsibility onto robots or manufacturers if something goes wrong. This

European Parliament. Among the several proposals approved, it expressly recommended the Commission to explore, analyse and consider the implications of all possible legal solutions, such as "*creating a specific legal status for robots in the long run, so that at least the most sophisticated autonomous robots could be established as having the status of electronic persons responsible for making good any damage they may cause, and possibly applying electronic personality to cases where robots make autonomous decisions or otherwise interact with third parties independently*.[96]"

As for whether such a proposal would be effective to tackle the legal issues arising from use of and interaction with autonomous robots, we must ask the following questions: (*i) What would an electronic personhood legally entail? (ii) What problems would it intend to solve?* And *(iii) Would it be effective in solving said problems?*

On the matter of the first question, a separate electronic legal personhood for autonomous robots and AIs would in essence entail an effective limitation of liability for the natural or legal persons which either have produced or programmed the robot or the users themselves[97]. This is what authors call "owner shielding", as it would ensure that the person behind the robot would be exempt of liability[98]. Such a protection would necessarily entail the transference of assets to this new electronic person, so that it can effectively respond for any damages caused[99].

Some scholars argue that an electronic personhood would ease the main problem regarding damages caused by autonomous robots: the identification of the liable subject[100]. And although this is partly true, for defects in programming or manufacturing would still play a role, it would still create problems of its own. For starters, what need would an electronic person have for any assets of its own? Artificial beings would not have need for clothing, feeding nor housing, nor a desire to seek

is the problem with the strict liability approach or an electronic personality for robots.", rapporteur of the Committee on the Internal Market and Consumer Protection Dita Charanzová who stated that "We must reject that we are creating 'electronic persons': I am sorry, but robots are not humans, it is pure science fiction to think otherwise." or Jan Philipp Albrecht of the Verts/ALE-Fraktion who said that "We are of the opinion that, especially when it comes to liability issues, it is a question of responsibility, that a natural or legal person must be behind every decision made by a robot or an intelligent machine."

[96] Principle 59 section f) of the European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)).

[97] See Expert Group on Liability for New Technologies (2019), p. 38.

[98] See HANSMANN et al. (2006, p. 3). In fact, this is the main concern regarding an electronic personhood, as WAGNER (2019, p. 609) notes that "recognizing robots as ePersons would protect all actors "behind" the robot from liability. In the example of company shareholders, the creation of a distinctive legal entity, such as a corporation, works as a shield against liability for the actors who created the entity. This shield acts to stimulate risk-bearing; shareholders cannot lose more than the money they invested into the corporation. Applying the principle of limited liability to ePersons, manufacturers and users of robots would be exempt from liability, as they qualify as quasi shareholders of the robot. The robot's manufacturers, programmers, and users would no longer be liable, as the "behavior" of the robot would no longer be ascribed to them, but instead to the robot itself. This could be tolerated, in the sense of a price worth paying, if the newly created legal entity itself were capable of responding to the threat of liability. This is emphatically not true for robots. Under the proposition of ePerson liability, no one responsive to the financial incentives of the liability system would in fact be exposed to it."

[99] See ALFARO ÁGUILA-REAL (2016, pp. 13-15).

[100] See HOLDER et al. (2016, p. 395); HOLDER et al. (2016, pp. 562-563) and WAGNER (2019, pp. 611–612).

pleasure, if we can even as humans truly even begin to define what an artificial being would want, and if it would want anything at all. In practice, the transference of said assets to this electronic person would effectively imply their necessary introduction into the market as agents of their own.

On the matter of the second question, as it has been mentioned, proponents of an electronic personhood and legal status for artificial intelligence and autonomous robots would be the easing of the identification of the liable subject. However, as already mentioned, this would not truly solve the issue. Problems regarding possible defects in manufacturing or programming would still play a role, and even liability of the user would still play a role as well in so far as those artificial beings act and interact under the scope of authority or control of a human being[101]. In truth, an electronic personhood would not seem to solve the issue of liability in so long as artificial beings are still subject to defects in manufacturing and programming, as well as subject to commands and orders from a human being which has them under their control.

Finally, on the matter of the third question and as mentioned, an electronic personhood would not truly solve problems regarding liability of current artificial intelligence and autonomous robots, because current and near-future such beings would still be limited enough to not need such complex legal constructions. It would not solve the issue of identification of the liable subject and would create legal problems of its own regarding asset transference and allocation. It is the author's opinion that perhaps an electronic personhood could be a possible solution for the time in the not-so-distant future when artificial intelligence reaches a level of intelligence and conscience similar to our own or advanced enough to have a will and needs of its own. However, and until then, an electronic personhood as a separate legal status for artificial beings would not make sense in so long as the purpose of a legal person is to give the person which it empowers the means to fulfil its own ambitions and needs, both concepts still far from being applicable to current artificial intelligence nor autonomous robots.

V. Conclusions

The main goal of the present thesis was to establish whether our current legal instruments for liability were suited to tackle with the legal issues arising from human interaction with autonomous humanoid robots and to propose new ways to regulate such interactions beyond our current legislation, both through EU proposals as well as proposals of my own.

To achieve this, I have elaborated a hypothetical future scenario of an Atlas-kind of robot taking care of children or elderly people at home and used the current legal Spanish framework to address hypothetical issues of liability. I have also analysed future regulatory proposals both by the EU as well as other authors to address the issue, and

[101] GARCIA-MICÓ (2021, p. 101) notes that "behind the legal person there is always a natural person, a person who can be made liable as an exception to the rule. In the case of fully autonomous robots, such a link seems to disappear, as the producer and the programmer can be different persons, and they cannot be held liable for actions or omissions of a robot that were not foreseeable at the time of its manufacturing and coding (e.g., when the machine learning abilities of the robot make it to act beyond of the original code.)"

the implications that such liability regimes would imply in relation with my solution as derived from current legislation.

On the matter of the first objective, we have seen how current legal instruments to regulate such interactions can be directed through three main pathways of liability: (i) liability of the manufacturer for defective product, (ii) liability of the programmer for defective software and (iii) liability of the user for damage caused to third parties. Of the three, we have also seen how the third type of negligence with third non-responsible parties is the less developed one, whereas until recently most (if not all) cases fell within the first one's scope.

We have also established how *vicarious liability*, or liability for another's act, as established by Art. 1903 SCC could offer a possible solution to establish effective liability for an autonomous humanoid robot's actions or omissions, and the way that such liability would be constructed. On that, we must note that such liability: (i) would be assimilated to the liability of a parent towards their children, and (ii) would be dependent on the level of due diligence as exercised by the master. Such level of due diligence would (a) vary on a case-to-case basis, and (b) would depend on both the level of autonomy and foreseeability of the behaviour of the robot itself and the precision and contents of the commands given by the user.

On the matter of the second objective, we have seen (i) two proposals regarding AI regulation and liability by the European Union, as well as (ii) two possible solutions for liability as proposed by both authors and EU institutions: (a) general insurance schemes for autonomous robot owners as well as (b) an electronic personhood for artificial intelligence.

Regarding the proposals, we have seen how our Atlas robot would fall within the scope of the high-risk systems classification and how this would have several implications on litigation for damages caused by such autonomous robots in the European Union. Such impacts would be: (a) all claims brought against the users would work under a presumption of fault under certain conditions, (b) users would be obliged to disclose all relevant evidence as requested by the claimant about their robot's AI specifications, (c) the failure to comply with such obligation would imply a presumption of non-compliance with a relevant duty of care, and (d) users would be presumed to not have fulfilled the necessary duties of care when either they did not comply with their obligations to use or monitor the AI system, or exposed the AI system to input data under their control which was not relevant.

We have established how this would imply a quasi-objective liability regime for owners of robots with high-risk AI systems in the EU, merely requiring harm and causation in so far as the user did not comply with the necessary duties of care and control. We have also seen how such a regime could be perfectly adapted to the solution I constructed of a vicarious liability regime through culpa in vigilando as established by Art. 1903 SCC.

Regarding the general and specific insurance schemes for robot owners, we have seen how such a proposal could solve issues regarding liable subject identification and liability allocation, but we have also seen how this could come at the cost of allocating too much fault on the owner of the robot, and how the assessment of the risk posed by such intelligent machines could be complex to determine and may lead to non-insurance situations. On that, we must note that a possible solution could be either to establish a mandatory minimum insurance for all robot owners or a compensation fund for those without insurance.

Regarding the electronic personhood, we have seen the proposal by the JURI Committee as presented to the European Parliament, and we have asked ourselves three successive questions regarding what such a proposal would legally entail, what problems would it try to solve and whether it would indeed solve them. On that, we must note: (i) how a legal status for AI and autonomous robots would entail a limitation of responsibility of the natural or legal persons behind them and the transference of assets or resources to this new person, (ii) how such transference of resources and legal capacity would not truly solve the issue of liable subject identification in so long as both the user or the manufacturer or programmer could still be made liable for the defects or negligence of their own, and (iii) how until artificial intelligence reaches a more advanced state of development, with a near or similar intelligence to our own, such a legal construction would create more legal problems than it solves.

Finally, we reach the point of the present thesis **where the author must give his opinion on the whole matter and offer a proposal of his own**. We have seen how, in essence, three effective solutions to the issue of the liability of autonomous robots have been offered: (i) vicarious liability as established by Art. 1903 SCC, (ii) a quasi-objective liability regime for high-risk AI systems as established by the AI Liability Directive in relation to the AI Act, and (iii) general and specific insurance schemes for robot owners through an objective liability regime. The first one being currently in force, the second one being in force in the near future, and the third one still a proposal by both authors and EU institutions.

Both the first and second proposal are in essence assimilable and offer a more flexible regime to establish liability with the possibility to exclude liability where enough care has been proven (semi-objective liability), whereas the third proposal offers a more efficient way to allocate liability, but at the cost of losing a certain degree of fairness in the process (objective liability). When it comes to designing effective regulation, I believe we must first consider three questions: *(i) What problem are we trying to solve? (ii) What means do we already have? And (iii) Are these means enough by themselves, or do we need new means?*

On the matter of the first question, the problem we are trying to solve, when simplified, is how we allocate liability for acts committed by robots which are not defective according to the definition as given by the law, but which still cause harm, and cannot be liable themselves. The way in which we design our solution will in essence depend on whether we want to incentivize the development of more advanced AIs and autonomous machines (maximizing the user's fault) or whether we want to ensure the highest level of care when designing such products is ensured (minimizing such fault). It will also depend on whether we want to ensure a greater degree of care by users of such products, and on balancing fairness with an efficient litigation that ensures reparation of the victims for any harm caused.

On the matter of the second question, we have seen how in practice, we do have effective means to solve the issue. Vicarious liability as established by Art. 1903 SCC is indeed an effective way to allocate liability, allowing for a proof of due diligence but still ensuring reparation of harm caused in most cases. In so far as autonomous robots remain as intelligent as children are, such a regime would suffice to ensure effective liability allocation and reparation, even if a more specific doctrine by the courts would need to be developed to ensure that such a liability regime is effectively adapted to such a particular case.

Finally, on the matter of the third question, we have seen how the proposals by the EU will offer a similar regime to the one proposed by Spanish law through vicarious liability, but at the same time ensuring that it is better adapted to the specifics of advanced AI systems. Both regimes would be perfectly complementary once the proposals go into effect, and the latter would not imply a major change to the regime already in place. However, we have also seen how such a regime would still require a significant degree of litigation-related costs, especially on the matter of proving the level of due diligence exercised on the user's part. This, in my opinion could be perfectly solved through the general insurance scheme we have also seen.

In truth, we do not have to choose one or the other, but rather, a combination of the three. My proposal would be the following: a quasi-objective liability regime similar to the one developed by both Art. 1903 SCC and the AI Liability Directive, coupled with a mandatory minimum insurance scheme for robot owners. This would imply that most cases would most probably be solved through the insurance itself, just as they are in the case of motor vehicles today, but in those cases were the diligence on the user's part is more disputed or can be more easily proven, they could still be solved through the alternative regime of vicarious liability.

This should be coupled with supervision on the development of more advanced AIs, perhaps with a regulatory agency or observatory, that ensures that even though AI development is not stifled, it is not completely unsupervised either. Once AIs begin to display more advanced levels of intelligence, and even perhaps consciences of their own, perhaps the idea of an electronic personhood, with a defined set of rights, obligations, and limitations of its own, could be implemented. Such a scenario is highly hypothetical, but I believe we should not fear nor completely disregard such a future. Artificial intelligence may be one of the most potent solutions to many of the problems we currently face. The question is not whether we will develop sufficiently advanced AIs or not but rather, how we will choose to treat and regulate those AIs, and who will benefit from the progress they may contribute to achieve. We must ensure that AI's fruits are properly shared and directed at the progress of humanity as a whole.

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