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PRELIMINARY REMARKS ON THE LEGAL REGULATION OF THE UNMANNED VESSELS

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SUMMARY: 1. Introductory notes and a first framework of the phenomenon – 2. The use of the unmanned ship for salvage purposes – 3. Prospects for amendments to international conventions with the aim of introducing rules on unmanned vessels – 4. Liability for damages to third parties arising from the command of unmanned ships – 5. Final remarks.

1. – The EU has recently allocated € 1.5 billion to develop projects in which artificial intelligence is involved: in this context the autonomous-vehicle industry is one of the first compounds that will surely be object of further and important progress [1].

In this way, EU wants to reduce the gap with the most developed nations in the world on robotics, including China, which, last February, has begun building one of the world's largest test site for unmanned ships [2] to test autonomous vehicles, including the use of autonomous steering and

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[1] According to the European Commission Database, of the 25April 2018, «The EU (public and private sectors) should increase investments in Artificial Intelligence research and innovation by at least €20 billion between now and the end of 2020. To support these efforts, the Commission is increasing its investment to €1.5 billion for the period 2018-2020 under the Horizon 2020 research and innovation programme». The European Commission outlines that new ethical and legal questions may rise with the use of artificial intelligence, related to liability or to automatization-based decision-making.

[2] According to the report of the government-authorized site China Internet Information Center. The above mentioned Wanshan Marine Test Field will provide a 225 square nautical mile (771 square kilometer) zone that will allow for the testing of maritime technology such as autonomous steering and obstacle avoidance. Furthermore, the site reports that infrastructures, such as communications networks and navigation radar, will be built on nearby islands to provide a comprehensive and realistic test environment to meet the demands that come with testing different types of ships.

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obstacle avoidance. Moreover, in China, the class society ABS has joined the *Unmanned Cargo Ship Development Alliance*, a group of class organizations, shipyards, equipment manufacturers who wants to deliver a working autonomous cargo ship by October 2021, with a design that integrates independent decision-making, autonomous navigation, environmental perception and remote control [3].

Indeed, in a recent EU Parliament resolution [4] on robotics, the autonomous means of transport are considered a specific robotics sector, which «covers all forms of remotely piloted, automated, connected and autonomous ways of road, rail, waterborne and air transport, including vehicles, trains, vessels, ferries, aircrafts, drones, as well as all future forms of developments and innovations in this sector» (paragraph 24).

Unmanned Surface Vessels (USVs) or *Maritime Autonomous Surface Ships* (MASS) as indicated by the IMO [5], represent in fact an important milestone in terms of technological innovation, cost cutting - to the extent that it eliminates or greatly reduces the human component - as well as an increase in efficiency and in safety, considering the means employed and the subjects generally involved in navigation [6].

Whatever the origin of the concept of a means of transport without people on board [7], reality shows an advanced degree of innovation in the

[3] The *Unmanned Cargo Ship Development Alliance* aims to promote changes in the ship design and operation, as well as ease the establishment of technology, regulation and standard system involved in unmanned cargo ships, as outlined by the China Classification Society.

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

[5] The International Maritime Organization has included navigation with autonomous means of transport among the topics on the agenda. See the work of the ninety-eighth session of the *Maritime Safety Committee* on June 7-16, 2017. As noted in the Secretary-General's final remarks «I appreciate that you have agreed to a new output on Regulatory scoping exercise for the use of Maritime Autonomous Surface Ships».

[6] On this subject see A. SERDY, M. TSIMPLIS, R. VEAL ET AL., *Liability for Operation in Unmanned Maritime Vehicles with Differing Levels of Autonomy*, European Defence Agency, Brussels, 2016; C. SEVERONI, *Prime osservazioni in tema di responsabilità derivante da urto con navi senza equipaggio,* in *Dir. trasp*. 2018/I, pp. 67-98; ID, *Soccorso e mezzi di trasporto autonomi,* in *Dir. trasp*. 2018/I, pp- 27-66.

[7] Indeed, the famous inventor Nikola Tesla at the end of 1800 had filed a patent application (No. 613,809, dated November 8, 1898, application dated July 1, 1898, serial number 684,934) entitled "Method of and apparatus for controlling mechanism" of moving vessel or vehicles', in

design of these means of transport which operate via a remote control or can perform the service for which they are designed autonomously, governed solely by the management software.

These vehicles are currently in a state of advanced experimentation, and they will soon be able to operate services on the water surface, while the underwater vehicles and the aerial vehicles (unmanned aerial vehicles) are already employed in many activities [8].

As an example, the vessel YARA Birkeland will be the world's first fully electric and autonomous container ship, whose testing of autonomous capability will be carried out in 2019, and that will ship products from YARA's production plant to Brevik and Larvik in Norway. From 2022 it will operate in autonomous mode. It has a 79.5 meters long hull and a transport capacity of 120 containers [9].

Furthermore, in the Norway's Trondheim Fiord the first test site for autonomous vehicles of Europe has been placed.

Moreover, short sea shipping connections with autonomous means are currently being studied in Europe, and the European Commission has set up a research project on unmanned ships, called *Maritime Unmanned Navigation through Intelligence in Networks* (MUNIN) [10].

which he underlined the fundamental characteristic of his invention, given the absence of cables or other means of controlling the movement of the vehicle.

[8] On the RPAs legale framework in the italian and european perspective see A. MASUTTI, *Prospettive di regolamentazione dell'uso dei velivoli senza pilota (UAV) nello spazio aereo comune*, in *Dir. trasp.* 2007, 783; U. LA TORRE, *Gli UAV: mezzi aerei senza pilota*, in *Sicurezza, navigazione e trasporto* (a cura di Tranquilli Leali-Rosafio), Milano, 2008, 93; ID, *La navigazione degli UAV: un'occasione di riflessione sull'art. 965 c. nav. in tema di danni a terzi sulla superficie*, in *Riv. dir. nav.* 2012, 553 ss. B. FRANCHI, *Aeromobili senza pilota (UAV): inquadramento giuridico e profili di responsabilità*, in *Resp. civ. e prev.* 2010, 1213 ss.; E. ROSAFIO, *Considerazioni sui mezzi aerei a pilotaggio remoto e sul regolamento ENAC*, in *Riv. dir nav.* 2014, 787 ss.; C. SEVERONI, *La disciplina normativa attuale degli aeromobili a pilotaggio remoto,* in *Dir. trasp.* 2016/I, 65-103; SIA, *Profili attuali della disciplina giuridica dei mezzi aerei a pilotaggio remoto e il regolamento dell'Ente nazionale dell'aviazione civile italiana (ENAC)*, *Dir. trasp.* 2014, 743 ss.; A. ZAMPONE, *Riflessioni in materia di responsabilità nell'esercizio di remotely-piloted aircrafi system (RPAS)*, in *Dir. trasp.* 2015, 63 ss.

[9] The vessel YARA Birkeland is an autonomous ship, developed by Konigsberg, who is responsible for the supply of all key enabling technologies including the sensors and integration required for remote and autonomous ship operations, in addition to the electric drive, battery and propulsion control systems.

[10] The project MUNIN is a research project, co-funded by the European Commissions under

2. – Therefore, unmanned ships represent a phenomenon in constant and rapid evolution, in which we currently identify small means of transport, but for which it is foreseeable that in the future they will be replaced by progressively larger and more complex vessels.

These particular kinds of ships can also be distinguished according to the function they perform. In this regard, construction projects of unmanned ships have been developed for military functions [11], scientific research purposes and for providing assistance to people in distress at sea [12].

In this last perspective, USV is assumed to be used in dangerous, dull and dirty scenarios, in which it may be dangerous to send a ship with a crew. Among these we may traditionally include many salvage hypotheses, where there is a danger even for the rescuer, or in respect of which it is foreseeable the repetitiveness and the length of the operations themselves.

We may consider, for example, the hypothesis in which the accident results in a leakage of hydrocarbons from the ship: in this case the intervention of small boats can lead to a high level of danger for rescuers, which are ex-

its Seventh Framework Programme. MUNIN aims to develop an autonomous ship, i.e. a vessel primarily guided by automated on-board decision systems but controlled by a remote operator in a shore side control station.

[11] We can take as an example of military purpose the case of the Sea Hunter, the world's largest unmanned surface vessel—a self-driving, 132-foot ship designed to travel thousands of miles out at sea without a single crew member on board, as evidenced by the article of Julie Watson, *Military tests unmanned ship designed to cross oceans*, May 2, 2016.

[12] In this regard I would like to refer to C. SEVERONI, *Soccorso e mezzi di trasporto autonomi*, in *Dir. trasp.*, 2018, I, p. 67-85. On the legal aspects of maritime salvage we may refer to A. ANTONINI, *Le obbligazioni pecuniarie nascenti dal soccorso: profili soggettivi e natura giuridica,* in *Dir. trasp.* 1997, 11; F. BERLINGIERI., *L'introduzione nell'ordinamento italiano della Convenzione del 1989 sul salvataggio, Dir., mar.* 1998, 1375; G. BRICE, *Maritime Law of salvage*, Londra, II ed. 1993; G. CAMARDA, *Convenzione "Salvage" 1989 e ambiente marino*, 1992; S. FERRARINI, *Il soccorso in mare*, Milano, 1964; J. LE CLERE, *L'assistance aux navires et le sauvetage des epaves*, 1954; G. RIGHETTI, *Trattato di Diritto Marittimo*, Milano, 1994, III, 421; P. RIZZO, *La nuova disciplina internazionale del soccorso in acqua e il codice della navigazione*, Napoli, 1996; R. RODIERE, *Traité général de Droit Maritime, événements de mer*, 1972; R. RUSSO, *Assistenza e salvataggio* (entry), in *Enc. Dir*., III, 1958, 818; S. SEVERONI, *La remunerazione del soccorso tra interesse pubblico ed interessi privati*, voll. I e II, Milano, 2005; E. VINCENZINI, *Profili internazionali del soccorso in mare*, Milano, 1985; E. VOLLI, *Assistenza e salvataggio*, Padova, 1957.

posed to pollutants and to the risk of a danger. The operations could also reveal to be monotonous and repetitive and lead to an increase in the related costs.

Among the projects of SAR with autonomous vessels we can outline the CART (*Cooperative Autonomous Robotic Towing System*) [13], which has developed a system of unmanned robotic marine vessels, capable of a semi-automatic high-risk connection operation of the towing system to ships in distress. The aim of the innovation is to reduce the risk to human lives and to increase the protection of the environment, for example by helping to prevent oil pollution at sea during rescue operations.

The key idea is to collect a floating object from the vehicle to be rescued, like a floating buoy, by making a knot around it with a floating rope by an unmanned robotic vehicle towing the floating rope connected to the tug ring.

This automatic system will be used in two distinct scenarios: the rescue to a ship involved in a fire and the hypothesis in which the tugboat has to recover the emergency towing system of the ship in distress in the open sea.

In the first case it is assumed that the tugboat needs to tow the ship out of the port, for example a cistern located in an oil terminal, while in the second case it is a matter of reaching the emergency towing system of the ship in difficulty.

In the field of search and rescue the result provided by the European project ICARUS (*Integrated Components for Assisted Rescue and Unmanned Search Operations)* in collaboration with *NATO's Center for Maritime Research and Experimentation* [14] is also of great interest.

[13] On this project see S. ARDITO, D. LAZAREVS, B. VASILINIUC, Z. VUKIC, K. MASABAYASHI, M. CACCIA, *Cooperative Autonomous Robotic Towing system: definition of requirements and operating scenarios*, IFAC Proceedings Volumes, Volume 45, Issue 27, 2012, p. 262-267. According to the authors « The project CART (Cooperative Autonomous Robotic Towing system) proposes a new concept for salvage operations of distressed ships at sea based on the development of robotised unmanned marine platforms able to (semi-)automatically execute the high-risk operation of linking the emergency towing system of distressed ships to towing vessels. The CART device will be able to optimize the operations for safeguarding the environment, helping to prevent oil pollution at sea, and minimizing the risk for human lives».

[14] The ICARUS project started in 2012 and is aimed at developing an advanced robotic platform able to provide help in case of danger, both in the maritime environment and in the terrestrial environment.

The project is divided into two distinct operational areas: the Urban Search and Rescue area (USAR) and the Maritime Search and Rescue area (MSAR).

As evidenced by the results of the project, the Unmanned Search and Rescue (SAR) vehicles can be valuable tools to save lives, especially in the case of maritime accidents in adverse weather conditions, where survival times are short and SAR teams are often exposed to significant risks.

However, the compatibility of the current regulatory framework with the aforementioned cases in the field of salvage has still to be analyzed.

The 1989 International Salvage Convention, applicable in Italy as *lex fori*, indicates the salvage operation as «any act or activity undertaken to assist a vessel or other property in danger in navigable waters or in any other water whatsoever», while the concept of vessel is a generic reference to «any ship or craft, or any structure capable of navigation» (art. 1).

It is evident that the mentioned convention, as any other regulation of maritime law, is not prepared to regulate the phenomenon of remotely piloted, or totally autonomous, navigation [15]. The international conventions do not contain references to the salvage carried out by a remotely piloted ship, or by a completely autonomous one; but there aren't any elements that indicate the absolute incompatibility of the current regulatory system with the presence of autonomous means of transport. With the consequent corollary that any regulatory provision must be harmonized with the proposed new scenarios of a salvage operation carried out with unmanned ships.

In this regard, there is the commitment of the Maritime Safety Committee (MSC) of the IMO to discuss again the rules with a view to enhancing maritime safety, preparing specific rules for the safety of autonomous ships,

[15] Article 136 of the Italian Code of Navigation provides that the ship is «whatever construction meant for transportation by water, also for the purpose of towage, fishing, leisure activity or other employments». The broad notion that derives from this article is based on the element of the construction, understood as *res connexa* and therefore as a set of heterogeneous elements united by the human work in a structure that is juridically understood in a unitary sense. The construction must have the ability to float, necessary also to possess the ability to navigate, or to travel by sea, regardless of the means of propulsion. The resulting ship, today as in the period of imperial Rome, is identified with the function that the floating construction is destined to perform, i.e. the navigation - *navis etenim ad hoc paratur ut naviget* - understood as destination to transport (i.e. a movement in the water of a construction used to carry out any activity), regardless of the means of propulsion used.

called MASS (Maritime Autonomous Surface Ships) [16], which will then have to be integrated with the existing legislation in this area.

In my opinion, the main problem related to the provision of a salvage operation with autonomous means of transport is the general obligation to provide assistance to people in distress at sea.

Our internal legal system contains binding rules which impose the obligation to provide assistance to people in distress (art. 489 c. nav.), in compliance with the sense of solidarity that pervades the maritime world and the degree of civilization of seafarers, without a remuneration for the rescuer [17].

However, the London Convention on Salvage on the one hand does not provide for compensation from the salved persons (No remuneration is due from persons whose lives are saved: Article 16, first paragraph of the London Convention), on the other it provides, among the ordinary criteria of definition of the reward, *in multis*, also the «skill and the efforts of the salvors in salving the vessel, other property or life» (article 13, letter e), a circumstance that may also apply to the salvage with unmanned ships, where skills and efforts are not those of the commander and of the crew inside the ship, but those of a pilot who operates outside the vessel, or of the ship-owner who has put instruments and rescue software on board the autonomous vessel.

I believe that even an unmanned ship may be subject to an increase due to «i) the availability and use of vessels or other equipment intended for salvage operations; j) the state of readiness and efficiency of the salvor's equipment and the value thereof» (art. 13 of the Salvage Convention), provided that it is professionally equipped to provide assistance.

This item will then include the investments and economic efforts incurred by professional salvors for the purchase of ships, and it is expected that the component of management software, or artificial intelligence serving the property or the person to be rescued, will affect the final reward.

The new perspective of a salvage with unmanned ships must take into ac-

[16] The new rules for enhancing maritime safety, also in view of the introduction of autonomous ships in commercial traffic, were discussed at the ninety-eighth session of the MSC on 7 June 2017.

[17] The art. 16.1 of the London Salvage Convention states: «No remuneration is due from persons whose lives are saved, but nothing in this article shall affect the provisions of national law on this subject»

count the legal provision of a duty for the salvor to operate with due diligence in the case of salvage to a ship in distress, even in the specific case where the ship has prevented od minimized damage to the environment (Article 8.1 , letter b) of the London Convention), also seeking assistance and accepting the help of other rescuers reasonably hired by the shipowner or master of the vessel or other property in danger (Article 8.1, letters c) and d).

In negative terms, if «the salvor has been negligent and has thereby failed to prevent or minimize damage to the environment, he may be deprived of the whole or part of any special compensation» (art. 14.5 London Convention).

We must conclude that one of the main duties of the salvor is the obligation to carry out operations with due care: «1. The salvor shall owe a duty to the owner of the vessel or other property in danger: (a) to carry out the salvage operations with due care; (b) in performing the duty specified in subparagraph (a), to exercise due care to prevent or minimize damage to the environment; (c) whenever circumstances reasonably require, to seek assistance from other salvors; and (d) to accept the intervention of other salvors when reasonably requested to do so by the owner or master of the vessel or other property in danger; provided however that the amount of his reward shall not be prejudiced should it be found that such a request was unreasonable» (art. 8).

Actually, if the vehicle is remotely operated, the obligation can be attributed to the subject who pilots the ship remotely. However, it must be considered that he is not at the place where the danger occurs, and therefore he may not have the exact perception of the danger in all its complexity, nor with regard to the ship or to the persons in danger, or, as specified in letter b), with regard to the danger to the environment where the salvage operations are carried out. On the other hand, it should remain the obligation to seek, or if circumstances require it, to accept the help of third parties who are nearby the ship to be rescued, as indicated in letters c) and d).

On the other side, we may ask is an autonomous vessel, not equipped to carry out the salvage, but for example used for commercial traffic, has in any case the obligation to render assistance to other ships in distress.

In this case we should consider the role of the shipowner, who has assumed the management of the vessel (Article 265 Italian c. nav.) and is consequently responsible for it, according to art. 274 Italian c. nav., which states,

in general terms, that he is responsible for the facts of the crew and the obligations contracted by the master of the ship, with regard to the ship and the shipment.

3. – As previously mentioned, the control of unmanned ships can be operated in two different ways: it can be a remote-control, whether a shore based remote controller uses a laptop computer and a joystick to steer the ship using radio and satellite communications [18], or the ship can be controlled by a computer program, predefined before deployment. In this second case, highly sophisticated software technology and sonar radar are involved in the ship manufacturing.

These different systems (remote controlled ship and autonomous ship) are both included in the concept of unmanned ships, even though they refer to different developments, particularly in regard to liability aspects.

In unmanned ships, a fundamental aspect of navigation should be reconsidered, that is the role of the master and the crew; this circumstance will affect many laws, both at international and at national level, *in primis* the UNCLOS convention, which in several places refers to the *manning of the ship* [19].

E.g. it provides, (par. 91) that «Every State shall fix the conditions for the

[18] According to the latest developments, a safe steering for the remote-monitored and controlled autonomous ships of the future in being worked out. The new technology has been developed for navigation systems and ship autopilots, which steer ships automatically, and are controlled by artificial intelligence. There are three modes of steering: track, heading and slow joystick control for docking situations. «In track mode, Apilot (autopilot) steers the ship along a previously agreed route. If the ship detects another vessel, which must be avoided, the autopilot switches to heading mode. This enables Apilot to avoid the other vessel with a small change in the ship's heading. Autopilot returns to track mode after the other vessel has been avoided. In the joystick mode, control and propulsion equipment are adjusted to low speeds manoeuvrings. Apilot puts the ship into the desired operating mode, for example to manoeuvre sideways into a dock. In all situations, the autopilot ensures that the ship remains within a set distance from the planned route. If the limits in question are exceeded, the autopilot gives a warning and remote control must be taken of the ship» (*Ship autopilot steers during evasive manoeuvres and docking*, June 20, 2017, VTT Technical Research Centre of Finland).

[19] On this subject, we may refer to CMI International Working Group Position paper on unmanned ships and the international regulatory framework, according to which «The prospect of unmanned ships addresses a very fundamental feature in shipping – the role of the master and crew on board a ship – and will hence affect a multitude of laws and regulation across the whole range of maritime law».

grant of its nationality to ships», and the State shall effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag, and in particular every State shall (…) *assume jurisdiction* under its internal law *over each ship flying its flag and its master, officers and crew* in respect of administrative, technical and social matters concerning the ship,; and it shall take such measures for ships flying its flag as are necessary to ensure safety at sea with regard, inter alia, to: (…) (b) *the manning of ships*» (art. 94, subsections 1 to 3). If unmanned vessels are considered ships, according to their size, features and functions, they will be subject to the same rules than manned ships.

Similarly, The International Convention for the Safety of Life at Sea, 1974 (SOLAS) doesn't provide for a general definition of ship, but in several parts, it refers to the position of the master and of the crew members as internal to the ship. All these provisions need to be modified in order to include even the cases of unmanned ships [20].

The International Regulations for the Preventing of Collisions at Sea, 1972 (COLREGS) declares to apply to «all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels» (Rule 1), whereas the term vessel includes «every description of water craft, including non-displacement craft, WIG craft and seaplanes, used or capable of being used as a means of transportation on water» (Rule 3, lett. a). In other parts it refers to appraisal by «sight and hearing» (Rule 5) or to vessels not under command, i.e. « a vessel which through some exceptional circumstance is *unable to manoeuvre* as required by these Rules and is therefore unable to keep out of the way of another vessel» (Rule 3, lett. f). Indeed, we can argue that in the case of unmanned ships the ship is still *under the command*, even if this derives from a remote station or by means of management software.

[20] For example, Chapter III of SOLAS Convention prescribes the life-saving devices to be carried on board the vessel. In the Regulation 10, related to survival craft, it refers «sufficient crew members, who may be deck officers or certified persons on board for operating the survival craft and launching arrangements»: this prescription will be difficult to comply with for unmanned ships. Similarly, Regulation 33 provides an obligation for the master of the ship to quickly provide assistance to people in distress at sea. In this case, the master can be replaced in his functions by a member of the shore-side personnel supervising the remote controlled or the autonomous ship.

4. – As regards to the liability aspects, we must distinguish between the shore-based remote-controlled ship and the autonomous vessel.

In the first case, it's still possible to attribute the responsibility to the vessel in fault, according to the 1910 Brussels Collision Convention and the Italian art. 484 c. nav., which provides for a principle of imputation of the liability to the ship in fault. The situation is different if the agent (shore-based remote controller/master) is replaced by an autonomous software. In this case, we can assume that the ship is still managed according to the use indicated by the shipowner. But we must add to the figure above mentioned, the software programmer, which should be contractually connected with the manufacturer of the ship, but it is not clear how he will be liable against third parties. We may assume that the software programmer and the producer of the ship can be responsible for defect of the product, according to the Italian consumer code and the Council Directive 85/374/EEC.

As for the rest, in both the aforementioned hypotheses, we may identify the subject that has the management of the ship, to which the principles of law contained in our legal system must be applied.

In this regard, both the 1910 Brussels Collision Convention and the Italian art. 484 c. nav. provide for a principle of imputation of the liability to the ship in fault, so that any ship in fault must compensate the damage suffered by the other ship in proportion to the degree of its fault [21].

[21] On collision we may refer to I. ARROYO, *Curso de derecho marítimo*, Cizur Menor, 2005, p. 671 ss.; S.M. CARBONE-P. CELLE-M. LOPEZ DE GONZALO, *Il diritto marittimo attraverso i casi e le clausole contrattuali*, Torino, 2006, p. 353 ss.; S. FERRARINI-G. RIGHETTI, *Appunti di diritto della navigazione*, Parte speciale, II, Torino, 1970, p. 29 ss.; M. GRIGOLI, *Diritto della navigazione*, Torino, 1982, p. 373 ss.; J. LE CLERE, *L'abordage en droit maritime et en droit fluvial*, Paris, 1955; S. POLLASTRELLI, L'urto di navi, in Trattato breve di diritto marittimo, III, Milano, 2010, 233, 251; F.A. QUERCI, *Diritto della navigazione*, Padova, 1989, p. 579 ss.; G. RIGHETTI, *Trattato di diritto marittimo*, Milano, 1994, III, 345; G. RIGHETTI, *Urto di nave e di aeromobile* (voce), in *Noviss. dig. it.*, XX, Torino, 1975, p. 190 ss.; R. RODIERE, *Traité général de droit maritime*, IV, Paris, 1972, p. 17 ss.; G. ROMANELLI-G. SILINGARDI, *Urto di navi o aeromobili* (voce), in *Enc. dir.*, XLV, Milano, 1992, p. 906 ss.; A.L.M. SIA, *L'urto di navi e di aeromobili tra disciplina speciale e diritto comune,* in *Studi in memoria di Elio Fanara*, II, Milano, 2008, p. 361 ss.; E. SPASIANO, *Urto di navi e di aeromobili (voce)*, in *Enc. giur.,* XXXII, Roma, 1994; G. RIGHETTI, *Urto di navi* (voce), in *Dig. disc. priv., Sez. comm.*, XVI, Torino, 1999, p. 324 ss.; A. LEFEBVRE D'OVIDIO-G. PESCATORE-L. TULLIO, *Manuale di diritto della navigazione*, Milano, 2008, p. 596 ss.; S. ZUNARELLI- M.M. COMENALE PINTO, *Manuale di diritto della navigazione e dei trasporti,* Padova, 2009, p. 151 ss.

Although the navigation code refers to the «ship in fault», the Italian case law has clarified that the fault is attributed to the master, to the crew or to the shipowner (armatore). The principle has an exception in the case that the event occurred by fortuitous event or by force majeure, or for doubtful cause, in which cases the damage is borne by the person who suffered it.

Rather, in a *de jure condendo* perspective on tort liability, it will be possible to introduce onerous responsibilities in conducting unmanned ships, gradually depending on the risk faced by the third party, up to a form of strict liability in the hypotheses that, according to predetermined parameters, the danger reveals to be maximum.

The concept would be in line with the latest prospects for amending Remotely Piloted Aircrafts legislation [22], respectful of the latest European guidelines on tort liability for dangerous activity [23], and it complies with the Italian liability regime on damage caused by foreign aircraft to third parties on the surface, where the strict liability is associated with the concept of risk for the exercise of a lawful activity and it is justified by the need to protect the third party who is not in a position to foresee the event and to be able to take suitable protective measures in relation to the

[22] We refer to the *EASA, Technical Opinion - Introduction of a regulatory frame work for the operation of unmanned aircraft, Related A-NPA*: 2015-10, RMT.0230, 18 December 2015, p. 7, and to the *EASA, 'Prototype' Commission Regulation on Unmanned Aircraft Operations* 22 August 2016, p. 3 for which «The choice for an operation centric approach is justified by the fact that there is no one on board unmanned aircraft as of yet. Therefore, the consequences of a loss of control of an unmanned aircraft is highly dependent on the operational environment». On the erosion of the principle of fault we may read the Italian Authors M. BARCELLONA, *Struttura della responsabilità e ingiustizia del danno*, in *Eur. dir. priv*., 2000, p. 307 ss., S. RODOTÀ, *Il problema della responsabilità civile*, Milano, 1967; L. MENGONI, *La responsabilità contrattuale,* in *Enc. dir.,* XXXIX, 1072 ss., p. 1093 ss.; P. TRIMARCHI, *Rischio e responsabilità oggettiva*, Milano, 1961, 191 ss.

[23] According to the *Principles of European Tort Law*, written by the *European Group on Tort Law*: «(1) A person to whom damage to another is legally attributed is liable to compensate that damage. (2) Damage may be attributed in particular to the person a) whose conduct constituting fault has caused it; or b) whose abnormally dangerous activity has caused it» (chapter 1:101); in the *Principles, Definitions and Model Rules of European Private Law Draft Common Frame of Reference (DCFR), Outline Edition - Study Group on a European Civil Code and the Research Group on EC Private Law (Acquis Group*), *Based in part on a revised version of the Principles of European Contract Law*, Monaco, 2009, VI, 1:101, « (1) A person who suffers legally relevant damage has a right to reparation from a person who caused the damage intentionally or negligently or is otherwise accountable for the causation of the damage» except in particular cases.

danger, which is the foundation of the special regime outlined [24].

5. – The bright descriptive framework referred to above, on the use of autonomous means of transport, does not hide the gray areas that appear in this specific and very particular matter. On the one hand, in fact, it is not clear which evolution human work will have, which has been so far fundamental in every sector of maritime, land and air transport. The conclusions of the first studies in this regard emphasize that machines will replace man in the heavy, repetitive and dangerous work and that the human contribution will increasingly be an activity of concept, design and construction of the machines. However, it is not yet clear how this will affect the many skills currently employed in maritime transport, at every level of activity.

On the other hand, we cannot ignore the fact that the artificial intelligence of nautical management will increasingly base itself on the characteristics indicated by the European Parliament of autonomy, obtained thanks to sensors and through the exchange of data with the environment in which it operates, as well as on the self-learning from the experience that derives from the interaction, and on the adaptation of its own behavior and actions to the environment.

A self-driving ship can therefore learn from the surrounding environment and change its operating behavior by interacting with the elements, the circumstances and the places in which it will operate [25].

However, this may have important repercussions on the liability regime currently focused on the owner's figure. We can ask ourselves to what extent the shipowner - held to account for the facts of the crew and the obligations contracted by the master of the vessel - will be liable for the damages produced by artificial intelligence steering a nautical vessel, that will reset its behavior by calibrating it on the circumstances and that will be capable of

[24] On this subject see some remarks in C. SEVERONI, *Prime osservazioni in tema di responsabilità derivante da urto con navi senza equipaggio,* in *Dir. trasp*. 2018/I, pp. 67-98.

[25] In relation to the ethical problems arising from a ship managed by an artificial intelligence we may consider the works of the german *Ethik-Kommission - Automatisiertes und Vernetztes Fahren Eingesetzt durch den Bundesminister für Verkehr und digitale Infrastruktur*, june 2017, and, on the juridical framework of the unmanned vehicles, C. SEVERONI, *Prime considerazioni su un possibile inquadramento giuridico e sul regime di responsabilità nella conduzione dei veicoli a guida autonoma*, in *Dir. trasp*. 2018/II, 332-367 and further authors referred.

self-learning and modifying its behavior compared to the initial parameters set by the manufacturer, or by the same owner.

It is clear, then, that the relationship between the vessel producer, the supplier of the driving software and the operator who resume the management must also be rethought, without thereby wanting to indulge in easy fantasy suggestions [26], but in the awareness that a new element has been definitively introduced in the juridical field, capable of independent evaluation with respect to the subjects considered up to now for the definition of responsibility. Concepts such as due diligence (e.g. *due care*: article 8, first paragraph, letter a, of the London Convention on Salvage) in the rescue operations and negligent behavior by the rescuer that «go to prevent or minimize damage to the environment» (Article 14, fifth paragraph, London Convention) will then have to be rethought in the light of a new element of evaluation such as the artificial intelligence or piloting software, which certainly cannot be ignored in the provision of appropriate insurance coverage for damages produced by autonomous vehicles [27].

[26] Indeed, in the study commissioned by the European Parliament's legal affairs commission, N. NEVEJANS (in *European civil rules on robotics*, 2016, p. 5) states that «Once a new legal and ethical sector surfaces, a general approach to the big theoretical questions needs to be found in the first instance, so as to eliminate any mis- understanding or misconceptions about robotics and artificial intelligence. When we consider civil liability in robotics, we come up against fanciful visions about robots. Here we must resist calls to establish a legal personality based on science fiction. This will become all the more crucial once the liability law solutions adopted in respect of autonomous robots determine whether this new market booms or busts».

[27] On this point the analysis made by N. NEVEJANS, in the Study commissioned by the Commission for legal affairs of the European Parliament, on *European civil rules on robotics*, cit., 17, on the various accountability that may arise for damages produced by the use of a robot, is commendable: «If the robot is sold with open source software, the person liable should, in principle, be the one who programmed the application which led to the robot causing damage. Robots tend increasingly to be sold with (full or partial) open source software, allowing buyers to develop their own applications. In principle, a contract governs relations between the parties. "Open Robot Hardware" is a further trend, where both the robot's software and hard- ware are open source. If a robot causes any damage that can be traced back to its design or production — such as an error in a robot's algorithm causing injurious behavior — the designer or producer should be held liable. However, in fact, the type of liability may vary depending on whether the victim bought the robot (contractual responsibility) or is a third party (extra- contractual responsibility). It might be important within the framework of the future instrument to consider this dichotomy and whether it would be a good idea to align its application with Directive 85/374/EEC, which does not distinguish whether or not the victim is contractually bound to the person having caused the dam- age. If a robot causes

Finally, unmanned ships will be used in the practice only if the higher costs of production and management of the software will be offset by a reduction in the costs of the personnel necessary to manage them from a remote location.

But I think the main challenge will be the one concerning the safety that the use of unmanned ships will guarantee compared to the manned means of transport.

Lastly, we must consider that a great unknown comes from the necessary changes and additions that have to be made in the infrastructures, in order to enable them to dialogue with the ship's software, especially in the port area.

any damage when in use or while still learning, its user or owner should be held liable. In this regard, the solution may vary depending on whether or not the user is a professional, and whether or not they are the victim. For example, any dam- age linked to a robot's instruction by a professional user and inflicted upon a third-party victim could be governed by the new instrument. It would be an entirely different story if the same damage were caused to a victim who was a professional, salaried user, since this would then be considered an accident at work».

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Abstract

The growing importance of the autonomous means of transport, and specifically of the unmanned ships, governed by an artificial intelligence, requires to frame the phenomenon in legal terms, with a view also to proposing amendments to the international conventions in order to introduce the hypotheses of unmanned ships in the specific body of law. The special purposes in the use of unmanned ships are here considered, including the use of these means of transport for the salvage of people and property in distress at sea. In this respect, it is analyzed the main problem of the general duty to provide assistance to people in distress at sea related to the salvage operation with autonomous means of transport. Navigation with unmanned ships involves also problems, which are here addressed, in defining the legal framework of the liability for the collision between vessels.

La crescente importanza dei mezzi di trasporto autonomi, e nello specifico delle navi senza equipaggio, governati da un'intelligenza artificiale, impone all'interprete di inquadrare il fenomeno in termini giuridici, al fine anche di proporre emendamenti alle convenzioni internazionali ed introdurre le fattispecie delle navi senza equipaggio a livello ordinamentale. Lo scritto considera in particolare l'impiego delle navi senza equipaggio con finalità di salvataggio di persone e cose in pericolo in mare. A tal proposito, viene analizzato l'obbligo di fornire assistenza alle persone in pericolo in mare relativo all'operazione di salvataggio con mezzi di trasporto autonomi. È stato inoltre oggetto di analisi il problema della responsabilità per la collisione tra navi quando uno dei mezzi coinvolti è privo di equipaggio.