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Maritime Product Liability

The Case of Unmanned Vessels

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1 Introduction

While maritime law has always been considered a conservative area of law, has been flexible enough to accommodate technological developments over centuries.[1] From containarisation to collision avoidance systems, shipping is undergoing a technological revolution. These developments, however, have always involved the presence of onboard crew.[2]

Recently there is a movement towards the goal of unmanned vessels, either remote-controlled or autonomous vessels. Remote control vessels are those that are capable of controlled movement on the water by a Shore Control Centre (SCC). The SCC is operated by qualified personnel who, through very advanced systems such as satellite communications, radar and sensors, receive all the necessary information and guide the vessel to its destination.[3]

The second category of unmanned vessels is that of the completely autonomous vessels, which are pre-programmed in such a manner that it is possible to schedule a nautical course without any human interaction at all.[4] With autonomous vessels, a human operator is only required to put in the destinations and the vessel itself will navigate autonomously.[5]

Despite the scepticism about the operation of these vessels, they have already reached a high degree of development and indicate how traditional maritime transport can undergo changes in response to a new generation of increasingly sophisticated machinery.[6] Worldwide, the number and scope of projects dedicated to unmanned vessels is increasing.

The ongoing research projects on unmanned vessels claim that the introduction of such innovative technology will bring exciting opportunities to redefine the way a ship is designed and functions.[7] Due to their sophisticated technology, which aims to increase safety and efficiency,

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[1] Simonsen Vogt Wiig Advokatfirma "Maritime Law in the Wake of the Unmanned Vessel", https://svw.no/contentassets/f424f309bd304e99b39f11355e98571f/svw_maritime-law-in-the-wake-of-the-unmanned-vessel.pdf, accessed 23.01.2018.

[2] Hooydonk, Eric Van. "The Law of Unmanned Merchant Shipping – an Exploration", Journal of International Maritime Law, (2014) p. 403.

[3] Norwegian Forum for Autonomous Ships "Definition of Autonomy Levels for Merchant Ships" (2017), p. 4-7, accessed 23.01.2018. http://nfas.autonomous-ship.org/resources/autonom-defs.pdf.

[4] Ibid. p. 4-7.

[5] Ibid.p.4-7.

6 Veal, Robert, Thimplis, Micheal "The Integration of Unmanned Ships into Lex Maritime" Lloyd's Maritime & Commercial Law Quarterly, (2017) p. 1-3.

[7] AAWA "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London, (2016) p. 4.

and to improve the quality of work[8], unmanned vessels are likely to change also the reasoning behind the allocation of liability with regards to collisions at sea, since accidents at sea in the case of unmanned vessels cannot be based on human acts or omissions in the same way as today. New liability players will be introduced and the manner in which duties are distributed will change.

The aim of this thesis is therefore to investigate how product liability law will impact the unmanned vessels for collision accidents at sea. More specifically, it attempts to divide the liability between the existing players such as shipowners and the new players such as developers and pre-programmers of software technology, as well as the manufacturers of those vessels. This assessment will be achieved through a comparison analysis of two different jurisdictions, the United States of America (the "US") and the European Union (the "EU"), in terms of product liability law through years up to now.

For the purpose of this paper, the term 'unmanned vessel' or 'unmanned ships' will be used, referring to the overall category of both remote-controlled and autonomous vessels. In cases where a distinction is necessary, the specific term of 'remote-controlled vessel' or 'autonomous vessel' will be used.

Finally, due to the lack of a uniform convention regulating maritime liability, Norwegian maritime law will be considered.

1.1 Research Structure

The first part of the thesis is focused on the concept of product liability and how the principles of product liability in the US and EU have progressed from privity to strict liability.

The study then proceeds with an analysis of the strict liability principle as an American concept that then spread worldwide. The aim is to reveal the reasons of adapting this legal regime through court cases and the impact this regime has had on the existing legal framework in the EU.

[8]Rødseth, Ørnulf Jan "Developments Toward the Unmanned Ship" MUNIN (2012), accessed 05.01.2018 http://www.unmanned-ship.org.

Section 4 and 5 intend to critically review the existing product liability regime in the US and EU. The Restatement (Third) of Torts of the US and the Product Liability Directive 85/374 EEC of the EU will be considered.

Sections 6 and 7 aim to look in to the application of product liability in the context of maritime industry in general and its interaction with international collision conventions such as the Convention on the International Regulations for Preventing Collisions at Sea 1972 (the "COLREGs") and the Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, 1910 (the "Brussels Convention").

Upon an understanding of the concept of product liability and its application, the last sections of the paper are dedicated to unmanned vessels. More specifically, an investigation of the interaction between international collision conventions and unmanned vessels will follow, as well as an analysis of the adaption of a new legal regime such as product liability in relation to damages that occur due to the collision at sea of unmanned vessels.

1.2 Methodology

The methods used for conducting the research, drafting the thesis and substantiating conclusions are manifold. First, the analysis of the EU and US legal framework subject of this thesis were conducted by using online databases (e.g., eur-lex.eu, westlaw.uk, lexisnexis.com).

Second, the library of the Scandinavian Institute of Maritime Law was another important resource (lovdata.no), as well as databases, reports and articles from relevant organisations and agencies, which have an interest in the operation of unmanned vessels.

Third, the most fascinating part of this project were the meetings and interviews with consultants from shipping and the insurance sector, as well as presentations and seminars that I personally attended.

2 The Peculiarities of Product Liability and its Evolution

The phrase 'product liability' has two meanings and each of them generates claims of extremely different importance and credibility.[9] In its narrower and more common usage, the term "product liability" refers to a tort action, mainly in strict liability.[10] More specifically, it denotes the legal liability of manufacturers, suppliers and other players such as distributors and retailers for personal injury or damage to property caused by a defective product which fails to meet the standards claimed expressly or implicitly by them.

In contrast, the term is also used broadly to determine further actions for which the manufacturer might be held liable for damages caused by its product; it is recognised as a breach of express and implied warranty, negligence and tort actions for strict liability.[11]

For most of the modern industrial era, the product liability law for recovery from defective products in the US and Europe has been regulated by the doctrine of privity or the "general rule of non-liability".[12] Under this theory, a manufacturer was liable to a party injured by a defective product only if that party was in contractual privity. In other words, if the plaintiff was not in a contract with the defendant, the court ruled in favour of the defendant on the basis of the doctrine of privity of contract.[13] The foundation of this principle is found in the English case *Winterbottom v. Wright.*[14]

The plaintiff Winterbottom had been contracted by the Postmaster General to drive a mail coach supplied by the Postmaster.[15] The defendant Wright had been contracted by the Postmaster to maintain the coach safely. The coach collapsed while Winterbottom was driving and he was harmed; therefore he claimed that Wright had "*carelessly behaved, and thus completely slighted his aforesaid contract and so wholly and negligently failed to perform his duty in this behalf*".[16]

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[9] Goldberg, John C.P. & Zipursky, Benjamin C. "The Easy Case for Products Liability Law: A Response to Professors Polinsky and Shavell" Harvard Law Review, Vol. 123, (2010) p.1923.
[10] Force, Robert "Maritime Product Liability in the United States" Maritime Lawyer, (1986) p. 2-3.
[11] Ibid. p.2-3.
[12] Miller C.J., & Goldberg, R.S. "Product Liability" 2nd Edition, Oxford University Press, (2004) p. 3-5.
[13] Ibid. 3-5.
[14] Winterbottom v. Wright 10M. & W.108 (1842),
[15] Ibid. 10M. & W.108.
[16] Ibid. 10M. & W.108.

In *Winterbottom v. Wright*, the court held that the plaintiff had no remedy. The principle of *Winterbottom* implied that purchasers who were harmed by defective products in the 19th century had no legal action against the inadequate execution of an agreement to which they were not explicitly privy.[17]

Due to the dissatisfaction that the privity rule caused, the courts began gradually to create exceptions, particularly in the cases wherein the product was dangerous to human beings. This statement was reflected for the first time in the decision of the *MacPherson v. Buick Motor Co.* case in the US.[18] The judge removed the requirement of privity of contract for duty in negligence actions, accepting the claim of the plaintiff against the manufacturer of a defective car whose wheel collapsed and caused personal injuries to him.[19] Although the injured party had purchased the automobile from a dealer, who was not in privity with the manufacturer, the court stated that:

> *We have put aside the notion that the duty to safeguard life and limb, when the consequences of negligence may be foreseen, grows out of contract and nothing else. We have put the source of the obligation where it ought to be. We have put its source in the law.*[20]

Based on *MacPherson* decision, a manufacturer is liable for harm caused by the use of his product in the manner and purpose for which it was supplied, if he fails to exercise reasonable care in manufacturing a product which he should recognize might create an unreasonable risk of harm to those who use it.[21] Although it removed the requirement of privity, the MacPherson rule did not swept away the necessity of proving negligence. A plaintiff was required to show that the product was defective due to manufacturer's negligence.[22]

In England, an important step toward this reasoning is associated with a Scottish case, *Donoghue v. Stevenson*[23] in 1932. While Mrs Donoghue was drinking a bottle of ginger beer in a

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[17] Ibid. 10M. & W.108.
[18] MacPherson v. Buick Motor Co. (1916), 217 NY.382, 111 N.E. 1050.
[19] Ibid. 217 NY.382, 111 N.E. 1050.
[20] Ibid. 217 NY.382, 111 N.E. 1050.
[21] Ibid. 217 NY.382, 111 N.E. 1050.
[22] Ibid. 217 NY.382, 111 N.E. 1050.
[23] Donoghue v. Stevenson (1932) S.L.T 520.

café, she found a dead snail in the bottle. She fell ill, and she sued the ginger beer manufacturer, Mr Stevenson. The House of Lords held that "*the manufacturer owed a duty of care to her, which was breached, because it was reasonably foreseeable that failure to ensure the product's safety would lead to harm of consumers*".[24]

The issue of manufacturer liability from the European courts began to be tackled in 1960[25]. Varieties of approaches were developed to facilitate suits by injured parties. Some, for example, emphasised tort remedies.[26] They applied generic rules, which imposed near strict liability on the keepers of things causing harm or on manufacturers of particular products, or simply reversed the burden of proof regarding fault. [27] Others broadened the contractual liability.

Yet, although the endeavours to remove privity were substantial, the necessity of proving negligence remained in many cases still an important ground, particularly in Europe. British courts remained loyal to the classical contract requirement and were hesitant to tackle its neglect of the impact of contracts on third parties.[28]

Due to the difficulties that the requirement for proof of negligence presented in most cases the American courts followed a different approach to this matter: the concept of warranty based on negligence.[29] *Henningsen v. Bloomfield Motors, Inc.*[30] case allowed for the first time recovery for damages without proof of negligence. In this case, both the manufacturer and the dealer were held liable for injuries to the wife of the purchaser of an automobile with a defective steering mechanism, without being required to show either privity of contract or the manufacturer's failure to use due care.[31]

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[24] Ibid. S.L.T 520.
[25] Reimann, Mathias "Product Liability in a Global Context: The Hollow Victory of the European Model", 11 Eur. Rev. Private L. 128, (2003) p.131.
[26] Ibid. p.131.
[27] Ibid. 130-135;
[28] Stapleton, Jane "Product Liability" Balliol College, Oxford (1994), p. 37.
[29] Alvey, George R. Jr. "MacPherson Sprouts Fins: Development of Products Liability Theories in Admiralty", 28 Loy. L. Rev.1071, (1982) p. 1074.
[30] Henningsen v. Bloomfield Motors, Inc 32 N.J. 358, 161 A.2d 69 (1960).
[31] Ibid. 32 N.J. 358, 161 A.2d 69.

The principle of liability in *Henningsen* was founded on an implied warranty that a product is reasonably suitable for its intended use.[32] Consequently, when the manufacturer places a product in the market, he shall be held to guarantee it to the consumer.

3 The Adoption of the Strict Liability Principle

Originally, the field of modern product liability law, governed by strict liability in tort, was an American concept. The primary purpose behind this new doctrine was to help plaintiffs in conditions where evidence of carelessness and setting up causation would be problematic or impossible[33]. It was additionally assumed by American courts that a strict liability policy would increase consumer protection.[34] If manufacturers realise they are dealing with the risk of strict liability, the American courts reasoned, they will take additional precautions at the different phases of the production process.

The leading case towards the strict liability principle is *Greenman v. Yuba Power Products Inc.*[35], where the Supreme Court of California imposed a general, strict liability upon the manufacturer in tort even though the case was in fact brought as a claim for breach of warranty.[36] The Court acknowledged that:

> *although strict liability has usually been based on the theory of an express or implied warranty running from the manufacturer to the plaintiff, the abandonment of the requirement of a contract between them, the recognition that the liability is not assumed by agreement but imposed by law, the refusal to permit the manufacturer to define the scope of its own responsibility for defective products make clear that the liability is not one governed by the law of contract warranties but by the law of strict liability in tort.*[37]

[32] Alvey, George R. Jr. "MacPherson Sprouts Fins: Development of Products Liability Theories in Admiralty", 28 Loy. L. Rev.1071, (1982) p. 1074.
[33] Kriek, Carla "The Scope of Liability for Product Defects under the South African Consumer Protection Act 68 of 2008 and Common Law - A Comparative Analysis" Stellenbosch University, (2017) p. 17. Available at: https://scholar.sun.ac.za.
[34] Ibid. 21.
[35] Greenman v. Yuba Power Products Inc L. A. No. 26976 (1963).
[36] Ibid. L. A. No. 26976.
[37] Ibid. L. A. No. 26976.

The approach held in *Greenman* discarded the contractual concept of warranty held in *Henningsen*. These new developments greatly influenced the American Law Institute in drafting the Restatement, (Second), Torts §402A, which was embraced by the majority of American jurisdictions at the time. This faultless liability was based on the central notion of a product reaching the consumer "in a defective condition unreasonably dangerous"[38] and was widely considered in the US as the "most prominent feature of modern civil jurisprudence".[39]

Section 401A introduced a test for product defectiveness known as the "consumer expectations test", stating that:

> *one who sells any product in a defective condition unreasonably dangerous to the user or consumer or to his property is subject to liability for physical harm thereby caused to the ultimate user or consumer, or to his property, if:*
> *(a) the seller is engaged in the business of selling such a product, and*
> *(b) it is expected to and does reach the user or consumer without substantial change in the condition in which it is sold." This rule applies even though*
> *"(a) the seller has exercised all possible care in the preparation and sale of his product, and*
> *(b) the user or consumer has not bought the product from or entered into any contractual relation with the seller.*[40]

The purpose of Section 401A was to evaluate if the product was unreasonably dangerous from the consumer's viewpoint and not on the blameworthiness of the manufacturer's duct.[41] This legal standard faced several criticism and was found inappropriate as a controlling test for a product's defectiveness. Consequently, it was turned down by the subsequent Restatement (Third) as an independent measure of defect and courts developed a 'risk-utility defence'.

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[38] Restatement of the Law (Second) of Torts (1977), 401A.
[39] Stapleton, Jane "Product Liability" Balliol College, Oxford, (1994) p. 4.
[40] Restatement of the Law (Second) of Torts (1977), 401A.
[41] Harchut, Robert F. "Products Liability - Restatement (Second) of Torts - Section 402A - Uncertain Standards of Responsibility in Design Defect Cases - After Azzarello, Will Manufacturers be Absolutely Liable in Pennsylvania" Villanova Law Review, Vol 24, (1979) p. 1037-1040, available at: http://digitalcommons.law.villanova.edu/vlr/vol24/iss5/7.

In Europe meanwhile, after a long period of negotiations during the 1970's between the Member States, it was agreed on the adoption of a Directive on Product Liability on 25 July 1985. The developments in product liability reform in Europe have their origin in the Thalidomide tragedy.[42] Thalidomide is an immunomodulatory drug which was first marketed in 1957 in West Germany.

People used this drug for curing anxiety, insomnia and tension. Also, it was used against nausea to relieve morning sickness in pregnant women.[43] After the drug was sold in West Germany, between 5,000 and 7,000 infants were born malformation of the limbs and only 40% of these children survived.[44] The children who were born with malformation of the limbs had no claim in contract; therefore they had to rely on the tort of negligence.[45]

The Thalidomide crisis in Europe, as well as the pressure for harmonisation of laws in the European Economic Community (the "EEC") were the core reasons for introducing a strict product liability regime to the European Community. The thrust of the EU Directive provides that, "*a person who is injured, or whose personal property is damaged, by a product will be able to claim against the manufacturer or supplier of that product and certain other parties if it can be shown that the product was defective"*.[46] In principle the EU Directive utilises a "consumer expectations test" for determining product defectiveness.

Despite the fact the less emphasis has been placed on the traditional negligence and warranty theories with the adoption of a strict liability regime in both legal systems, in practice these approaches continue to be important supplements to the strict liability doctrine. The aim of the upcoming sections is therefore to analyse the current product liability framework and its strictness in both jurisdictions, and how this regime interacts with maritime law.

4 The Restatement (Third) of Torts – The Concept of Defect

Determining what constitutes a defect has generated confusion and debate[47], since

[42] Miller C.J., & Goldberg, R.S. "Product Liability" 2nd Edition, Oxford University Press, (2004) p. 209-210.
[43] The Thalidomide Tragedy: Lessons for Drug Safety and Regulation, accessed 05.02.2018. Available at: https://helix.northwestern.edu/article/thalidomide-tragedy-lessons-drug-safety-and-regulation.
[44] Ibid.
[45] Miller C.J., & Goldberg, R.S. "Product Liability" 2nd Edition, Oxford University Press, (2004) p. 209-210.
[46] Council Directive 85/374/EEC of 25 July 1985, Preamble.
[47] Digges, Edward S. & Billmyre, John G. "Product Liability in Maryland: Traditional and Emerging theories of Recovery and

"proof of defectiveness is the touchstone of any claim".[48] The core provision of the Third Restatement, §2, states that "*a product is defective when, at the time of sale or distribution, it contains a manufacturing defect, is defective in design or is defective because of inadequate instructions or warnings*".[49]

One of the most significant feature of the Third Restatement of Torts, section 402A is the elimination of the consumer expectation test as a controlling standard for defect and the division of the concept of defect into the three conventional categories of defectiveness: manufacturing defects, design defects and products which are defective due to inadequate instructions or warnings.[50] The form of liability for each of these defects under Section 2 of the Restetament differs.

A manufacturing defect is said to exist when a product fails to conform to its construction or quality from its specifications or planned output and as such, is an unreasonably dangerous product.[51] Due to the special significance in the manufacturing flaw context of the user's expectation interests;[52] American courts apply strict liability in its purest sense by imposing liability where the manufacturer has exercised all possible care in producing the product and irrespective of whether the injury-causing defect was unknown or not reasonably discoverable.[53]

In contrast, the Third Restatement envisages different standards for defective design and failure to warn defects. Specifically, according to section 2(b) of the Restatement (Third) a product:

> *is defective in design when the foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative design by the seller or other distributor, or a predecessor in the commercial chain of distribution, and the omission of the alternative design renders the product not reasonably safe.*[54]

Design liability, as defined in section 2(b) is structured around the principle of reasonableness "risk-utility balancing" test; an important notion from which derives the concept of negli-

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Defense" University of Baltimore Law Review, (1986) p. 12.
[48] Ibid. p. 11.
[49] Restatement (Third) of Torts, section 402A, § 2.
[50] Owen, David G. "Defectiveness Restated: Exploding the "Strict" Products Liability Myth" University of South Carolina Scholar Commons, (1996) p. 748.
[51] Miller C.J., & Goldberg, R.S. "Product Liability" 2nd Edition, Oxford University Press, (2004) p.351.
[52] Owen, David G. "Defectiveness Restated: Exploding the "Strict" Products Liability Myth" University of South Carolina Scholar Commons, (1996) p. 750.
[53] Restatement of the Law (Third) of Torts, § 2(a).
[54] Restatement of the Law (Third) of Torts § 2(b).

gence.[55] The reasoning behind this test in designed deffects is because the degree of risk in every product design is counterbalanced by considerations such as cost, utility, and safety.[56]

Thus, the adoption of a risk-utility balancing test as the standard for judging defectiveness in product design has a dual function: firstly to show whether there was available an alternative design at the time of manufacture or sale, which would have reduced the foreseeable risks of harm posed by the product;[57] and secondly whether the manufacturer's failure to adopt such a design rendered the product not reasonably safe.[58]

In order the reasonableness of an "alternative design" to be assessed and to determine whether its omission rendered the product not reasonably safe, the utilities of the design against their inherent risks of danger shall be balanced.[59]

The third major variety of defect is the absence or inadequacy of needed warnings. Warnings provide consumers with information that helps them better understand the true utility, cost and safety that constitutes each product[60]. In terms of section 2(c) a product is defective when the manufacturer or seller failed to give reasonable intructions for safe use or warnings of the product in question.[61] Basically, the Restatement (Third) mirrors the section 2(b) standard for design defectiveness such as foreseeable risk, reasonableness, optimality, and balance.

Based on the above analysis, it is argued that "while true strict liability is has been adopted for manufacturing defects; a reasonableness standard properly applied by courts in design and warnings cases is simply negligence, wrapped in a strict liability shroud".[62] As a general rule, a product must meet the expectations of the consumer and not be unreasonably dangerous.

Manufacturers are required to provide warnings and instruct the user in the way that make the product reasonably safe. He may be liable of negligence by many means; therefore he has a

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[55] Owen, David G. "Defectiveness Restated: Exploding the "Strict" Products Liability Myth" University of South Carolina Scholar Commons, (1996) p. 758.
[56] Ibid. p. 748.
[57] Toke, Michael J. "Restatement (Third) of Torts and Design Defectiveness in American Products Liability Law" Cornell Journal of Law and Public Policy, (1996) p. 246.
[58] Ibid. p.246.
[59] Owen, David G. "Defectiveness Restated: Exploding the "Strict" Products Liability Myth" University of South Carolina Scholar Commons, (1996) p. 748.
[60] Ibid. p. 762.
[61] Restatement of the Law (Third) of Torts § 2(c).
[62] Owen, David G. "Defectiveness Restated: Exploding the "Strict" Products Liability Myth" University of South Carolina Scholar Commons, (1996) p. 744.

continuing duty of care throughout all aspects of the production and distribution towards third parties. In addition to the manufacturer, the Restatement (Third) imposes also on subsequent sellers a duty to warn or instruct whenever it is "feasible and reasonably necessary".[63]

5 Product Liability Directive 85/374 EEC – The Concept of Defect

Traditionally, product liability in Europe was governed by the national laws of the EU Member States. With the adoption of Product Liability Directive in 1985, all the EU Member States were obliged to transpose and enforce the European Directive with their legal system as closely possible.

The main difference between the American and the European models with reference to the product liability law concerns to defect categories. As we have seen in the above section, American product liability law divides the concept of defect between manufacturing defects, design defects and insufficient warnings or instructions, whereas the European Directive "treats the defect concept as a single notion".[64] Under Article 6 of the EU Directive a product is defective when:

> *it does not provide the safety which a person is entitled to expect, taking all circumstances into account, including: the presentation of the product; the use to which it could reasonably be expected that the product would be put; the time when the product was put into circulation.*[65]

The second important difference is related to the definition of defectiveness. While there is a consensus regarding the definition of defectiveness for manufacturing defects, both systems diverge to a considerable extent in design and warning cases.[66] Instead of the risk utility test which prevails in the Unites States, the European Union embraced a new standard, the so-called the consumer expectation test;[67] in accordance with a product is considered defective if it is more dangerous than a reasonable person expects in light of all relevant circumstances.[68]

This standard is applicable within all the EU jurisdictions concerning the concept of defec-

[63] Restatement of the Law (Third) of Torts § 2(c).
[64] Council Directive 85/374/EEC, § 6.
[65] Ibid. § 6.
[66] Reimann, Mathias "Product Liability in a Global Context: The Hollow Victory of the European Model", 11 Eur. Rev. Private L. 128, (2003) p. 139.
[67] Ibid. p. 140.
[68] Ibid. p. 140.

tiviness and is based on the legitimate expectations of consumers in general, or the public at large, and not upon the subjective expectations formed by the individual consumer.

As Dr. Hans Taschner (a leading figure in the drafting of the Directive) has said: the question is not one "*of the individual injured party with his subjective expectations, nor even of the expectations of a specific group of consumers, but of what the community as a whole considers to be right*".[69]

The defectiveness of a product is assessed on a case by case basis, considering all the relevant circumstances on the basis of objective criteria, giving to the courts in this manner considerable discretion in deciding which other factors are relevant to the enquiry.[70] Based on this, both systems differs to the degree to which they impose liability regardless of due care; particularly in design and warning cases, since the manufacturing defects in both jurisdictions trigger true strict liability.[71] More specifically, while the Third Restatement considers elements of negligence such as reasonable care, under the EU Directive liability for all defects is simply strict.[72]

Although, today some scholars[73] agree that there is room for considering negligence due to the ambiguity of some terms used in the European Directive, such "the safety which a person is entitled to expect" or when it allows the "development-risk defense"; still the Directive intents to impose true strict liability in principle.[74]

6 Product Liability Law in a Maritime Context, in the United States and the European Union

In the United States, product liability in the context of maritime law has its origin in land-based product liability cases.[75] When privity was initially a bar to product liability action at law, the admiralty courts followed suit, imposing a similar requirement.[76] In the Mary Stewart case, pursuant to a charter party, the shipowner had furnished a cargo line, which parted,

[69] Shapo, Marshall S. "Comparing Products Liability: Concepts in European and American Law" Cornell International Law Journal, (1993) p. 293.
[70] European Commision "Liability for Emerging Digital Technologies", Brussels, (2018) p. 18.
[71] Reimann, Mathias "Product Liability in a Global Context: The Hollow Victory of the European Model", 11 Eur. Rev. Private L. 128, (2003) p. 141.
[72] Ibid. p. 141.
[73] Kriek, Carla, "The Scope of Liability for Product Defects under the South African Consumer Protection Act 68 of 2008 and Common Law-A Comparative Analysis" Stellenbosch University, (2017) p. 14-15.
Available at: https://scholar.sun.ac.za
[74] Ibid. p. 141.
[75] Force, Robert "Maritime Product Liability in the United States" (1986) 11 Maritime Lawyer. p. 1-10.
[76] McCune, D. Thomas "Maritime Products Liability", Hastings L.J. 831, (1967) p. 844.

causing a bale of cotton to drop on the plaintiff who was an employee of the stevedore firm hired by the charterer.[77] Citing the decision from the Winterbottom case regarding privity, the court said: "*Where a party is delinquent in a duty imposed by the contract, no one but a party to the contract can maintain an action*".[78]

As the privity requirement began to assume less significance and eventually was abandoned in land-based product liability actions, similar developments occurred in admiralty cases.[79] The first case to extend MacPherson principle of the contractual theory of implied warranty with elements of tort to the maritime setting was *Seas Shipping Co. v. Sieracki.*[80]

This case primarily involved extension of the warranty of seaworthiness to dockworkers, granting them the benefits of one of the oldest types of strict liability recognised in maritime law.[81] A longshoreman was injured when a newly installed boom used to load cargo broke and fell on him.[82] The court found, in addition to being owed a warranty of seaworthiness by the vessel, that the longshoreman was entitled to recover from the manufacturer, whom the court concluded was negligent in failing to test the boom adequately before selling it.[83]

Further, in the *S.S. Samovar* case, the court granted a judgment to a seaman against the builder of a vessel on which he was injured when a defectively welded cargo-lashing ring gave way.[84] Applying the MacPherson decision as a general principle, the court concluded that the ship-builder owed the plaintiff a general duty of care, which was breached by faulty welding; consequently the court held the manufacturer liable.[85]

In 1960 when strict liability became accepted as a basis for general product liability actions, it became accepted in maritime product liability cases as well. One of the best expressions of the principle underyling strict product liability in maritime law is from an admiralty judge in *Union Lines v. A.O Andersen & Co.*[86] In this case, strict liability was alleged against the shippers of a chemical called acrylonitrile, which was stowed in the chemical carrier's skin tanks[87]. The

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[77] The Mary Stewart case cited from Alvey, George R. Jr. Alvey "MacPherson Sprouts Fins: Development of Products Liability Theories in Admiralty", 28 Loy. L. Rev.1071 (1982), p. 1078.
[78] Ibid.
[79] McCune, D. Thomas "Maritime Products Liability", Hastings L.J. 831, (1967) p. 850.
[80] Seas Shipping Co., Inc. v. Sieracki, 328 U.S. 85 (1946).
[81] Ibid. 328 U.S. 85.
[82] Ibid. 328 U.S. 85
[83] Ibid. 328 U.S. 85
[84] The S.S Samovar case cited from Alvey, George R. Jr. Alvey "MacPherson Sprouts Fins: Development of Products Liability Theories in Admiralty", 28 Loy. L. Rev.1071 (1982), p. 1079.
[85] Ibid. p.79.
[86] Union Lines v. A.O Andersen & Co, 364 F. 2d 769 (1966)
[87] Ibid. 364 F. 2d 769.

tanker was involved in a collision, which caused the chemical to catch fire and burn, giving off highly toxic fumes.[88] The case involved large claims for loss of life, personal injury and property damage. The case against the shipper was dismissed, but Judge John R. Brown stated in his dissent:

> *Cyanamid ... is the manufacturer and supplier of a chemical that it knows can and does kill. Cyanamid's awesome obligations in this day of products liability when Acrylonitrile goes to sea is no less than on land.... It owed a duty literally to the world.... The duties owed to his limitless group of protectors require as a minimum that it not knowingly participate in a method of handling or transport which would imprudently imperil the lives of these people. I do not suggest here that Cyanamid ...has the liability of an insurer, but but when the material is fraught with so much danger, the liabilities may be almost absolute either because the so-called ordinary care of the prudent person itself calls for care which is extraordinary or because of principles of strict liability.*[89]

However, the case which is considered to be the one that established product liability claim in admiralty is *East River Steamship Corp. v. Transamerica Delaval Inc.*[90] In this case a distinction between consumer and commercial transactions was made in the context of maritime product liability claims. The decision involved manufacturing defects in the turbines of four supertankers that caused malfunctions and damages to the turbines.[91]

The shipowner brought suit in admiralty, alleging strict products liability against the manufacturer of the turbines to cover repair costs and loss of profits.[92] In its decision, the court explicitly stated that products liability law and concepts of strict liability are part of the general maritime law.[93]

In comparison to the developments regarding strict liability in the US, in Europe product liability within the area of maritime law has attracted little attention and the claims are handled mainly by means of maritime law rules.[94] Nevertheless, many jurisdictions already impose strict safety and quality obligations upon manufacturers within the maritime arena, with national regulations and legislation setting criteria based on a product's fitness for its intended use. A

[88] Ibid. 364 F. 2d 769.
[89] Ibid. 364 F. 2d 769.
[90] East River Steamship Corp. v. Transamerica Delaval Inc. 476 U.S. 858 (1986).
[91] Ibid. 476 U.S. 858.
[92] Ibid. 476 U.S. 858.
[93] Ibid. 476 U.S. 858.
[94] Ulfbeck, Juris Vibe "Maritime Product Liability" Scandinavian Inst. Mar. L. Y.B. 65, (2006) p. 66-67.

good example of the application of product liability law in a maritime context is a recent Danish case:

> *A ship's engine had been damaged due to a fault in a lubrication system integrated in the engine. The engine was sold as part of a purchase of seven fully built ships. The manufacturer had sold the engine to the shipyard and had no contractual relationship with the purchaser of the ships. When damage to the engine occurred, the purchaser claimed damages directly from the manufacturer of the engine, claiming that the manufacturer had incurred liability under the product liability rules that warrant direct claims against the manufacturer.*[95]

The case was submitted to the Maritime and Commercial Court in Copenhagen in the first instance. The Court found that the lubrication system had been marketed as an individual and separate product in other cases and should therefore be viewed as a separate product from the engine.[96] On that basis, the Maritime and Commercial Court concluded that the lubrication system had been defective and had caused damage to another product (the engines) and that the manufacturer of the system had therefore incurred a product liability.[97]

Considering the new development of technology and general digitalisation of shipping which lead to the creation of new services and products the question arise is whether the directive would cover defects that may occur from these new innovations such as unmanned vessels. According to art. 2 of the directive, a "product" means "all movables". The directive does not extend to digital content products and services.[98] Thus, a reflection on future needs and developments is necessary from the European product liability framework.

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95 Jensen, Jens Rostock …[et al] **"**Product Liability and Safety in Denmark: Overview" accessed 10.05.2018, https://uk.practicallaw.thomsonreuters.com/w-012 5376?transitionType=Default&contextData=(sc.Default)&firstPage=true&bhcp=1.

96 Ibid.

97 Ibid.

98 European Consumer Organisation "Review of Product Liability Rules" BEUC, Position Paper, (2017) p. 5.

7 Product Liability Law and International Law Applicable to Collision Liability

Collision is the most common accident at sea and liability for damages in collision cases is in particular based on negligence.[99] In common law negligence is defined as the breach of a recognised duty of care owed to a person who may reasonably be foreseen to suffer loss as a direct result of that breach.[100] There is a duty of care imposed on every ship against all the other users of the sea and most collision claims are based on the negligent breach of this duty.

The Collision Regulations were developed by the Intergovernmental Maritime Commission (IMO) and agreed on in the 1972 Convention on the International Regulations for Preventing Collisions at Sea. Collision law applies in two situations. The first is the traditional collision situation where two moving vessels come in physical contact with each other.[101] The second situation occurs when a moving vessel strikes a stationary object, such as a docked vessel, a bridge or a wharf.[102] Each rule refers directly to the vessel itself rather than an individual, deals with the safe navigation of vessels similar to rules of the road and provides standards of good seamanship.[103]

The basic international law applicable to collision liability is embodied in the 1910 Brussels Collision Convention.[104] Under this convention, liability for damage or injury caused by a collision is based on fault.[105] Fault in a collision case may arise for many reasons: negligence or lack of proper care or skill on the part of the navigators; failure to comply with local navigational customs or usage; unseaworthy condition or malfunction defect.[106] The convention was adopted by most major maritime nations except the United States of America.[107]

While the tort of product liability has been used in a number of diverse maritime cases in the US and it has been held to be appropriate in different actions such as collision where the defec-

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[99] Thimplis, Micheal "The Liability of the Vessels" in Baatz, Yvonne "Maritime Law" 4th Edition, Informa Law from Routledge, (2018) chapter 7 p. 234.
[100] Donoghue v. Stevenson S.L.T 520 (1932).
[101] Falkanger, Thor… [et al] "The Scandinavian Maritime Law" the Norwegian Perspective, 4th Edition, (2017) p. 226.
[102] Ibid. p. 226.
[103] Ibid. p. 227.
[104] Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels, Brussels, 23 September 1910.
[105] Ibid.
[106] Force, Robert "Admiralty and Maritime Law" Tulane Maritime Law Center, Federal Judicial Center, (2004) p. 125.
[107] Ibid. p.125.

tive product causes injury or damage; in Europe the collision liability rules differ from normal rules for damages in tort especially in two circumstances. First, the colliding parties have a responsibility based on their degree of fault, towards the injured third party – except for personal injuries where they are joint and severally liable;[108] and second, strict liability for collision between ships is not possible as a consequence of the Brussels Convention.[109]

The Brussels Convention has also been incorporated into the Norwegian Maritime Code (the "MC"), chapter 8 on "Collisions". The collision convention and Chapter 8 of MC are both based on fault. The MC doesn't, however, provide any guidance concerning the evaluation of fault. Consequently, the evaluation of fault shall be handled in the same way as negligence in ordinary tort law.

The courts must decide whether the actions taken by the parties which cause the collision were reasonable in light of what could be expected from a normally intelligent and insightful person in such a situation.[110] In addition, the court will evaluate if there was time and possibility to prevent the accident.

The shipowner is only liable for the damage to the collided vessel if he or someone who acts on his behalf is at fault under § 151. Since the rules on collision exclude the application of strict liability as developed by the courts, Chapter 8 on "Collision" applies only to a collision between ships.[111]

Strict liability has only been invoked by the Norwegian courts in special circumstances and only for damages caused by a technical defect with a bridge and dock. The Norwegian Supreme Court for example has concluded with strict liability in two cases: ND 1921 s.401 "*Neptun*" (collision with a bridge), and ND 1952 s. 320 "*Sokrates*" (collision with a dock). In both cases the damage was due to technical failure in the reversing engine, which could not be blamed on the shipowners or their servants.[112]

Taking into consideration the aforementioned decisions concerning strict liability and the fact

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[108] Falkanger, Thor…[et al] "The Scandinavian Maritime Law" the Norwegian Perspective, 4th Edition, (2017) p. 227.
[109] Hald, Hans Jørgen "Apportionment of Collision Liability; A Survey of Nordic Maritime Collision Case Law" University of Oslo, (2007) p. 34.
[110] Falkanger, Thor…[et al] "The Scandinavian Maritime Law" the Norwegian Perspective, 4th Edition, (2017) p. 227.
[111] Ibid. p.226.
[112] Ibid. p.239.

that nowadays there is a tendency for ships to become more reliant on technical solutions such as software and communications systems, it is expected that the instances of damage caused by technical failure will increase.[113]

This development will bring changes in the division of responsibilities and liabilities between the shipowner, shipbuilder and third parties, as well as which liability regime will be followed: fault-based or strict liability.

It is likely the product liability regime to be the most objective standard to determine who will be liable in the event of a malfunction defect. Currently, the product liability is not very extensive in maritime cases in Europe and the possibility that the European Directive will be considered as an option to handle maritime claims in the event of a malfunction defect is not yet clear. The reason behind this is its strict liability character, which intends to harmonise the standards between Member States in terms of product liability law, but in the meanwhile is contrary in principle to the Brussels Convention based on fault.

As it is argued so far in this paper, the producer is liable for delivering a product that is fit for its purpose, which is in harmony with the reflections behind the product liability law. Under the current version of the European Directive, producers are strictly liable within its scope[114], whereas the extent to which ordinary manufacturers' liability will apply to unmanned shipping is not yet clear.[115] Since in the upcoming decades there may be autonomous ships navigating alongside conventional ships, it might be necessary to develop a single liability regime, applicable to both types of ships and in compliance with the international maritime law framework.

8 Interaction between unmanned vessels and COLREGs

One of the obligations of the flag State that needs to fulfil when allowing ships to fly its flag, is to take measures regarding safety of navigation and seaworthiness of the ship in particular with respect to the prevention of collisions.[116] Unmanned ships are characterised by a very advanced technology, which differs substantially from traditional manned ones. The advantages

[113] Rødseth, Ørnulf Jan & Burmeister, Hans Christopher, "Developments toward the unmanned ship", MUNIN, 2012, p. 9.
[114] Council Directive 85/374/EEC of 25 July 1985 on "the Approximation of the Laws, Regulations and Administrative Provisions of the Member States concerning Liability for Defective Products".
[115] CMI International Working Group, Position Paper on Unmanned Ships and the International Regulatory Framework. Available at: http://www.comitemaritime.org/Uploads/Questionnaires/CMI%20Position%20Paper%20on%20Unmanned%20Ships.pdf
[116] UNCLOS, Art. 94 (4)(c).

offered by the former are plenty; consequently they are leading to increased interest in adapting the technology to larger and more commercial vessels.

Yet, the introduction of these new innovations may lead to pressure within existing legal system, which can struggle to adapt settled legal principals to unexpected situations created by the new technology. In the case of unmanned vessels such a pressure refers to legal structures such as watchkeeping, collision prevention and navigational rules.[117] What follows in this section is an exploration of the COLREGs rules, fundamental to the navigation and operation of unmanned vessels.

8.1 Rule 2 – Responsibility

Rule 2 of the COLREGS, titled "Responsibility", reaffirms the principle of good seamanship.[118] This rule is considered the foundation of all the convention's provisions. Seamanship encompasses a variety of qualities and practices that together make a safe, well-run ship. The most basic principle of this term is a good judgment of the ship's crew to react to different situations and manage multiple problems and solve them with equal commitment.[119]

They must carry out the duties and take the actions stipulated by the rules. They must also take the precautions required by the ordinary practice of seamen. Failure to comply with the rules of the ordinary practice of seamen may be regarded as fault, which, if it causes damage, will bring liability.

In the case of remote-controlled vessels this approach may be provided by a remote controller, on the assumption that he has the relevant training to discharge the seamanship obligation effectively.[120] Whereas, in the context of fully autonomous vessels the lack of human supervision can be contrary to the duty of good seamanship.[121] Specifically, Rule 2 (b) stipulates: "*in construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate dan-*

[117] Pritchett, Paul W. "Ghost Ships: Why the Law Should Embrace Unmanned Vessed Technology" Tulane Maritime Law Journal, 40 Tul. Mar. L.J. 197, (2015) p. 4.
[118] The International Regulations for Preventing Collisions at Sea 1972.
[119] Veal, Robert, Thimplis, Micheal "The Integration of Unmanned Ships into Lex Maritime" Lloyd's Maritime & Commercial Law Quarterly, (2017) p. 325.
[120] CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework.
[121] Veal, Robert & Thimplis, Micheal "The Integration of Unmanned Ships into Lex Maritime" Lloyd's Maritime & Commercial Law Quarterly, (2017) p. 325.

ger".[122]

This section does provide an exceptional situation which allows the vessel to depart from the COLREG rules, if there is an immediate danger. Good seamanship is a matter of a qualified and experienced ship's crew that is able to understand when it is required to deviate from the rules, by using their experience and taking the necessary actions to avoid collision. This may not be programmed before the event happens.[123]

In the short term, experienced seafarers, either on board or ashore seem to be the most effective way of performing the duty of good seamanship.[124] In the meantime today, developers of collision avoidance systems are engaged in designing programming in such a manner that would avoid deviation from COLREGs.

8.2 Rule 5 – Lookout

Rule 5 requires: "*every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and or the risk of collision*".[125]

Keeping watch is one of the most important duties of a vessel's crew and Rule 5 of COLREGs requires the use of all available means in order to ensure the performance of this duty. It is argued that the language used in Rule 5 such as "sight" and "hearing" presents a particular challenge in the context of unmanned ships, since according to some scholars[126] it requires the presence of human perception. Nevertheless, this is a matter of interpretation and it is possible the language could be used in favour of unmanned vessels.

A lookout's primary functions are to gather information about a vessel's surroundings and report that information to someone who can then evaluate it and make decisions with respect to actions in avoiding collisions.[127] What's important is the collection of information in time and the actions that will be taken when an occasion occurs, regardless if these actions are performed

[122] The International Regulations for Preventing Collisions at Sea 1972, Rule 2.
[123] Veal, Robert & Thimplis, Micheal "The Integration of Unmanned Ships into Lex Maritime" Lloyd's Maritime & Commercial Law Quarterly, (2017) p. 2-5.
[124] Ibid. p. 326.
[125] The International Regulations for Preventing Collisions at Sea 1972, Rule 5.
[126] Veal, Robert & Thimplis, Micheal "The Integration of Unmanned Ships into Lex Maritime" Lloyd's Maritime & Commecial Law Quarterly, (2017) p. 325.
[127] AAWA "Remote and Autonomous Ships: The next steps, Rolls-Royce" plc, London, (2016), p. 45-47.

by human beings or machines.[128] Last but not least the terms used in the convention "proper" and "appropriate means" indicate that there is some room for flexibility in organising the look-out.[129]

Currently, numerous projects are in the process of developing optical and aural sensors and radar equipment to transmit a very accurate view of the craft's vicinity.[130] These systems are safer, more accurate and more reliable, detecting beyond the human capabilities. In other words, the advanced technology that will be used for both remote-controlled and autonomous marine craft will be an evolution of the traditional term "lookout".

8.3 Rule 6 – Safe Speed

The obligation to proceed at safe speed is perhaps the most important risk management factor.[131] Excessive speed reduces the time available to detect and assess developing risks and to take effective avoiding action. High speed also increases the potential of more devastating damages if a collision should occur. This rule is the most frequently used by the courts in collision cases. Rule 6 stipulates a list of factors for determining a safe speed. These factors are divided into two categories. The first category consists of the factors that need to be considered by all vessels such as:

> "*the state of visibility; the traffic density, including the concentrations of fishing vessels or any other vessels; the manoeuvrability of the vessel, with special reference to the stopping distance and the turning ability in the prevailing conditions; the presence of background light at night, such as from shore lights or from back scatter of the vessels' own lights; the state of the wind, sea and current, and the proximity of navigational hazards; and the draft in relation to the available depth of water*".[132]

The second group, which is relevant to unmanned vessels, includes vessels with operational radar. These vessels will mostly sail at higher speeds in situations of restricted visibility; consequently they need to take additional elements in consideration when determining a safe speed, such as:

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[128] Ibid. p. 45-47.
[129] Ibid. p. 45-47.
[130] Veal, Robert & Thimplis, Micheal "The Integration of Unmanned Ships into Lex Maritime" Lloyd's Maritime & Commercial Law Quarterly, (2017) p. 326.
[131] Hald, Hans Jørgen "Apportionment of Collision Liability; A Survey of Nordic Maritime Collision Case Law" University of Oslo, 2007 p.10.
[132] The International Regulations for Preventing Collisions at Sea 1972, Rule 6 (a).

"*the characteristics, efficiency and limitations of the radar equipment; any constraints imposed by the radar range scale in use; the effect on radar detection of the sea state, weather and other sources of interference; the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range; the number, location and movement of vessels detected by radar; the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity*".[133]

In the event of remote-controlled vessels the SCC may have a decisive role regarding this duty, although even in fully autonomous vessels this requirement does not produce an obstacle for its application, since Rule 6 does not specifically requires a "human" factor.

8.4 Navigation and safety

Part 2 of the COLREGS on "steering and sailing" is applied to all vessels. The Advanced Autonomous Waterborne Applications (AAWA) project, which aims to produce the specification and preliminary designs for the next generation of advanced ship solutions states that the convention does not include any textual obstacle regarding the person who is responsible for the operational decisions on the ship's navigation and manoeuvring.[134]

As argued in this paper, SCC will take responsibility for the operating part in the case of remote-controlled vessels. SCC, by substituting the crew, must take all the preventive actions and make optimal use of the information delivered by the radar and sensor systems.

The situation is slightly different and difficult for fully autonomous vessels due to the lack of an operator for decision-making. However, even in the case of autonomous vessels algorithms will be created and tested so that they can precisely comply with the steering and sailing rules, and be able to operate.[135]

A good example of this is a recent project: MAchine eXecutable Collision regulations for Marine Autonomous Systems ("MAXCMAS"), which aims to develop a COLREGs-compliant

[133] The International Regulations for Preventing Collisions at Sea 1972, Rule 6 (b).
[134] AAWA "Remote and Autonomous Ships: The next steps, Rolls-Royce" plc, London, (2016) p. 5.
[135] The International Regulations for Preventing Collisions at Sea 1972, Rule 6 (b).

path planner for autonomous vessel guidance and control.[136] The project brings together key expertise of industrial partners: Rolls Royce (RR) as lead; Atlas Elektronik UK (AEUK) and Lloyd's Register (LR); and academic partners Queen's University Belfast (QUB) and Southampton Solent University's Warsash Maritime Academy (WMA).

The team found that use of newly developed algorithms allowed existing COLREGs to remain relevant in a crewless environment, as artificial intelligence-based navigation systems were able to enact the rules to avoid collision effectively, even when approaching manned vessels that were interpreting the rules differently.[137] A key aspect of the research was the use of WMA's networked bridge simulators. The simulators were used to analyse reactions from the crew when faced with a range of real-world situations and subsequently hone the MAXCMAS algorithms[138].

Ralph Dodds, representative of Innovation & Autonomous Systems Programme Manager at AEUK, said that: "during the sea trials it was proved that an unmanned vessel was capable of making a collision avoidance judgment call even when the give-way vessel wasn't taking appropriate action".[139] This statement was also supported by Eshan Rajabally, leader of the project and representative of Rolls-Royce Future Technologies Group, who said that: "Through MAXCMAS, we have demonstrated autonomous collision avoidance that is indistinguishable from good seafarer behaviour, and we've confirmed this by having WMA instructors assess MAXCMAS exactly as they would assess the human".[140]

This project is a step forward, which proves that autonomous navigation can meet existing COLREGs requirements.

9 Product Liability and Unmanned Vessels

Liability regime in maritime law includes a number of peculiarities. Traditionally, the matters of maritime liability have been based on a state's national legal system, as there is no

[136] Varas, J…[et al] "MAXCMAS Project. Autonomous COLREGs Compliant Ship Navigation", Queen's University Belfast, (2017), p. 1-5.
[137] Ibid. p.1-5.
[138] Ibid. p. 1-5.
[139] Ibid. p.1-5.
[140] Ibid. p. 1-5.

uniform convention regulating the maritime liability. The shipowner is the one that often bears a pre-dominant responsibility for most maritime liabilities. This is either because of a specific provision for such a position such as the Brussels Convention which places liability on a relvant ship rather individual people involved in the operation of the ship;[141] or because of the vicarious liability rule which is followed by many jurisdictions, including Norway.

Section 151 of the Norwegian Maritime Code is the main regulation regarding the reder's (the "shipowner") liability for damage caused by fault or neglect in the performance of duties by the master, any member of the crew or other people acting on behalf of the ship.[142] In order for this section to be applied, certain requirements must be met. First, negligence and causation must be present, and also, the tortfeasor should have foreseen that his actions could result in damage or injury.

Further, § 151 stipulates that "the shipowner is liable for fault or neglect from any of the persons involved in service of the ship", even if there is no employment contract between them.[143] What's important is the person who performs what's important is that the person performing the work is involved with that particular ship. This person can be a hired crewmember onboard as well as anyone assisting the ship independently, such as a pilot.[144]

Emerging autonomous systems lead to the creation of new products and services that bring new opportunities for our economy and society, such as unmanned vessels subject of this thesis. Due to their specific characteristics with regards to the operation, these new technological advancements may challenge the current maritime legal framework as explained above.

The more autonomous systems are, the less they depend on human wrongdoing. Therefore we are likely to move away from the traditional errors, caused by the existing actors such as shipowners. The reliability and problem-solving capacity of an autonomous system become critical[145] and the accident caused by a device operating with a certain autonomy degree it is likely to be linked with the manufacturer, as well as with all those parties who play a significant role

[141] Brussels Convention 1910, Rule 1.
[142] The Norwegian Maritime Code 1994, §151.
[143] Ibid.
[144] Falkanger, Thor… [et al], "The Scandinavian Maritime Law" the Norwegian Perspective, 4th Edition, Universitetforlaget (2017) p.182-183.
[145] AAWA "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London, (2016) p. 49.

in the development of the automated technology[146].

As AAWA states this would mean a shift towards "product liability in the maritime context to fill a perceived 'liability gap' in maritime law"[147]. Under the Product Liability Directive and in the framework of harmonising the European legislation on products, manufacturers of these vessels must ensure that they inform the interested parties sufficiently as to how the automated features should be used safely, as well as explain any potential risks[148]. This will engage them to make sure that they do absolutely everything possible to keep their product at high standards.

As a consequence of this new legal regime in a maritime context, the allocation of liability may vary between the existing players in shipping and new one, as it will be dicussed in the next section.

10 Liability and Unmanned Vessels

One of the primary motivating objectives of creating unmanned vessels is the presumption that they will increase safety. For instance, the European Maritime Safety Agency states that 62% of the accidents that happened over the period 2011-2016 were attributed to human errors.[149]

The Managing Director at the Nordic Association of Marine Insurers, Ms. Helle Hammer, supported the same statement. During her presentation on 'The challenges with autonomous ships from an insurance perspective', which took place in November 2017 in Oslo, she said that "*the human factor is the most important cause of many marine accidents*".[150] Consequently, by replacing humans with satisfactorily efficient machinery, it is believed that maritime accidents will substantially decrease, with significant implications for safety.

However, this does not imply that there will be no more maritime accidents in the future. Unforeseen issues can always arise even in the case of unmanned vessels and the allocation of liability poses some challenges for the current liability framework. Even if there is not an immediate need to change the foundations of maritime liability for autonomous ships, there are

[146] European Commision "Liability for Emerging Digital Technologies", Brussels, (2018) p. 10.
[147] AAWA "Remote and Autonomous Ships: The Next Steps, Rolls-Royce" plc, Position Paper, London, (2016) p. 52.
[148] European Commision "Liability for Emerging Digital Technologies", Brussels, (2018) p. 5.
[149] European Maritime Safety Agency "Annual Overview of Marine Casualties and Incidents 2016" http://www.emsa.europa.euù.
[150] Helle Hammer, Managing Director at the Nordic Association of Marine Insurers, Presentation on "The Challenges with Autonomous Ships from an Insurance Perspective' November 2017, Oslo, Norway.

numerous questions regarding the liability of autonomous operations due to the absence of a regulatory framework and legal precedent.

Due to the operational peculiarities of both remote-controlled and autonomous vessels, these will be handled under separate titles.

10.1 Liability of Autonomous Vessels

In 2015, Swedish carmaker Volvo announced that it will accept liability whenever one of its vehicles is operating in autonomous mode: "*We are the suppliers of this technology and we are liable for everything the car is doing in autonomous mode… If you are not ready to make such a statement, you shouldn't try to develop an autonomous system*"[151].

On March 19, 2018 a woman in the street in Arizona died when hit by an autonomous Uber car, in what appears to be the first reported fatal crash involving a self- driving vehicle and a pedestrian in the US.[152] Local police reported the self-driving car was in autonomous mode at the time of the crash and that the vehicle hit a woman, who was walking outside of the crosswalk and later died at a hospital.[153]

There was a vehicle operator inside the car at the time of the crash. Altough the accident appears to be primarily caused by the pedestrian, proponents of self-driving car criticized the industry for moving too fast to put untested technology on public roads.[154]

From a technology point of view autonomous vessels are equally sophisticated as self-driving cars; they are pre-programmed before deployment and perform a predetermined nautical course without any human interaction.[155] The pre-programmer is potentially the last human input into the ship's navigational course.

As Comite Maritime International argues, in the context of an autonomous collision avoidance system with no onboard oversight, "the pre-programmer can be sure his before-the-event con-

[151] "Rolls-Royce Predicts Autonomous Shipping by 2020" accessed 23.03.2018. Available at: http://www.professionalmariner.com/Web-Bulletin-2016/Rolls-Royce-predicts-autonomous-shipping-by-2020/, accessed 23.03.2018.
[152] The Guardian, Self-driving Uber kills Arizona woman in first fatal crash involving pedestrian, 19 March 2018. Available at: https://www.theguardian.com/technology/2018/mar/19/uber-self-driving-car-kills-woman-arizona-tempe.
[153] Ibid.
[154] Ibid.
[155] CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework. Available at: http://www.comitemaritime.org/Uploads/Questionnaires/CMI%20Position%20Paper%20on%20Unmanned%20Ships.pdf.

duct potentially has a far more profound bearing on the ship's navigational safety than an ordinary component manufacturer traditionally would".[156]

In unmanned autonomous vessels, shipowners will continue to supervise and inspect them; the software manufacturer will be under the duty to provide to the shipowners a product that fills all the standards of safety which might reasonably have been expected by the shipowners[157]. The pre-programmer shall act in due diligence when he pre-programmes the unmanned navigational course.

Based on this arrangement, the liability arising from an accident involving a pre-programed autonomous unmanned ship stands to be apportioned in some proportion between the shipowner, the software manufacturer and the pre-programmer[158].

Nevertheless, in case the defect has its origin to its production then the victim has the right to pursue a claim against the manufacturer based on the national legislation, implementing the Product Liability Directive[159].

10.2 Liability of Remote-Controlled Vessels

In the operation of remote-controlled vessels there is still a human factor, the SCC. The difference between manned and remote-controlled vessels is that crew in the former is working on board, while the operator of the latter is working at the shore-based office centre. Remote-controlled vessels will be equipped with very advanced communications and software technology, which requires well-trained operators, acting in due diligence.

All the duties performed by the crew will be transferred to them; therefore the role and the responsibilities of the operators regarding the navigation and management of the ship will be equal to those of the crew.[160] All these responsibilities of the operator indicate that the risk of human errors still exists.

As discussed above, based on the traditional maritime rule the shipowner will be held liable for

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[156] Ibid.
[157] Ibid.
[158] Ibid.
[159] European Commision "Liability for Emerging Digital Technologies", Brussels, (2018) p. 14.
[160] CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework. Available at:
http://www.comitemaritime.org/Uploads/Questionnaires/CMI%20Position%20Paper%20on%20Unmanned%20Ships.pdf.

the acts and omissions of the master, captain and crew. With the operators controlling the vessel from ashore, it is likely that this will still remain the case, covered by § 151 or employment agreement with the shipowner, as long as their actions are in the service of the ship in question and in relevance to their job and duties.

Although the primary goal of these ships is to increase safety at sea and avoid accidents, collisions still will happen, either because of the operator's behaviour or because of new types of errors. With reference to the first situation, the "operator's behaviour", the person in charge of performing such duties is expected to act in due diligence and following the legal framework including the rules provided in the COLREGs regarding proper lookout and safe speed, so that they can avoid collision.

Also, the operator is responsible to make sure that the ship itself meets all the standards for ship's seaworthiness. This is one of the duties of the master provided in § 131 of the MC. Assuming that the operator has breached the aforementioned duties due to his negligence in the SCC, and this leads to the ship causing damages, the shipowner will be liable based on the normal interpretation of MC §151. How far the vicarious liability will extend for the shipowner, this will depend on the casual link between negligence and causation.

Riverstone Meat Co Pty Ltd v. Lancashire Shipping Co Ltd[161] decision of the House of Lords in 1961, also known as the *Muncaster Castle* case is a good example regarding the extension of liability to shipowners. The Muncaster Castle experienced heavy weather conditions during a voyage from Australia to London; as a consequence the cargo was damaged by seawater.[162] The most likely approach of access was found to be leakage through inspection covers over storm valves.[163]

These covers had been replaced before the vessel's prior voyage from the UK to Australia, immediately after an inspection of the valves themselves, but the court found that the securing nuts had been improperly fitted.[164] The replacement of the covers and fitting of the nuts was carried out by a fitter employed by a firm of ship-repairers who were instructed by the owners'

[161] Riverstone Meat Co Pty Ltd v. Lancashire Shipping Co Ltd. AC 807 (1961).
[162] Ibid.
[163] Ibid.
[164] Ibid.

managers to remove the covers for the inspection specified.[165]

The discussion was about as to whether the shipowners were liable to cargo interests for the fitter's negligence. The judge decided not to find them liable. When this decision was appealed from cargo interests to the House of Lords where the decision this time was in favour of the cargo owners and against the shipowners.[166]

This decision was assumed to be based on the Article III Rule I of the Hague Rules, in accordance with "*the due diligence required from a shipowner covers not only the shipowners, their employees and servants but also their sub-contractors and agents, whether independent or not*"[167]. Their Lordships decided that the ship-repairers and their negligent employee fell into the second category.[168] On this basis, the shipowners were held liable.

Yet, in the event these errors are due to a technical failure that has its origins in its production, then the liability framework will take a different perspective. More specifically, according to experts in this field, all the duties performed by the operators are fully reliant on technology.

If the operators make a wrong decision, without it really being their fault but due to equipment defects, then the liability for damage is triggered by product liability. The investigation of the failed technical device will help to assess the reason behind a potential collision and understand if the shipowner or producer is the closest person to cover the damages.

11 Applicable Standards for Unmanned Vessels Operating

With the introduction of unmanned service, safety and security standardisation will be essential for the design from the beginning to the end of the whole life-cycle of this new technological innovation. Generally, it is agreed that unmanned vessels will face similar safety risks as conventional vessels. Consequently, they will be acceptable for commercial use if they have at least the same safety standards as conventional vessels in use for the same purpose.[169] Currently, the production of European harmonised standards for autonomous systems is ongoing.[170]

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[165] Ibid.

[166] Ibid. AC 807.

[167] Article III Rule I The Hague-Visby Rules - The Hague Rules as Amended by the Brussels Protocol 1968.

[168] Riverstone Meat Co Pty Ltd v. Lancashire Shipping Co Ltd. AC 807 (1961).

[169] AAWA "Remote and Autonomous Ships: The next steps, Rolls-Royce" plc, London, (2016) p. 55-57.

[170] European Commision "Liability for Emerging Digital Technologies", Brussels, (2018) p. 5.

Chapter II-1 of International Convention for the Safety of Life at Sea ("SOLAS") provides internationally uniform standards in respect of the construction and equipment on ships. The flag states shall ensure that ships under their flag fulfil their requirements. To a considerable extent, unmanned ships can benefit from this framework, particularly in the context of the materials and methodologies for hull construction, electrical installations etc.[171]

Nevertheless, due to a new infrastructure, communication systems and electronic sensors of unmanned ships, additional risks will be introduced and the threats will be transferred from the onboard crew to intelligent software systems.[172] Software in support of unmanned ships plays an important role, because it includes data and information which aims to harmonise, integrate, exchange, present and analyse maritime data and information to meet user needs.[173] Therefore it is crucial this system is safe, secure and implemented in the context of the rules of classification societies and regulatory bodies.

From the safety point of view, the attribution of classification societies as independent legal entities to ensure the safeness of the maritime industry is expected to continue even after the introduction of autonomous ships. The three core pillars of ship safety addressed by classification societies such as safety at sea, avoiding human injury and protecting the environment should remain unchallenged by the development of unmanned ships.

According to Bjørn-Johan Vartdal, Program Director at DNV GL, quality of software seems to be a crucial component for designing unmanned ships. In order to achieve the standard of a quality software-based system, enhanced testing will be required, although according to him it is not possible to test *everything* in a complex, software-based system.[174]

DNV GL requires that verified system and software development and configuration processes are used to create and deliver the functionality in question.[175] The verification of the processes in question can be done by submitting proof that an independent party has verified the content and the application of the processes.[176]

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[171] International Convention for the Safety of Life at Sea, 1974.
[172] AAWA "Remote and Autonomous Ships: The next steps, Rolls-Royce" plc, London, (2016) p. 60.
[173] IMO MSC.1/Circ.1512 "Guideline on Software Quality Assurance and Human–Centred Design for E-Navigation" (2015).
[174] Vartdal, Bjørn-Johan, Program Director at DNV GL, Interview on "the Standards of Programming, that shall be fulfilled by the Unmanned Ships", April 2018.
[175] Ibid.

Presently, according to Mr. Vartdal, there are several available standards the supplier can choose such as: AoM for Systems and Software Engineering (DNVGL-CP-0507); Systems and Software engineering – Software life cycle processes (ISO/IEC 1207); Systems and Software engineering – System lifecycle processes (ISO/IEC 15288).[177]

Although this statement is not yet official from DNV GL, a guideline to the classification of autonomous ships, as well as a position paper are expected to be published before summer 2018.

Security is an equally essential requirement that needs to be fulfilled in the design and implementation of unmanned ships. Security refers to unauthorised intentional acts of persons or organisations aimed to cause harm or damage to a system for the purposes of the malicious actor.[178] Traditionally execution of malicious acts has required physical presence of the actors and intrusion into the target system.

The growing usage of networked ICT technology, however, has made it possible to try to access systems virtually through network interfaces and gain unauthorised remote capability to manipulate or exploit the system or its particular elements in some undesired manner.[179] This implies that, in principle, anybody skilful and capable enough to attain access into the ICT system could take control of the ship and change its operation according to the hacker's objectives. Therefore, concerns about cyber security are further increased in the context of unmanned ships.

The issue of security is handled by Lloyd's Register, which has launched a goal-based code that takes a structured approach to the assessment of unmanned marine systems (UMS) against a set of safety and operational performance requirements.[180] According to Lloyd's Register Code, "*any e-navigation implementation should provide a secure digital environment, in particular: addressing avoidance, prevention and detection of any cyber security threats, locally, regional-*

[176] Ibid.
[177] Ibid.
[178] AAWA "Remote and Autonomous Ships: The next steps, Rolls-Royce" plc, London, (2016) p. 65.
[179] Ibid. p.65.
[180] Lloyd's Code for Unmanned Marine Systems February (2017).

ly and internationally"[181].

In addition to the endeavours of classification societies in gaining expertise in such operations the management of safety and security shall be expected also by IMO to introduce regulations for the innovative practices presented by unmanned vessels.

12 Conclusion

With the introduction of remote-controlled and autonomous ships, a new era starts for the shipping industry and interested parties. Unmanned vessels and particularly completely autonomous vessels rely on IT and software systems, which substantially will affect the role and responsibilities of the parties involved.

Having presented briefly the evolution of product liability law in the US and EU and taking the experience of the United States, which has successfully incorporated the doctrine of product liability law into the general maritime law, we can see that this regime has to be potential practiced in Europe also, mainly after the introduction of unmanned vessels.

Concerning the current international framework on collision in relation to unmanned vessels, I must admit that the existing maritime legal framework as provided by COLREGs does not fully accommodate the new risks that may occur from their operation due to the human involvement in the decision-making process. However, taking into consideration the ongoing projects that involve big players in the industry, the compliance with COLREGs is not so problematic.

Liability, as many commentators agree will depend on the level of automation. In the event of remote-controlled vessels, the COLREGs rules might be not so challenging, as an operator located ashore in the Shore Control Centre will replace the "crew". Since all the duties performed by the crew will be transferred to him the liability matters will be handled in the same way as today; the shipowners will be liable through vicarious liability.

On the other hand, in the case of autonomous vessels which intend navigation without any human interference, liability matters are not very clear yet. It is likely the issue of liability to take different perspective from the traditional maritime rules due to their design and the new players

[181] Ibid.

who will enter into the industry.

Nevertheless, both vessels either remote control or completely autonomous have something in common in case of a technical defect which has its origin to its production: the victim has the right to pursue a claim against the manufacturer based on the national legislation, implementing the Product Liability Directive. Justice is best served when all the parties are satisfied and in that particular case the producer is the party that shall be liable and the shipowners will be released from liability.

Safety and security shall be the priority of these vessels and a lower standard of the manned vessels should not be accepted. The classification societies such as DNV GL, as well as the European Commision has already been engaged in activities which includes an evaluation of the standards that these vessels shall be fulfilled.[182]

The European Product Liability Directive will be a significant legal resource to the current legal vacuum which exists concerning unmanned vessels. In order this to be reached two important elements shall be considered: firstly, the inclusion of autonomous system in its scope; and secondly, since unmanned ships are subject to the same rights and obligations as manned vessels[183], a uniform liability regime for both vessels in compliance with the traditional maritime liability framework should be agreed.

From my point of view, although the current legal framework is not yet determined, looking at the interest of big players in the shipping industry and their endeavours to invest in those vessels their production and use will prevail. As we have seen there are many ongoing projects which have already started to cooperate with national maritime authorities and classification societies in order these unique vessels to become a reality.

[182] European Commision "Liability for Emerging Digital Technologies", Brussels, (2018) p. 3.
[183] AAWA "Remote and Autonomous Ships: The next steps, Rolls-Royce" plc, London, (2016), Indroduction, 49-53.

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