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COLREGs and Autonomous Vessels: Legal and Ethical Concerns under Canadian Law

*Marel KATSIVELA**

Abstract

The present study focuses on legal and ethical questions raised with respect to autonomous – more specifically remotely controlled and fully autonomous – vessels and COLREGs under Canadian law. The legal questions revolve around issues such as whether an autonomous vessel may be qualified as a vessel under COLREGs and whether an autonomous vessel can abide by the COLREGs look-out (Rules 5) and good seamanship (Rule 2) requirements. It concludes that although the look-out and good seamanship requirements could be performed by remotely controlled vessels without making major changes to the existing rules, for fully autonomous vessels, decision making under Rule 5 (proper look-out) and Rule 2 (good seamanship) cannot be viewed, at this stage, as conforming with COLREGs. The legal issues examined under COLREGs and the solutions we provide to them reflect ethical concerns raised by autonomous vessels and the degree to which we trust AI in shipping. This study identifies the need for ethical principles to govern autonomous vessels and provides some direction in developing these principles.

Keywords: COLREGs, autonomous vessels, unmanned vessels, Canada, ethics, legal, artificial intelligence

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1. Introduction

For the first time, the possibility exists for ships to navigate the globe with no one at the helm.[1] Autonomous[2] ships are defined as ships which, to a varying degree, can operate independently of

*Associate Professor, University of Ottawa, Faculty of Law, Programme de Common Law en Français. I would like to thank Captain Chris Connor Chair - V&P Committee Company of Master Mariners of Canada, Donald Roussel, until recently Senior Advisor to the Assistant Deputy Minister, Transport Canada and currently President and CEO of Roussel Strategic Advisory Services inc, Jack Gallagher, Hammurabi Consulting, Ørnulf Jan Rødseth, Senior Scientist, SINTEF Ocean, Pierre Sames from DNV GL for their substantive feedback and input in directing my thoughts and discussing different aspects of this project.

1 Paul W Pritchett, 'Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology' (2015) 40 Tulane Maritime Law Journal 197, 199.

2 *Autonomous* means, in Greek, 'existing or capable of existing independently' Merriam Webster Dictionary <www.merriam-webster.com/dictionary/autonomous> accessed 8 January 2021. Another acronym used for autonomous vessels by the IMO is Maritime Autonomous Surface Ships (MASS).

human interaction.[3] The presence of ships without crew on board can be traced back to ancient Greece.[4] Autonomous ships today are being configured to operate via remote control, autonomous means or a combination of the two methods.[5]

Autonomous vessels present different levels of automation.[6] Level one involves ships with automated processes and decision support where seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control. Level two, by contrast, encompasses remotely controlled ships with seafarers on board where the ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions. Level three of vessel automation concerns remotely controlled ships without seafarers on board where the ship is controlled and operated from another location by remote controlled mechanisms, that is by a shore based human operator.[7] There are no seafarers on board. Finally, level four refers to fully autonomous ships in which the operating system of the vessel is able to make decisions and determine actions by itself.

This article focuses on remotely controlled ships without crew on board and fully autonomous ships (levels three and four) since these levels of autonomation appear to raise significant legal and also ethical issues. Robot ethics refer to the practical challenge of building robots which explicitly engage in making moral decisions.[8] Indeed, for levels of automation one and two involving human presence on board the current rules may remain largely unchanged.

Automation in shipping is possible due to the presence of sensors on board, cameras, radars, algorithms and software that interpret data and propose appropriate actions as well as the shore control centre[9] that will play an important role in the navigation of the ship. In the case of remotely controlled vessels, sensors on board feed information to a human operator not located on the vessel who evaluates the relayed

3 Maritime Safety Committee, 'Annex - Framework for the Regulatory Exercise' (6 December 2018) IMO Doc MSC 100/WP.8, para 3.

4 The ancient Greek engineer Archytas is regarded as having invented the first UAV, a mechanical pigeon, in the 4th Century BC. The Greeks and Chinese also used UAVs to send unmanned ships that were on fire into naval battles. Rehfuss Abigail, 'The Domestic Use of Drones and the Fourth Amendment' (2015) 8 Albany Government Law Review 313, 317 note 16 of this article citing other authors; see also Erich Grome, Spectres of the Sea: The United States Navy's Autonomous Ghost Fleet, its Capabilities and Impacts, and the Legal Ethical Issues that Surround' (2008) 49 Journal of Maritime Law and Commerce 31, 37. The technology used in ancient times was, of course, different from that used today.

5 Pritchett (n 1) 199.

6 For the following see IMO Doc MSC 100/WP.8, para 4.

7 IMO Doc MSC 100/WP.8, para 4 for this and all four levels of automation.

8 Wendell Wallach, 'The Challenge of Moral Machines' (*Philosophy Now,* 2009) <https://philosophynow.org/issues/72/The_Challenge_of_Moral_Machines> accessed 19 April 2021. Ethos means 'custom' or 'character' in Greek. As originally used by Aristotle, it referred to a man's character or personality, especially in its balance between passion and caution. Today, *ethos* is used to refer to the practices or values that distinguish one person, organization, or society from others. Merriam Webster, 'Ethos' *(Merriam Webster)* <www.merriam-webster.com/dictionary/ethos> accessed 8 January 2021. In the present study, the term 'autonomous' vessels or ships will refer to levels three and four of vessel autonomy as herein described.

9 T. Karlis, 'Maritime Law Issues related to the Operation of Unmanned Autonomous Cargo Ships' (2018) 17 World Maritime University Journal of Maritime Affairs 119, 121.

information and sends commands back to the vessel.[10] These commands are then carried out through its electronic systems. In the case of a fully autonomous vessel, information is collected from the various sensors and sent to an onboard computer that evaluates the information and issues commands to the engines, rudders, and other navigational and cargo care components with no human input.[11]

Such vessels have a variety of potential uses: they may be used for the transport of goods and passengers, scientific marine research, the maintenance/repair of oil platforms, pipelines, ships and ports, laying submarine cables, surveillance, espionage, border patrol, and detection of smuggling and of narcotics.[12] In the area of merchant shipping – the focus of the present study - Japanese shipping firms and shipbuilders are currently working to develop self-piloting cargo ships while a Norwegian project completed the world's first electrically powered autonomous container ship (the *YARA Birkeland*) in November 2020.[13] Chinese companies have also launched autonomous cargo ships in recent years and there are predictions that China will be leading the autonomous shipping market by 2025.[14]

Such vessels have numerous advantages. First, as human error accounts for more than 70% of all marine casualties,[15] automation in shipping has a beneficial effect in reducing the number of accidents at sea.[16] Second, cost-effectiveness is achieved since the costs of maintaining a crew on board, their accommodation and wages are eliminated, leading at the same time to vessels that weigh less, have more stowage space for cargo and consume less fuel.[17] Finally, considering that there is a declining interest in seafaring careers and a consequent shortage of seafarers, autonomous vessels will not be technologies of passing interest.[18]

The autonomous operation of ships raises, however, broad security and ethical concerns by introducing

10 Pritchett (n 1) 199.

11 ibid 199 who also notes that in this case a communication link between the vessel and a monitoring or command center will likely be a part of this system so that information can be uploaded to the vessel as necessary. The author further notes that a hybrid (remotely operated and completely autonomous system) is also possible and likely to be dominant, at least in the early stages of MASS, because it can eliminate many of the shortcomings.

12 Eric Van Hooydonk, 'The Law of Unmanned Merchant Shipping – An Exploration' (2014) 20 Journal of International Maritime Law 403, 404.

13 Paul Dean, Tom Walters, Jonathan Goulding, Henry Clack, 'Autonomous ships – MASS Mutations' (*Holman, Fenwick Willan*) <www.hfw.com/Autonomous-Ships-MASS-Mutations-Feb-2021> accessed 19 April 2021.

14 Martyn Wingrove, 'China Will Lead US$1.5Bn Autonomous Shipping Market by 2025' (*Riviera*) <www.rivieramm.com/news-content-hub/news-content-hub/china-will-lead-us15bn-autonomous-shipping-market-by-2025-58960> accessed 19 April 2021.

15 Pritchett (n 1) 201. Council of Canadian Academies, 'Commercial Marine Shipping Accidents: Understanding the Risks in Canada' (Council of Canadian Academies, 2016) <https://cca-reports.ca/wp-content/uploads/2018/10/cca_marine_shipping_risks_en_fullreport.pdf> accessed 8 January 2021.

16 Wróbel Krzysztof, Montewka Jakub and Kujala Pentti. 'Towards the assessment of potential impact of unmanned vessels on maritime transportation safety' (2017) 165 Reliability Engineering and System Safety 155, 163.

17 Pritchett (n 1) 201.

18 Aldo Chircop, 'Testing International Legal Regimes: The Advent of Automated Commercial Vessels' (2018) 60(1) German Yearbook of International Law 1, 4.

certain risks. First, electronically operated devices may malfunction, present defects or be hacked.[19] Electronic devices and artificial intelligence (AI)[20] used by autonomous vessels might, therefore, be detrimental. At the same time, while autonomous vessels may prevent accidents, counteracting damage produced following the accident (fire, environmental damage, flooding, and damage to the cargo) tends to be more effective if a crew is on board.[21] Second, the implementation of autonomous vessels will probably result in a loss of employment. Unions representing personnel working on board have reacted with skepticism regarding autonomous vessel safety and cost-effectiveness.[22] It is also argued that there is no shortage of individuals who are willing to work at sea but a shortage of individuals who are willing to work in the conditions that are currently prevalent in many parts of the industry. [23] Third, if the delegation of tasks to AI is based on artificially induced blind trust in the name of growth and prosperity, such delegation is not only imprudent but also morally problematic.[24] Considering these factors, one cannot but wonder whether the substitution of artificial intelligence for human judgment is socially acceptable.[25]

Automation in shipping requires adapted regulations and policies to govern it. Even though shipping in Canada and worldwide is heavily regulated, the existing rules either do not address or only partially address new technologies. The International Maritime Organization (IMO), responsible for regulating many aspects of the maritime activity at the international level, is currently undertaking a scoping exercise in order to determine which IMO legal instruments would apply or not to autonomous vessels and to what extent these instruments would require amendments or whether a new instrument to govern autonomous vessels would be necessary.[26] The scoping exercise

19 David Dubay 'Why we will Never See Fully Autonomous Commercial Ships' (*Center of International Maritime Security, 2019*) <http://cimsec.org/why-we-will-never-see-fully-autonomous-commercial-ships/40652> accessed 8 January 2020.

20 AI is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. 'Artificial Intelligence' (*Britannica*, 2019) <www.britannica.com/technology/artificial-intelligence> accessed 8 January 2021.

21 Wróbel, Montewka and, Kujala, (n 16) 164.

22 Hamburg School of Business Administration, 'Seafarers and Digital Disruption' (*International Chamber of Shipping,* 2018) <www.ics-shipping.org/wp-content/uploads/2020/08/ics-study-on-seafarers-and-digital-disruption-min.pdf> accessed 8 January 2021.

23 The Royal Institution of Naval Architects, 'Autonomous vessels: the Union's View' (*Royal Institution of Naval Architects,* 2017) <www.rina.org.uk/unionview.html> accessed 8 January 2021.

24 Ian Kerr, 'Bots, Babes and the Californication of Commerce' (2004) 1 University of Ottawa Law and Technology Journal 285, 314; W. Hartzog, 'Unfair and Deceptive Robots' (2015) 74 Maryland Law Review 785, 787-788;Rahwan Iyad, 'Society-in-the-Loop: Programming the Algorithmic Social Contract' (2018) 20(1) Ethics and Information Technology 1, 7; Bostrom Nick and Yudkowsky Eliezer, 'The Ethics of Artificial Intelligence' (2014) in William Ramsey and Keith Frankish (eds) *Handbook of Artificial Intelligence* (Cambridge University Press 2014) 317, 329-333.

25 Chircop (n 18) 34

26 On the commitment of the IMO Maritime Safety Committee, the Legal Committee and the Facilitation committee to undertake the scoping exercise its framework and methodology see IMO Doc MSC 100/WP.8 (para 1, 2 for the MSC). IMO, 'MASS List of Instruments under the Purview of the Legal Committee' (4 January 2019) IMO Doc LEG 106/8 (para 1, 2 for the Legal Committee), IMO, 'Report of the Legal Committee on the work of its 105th session' IMO Doc LEG 105/14, para 11.8, IMO, 'MASS' (4 February 2020) IMO Doc FAL 44/14/1 (para 1-11 for the Facilitation Committee). IMO, 'Autonomous Shipping: Why has IMO decided to look at the regulation of autonomous ships?' <www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx> for MSC, LEG and FAL.

was due to complete in 2020.[27] However, due to the coronavirus (Covid-19) pandemic the relevant IMO meetings were first postponed and then resumed in late 2020 and continue in 2021.[28]

The scoping exercise has identified a number of international rules that may require revision.[29] Among them appears the 1972 Convention on the International Regulations Preventing Collisions at Sea (COLREGs)[30], an international set of rules elaborated by the IMO and regulating collisions at sea.

The question raised by the present study is whether specific COLREGs provisions, notably Rule 5 regarding proper look out, Rule 2 on the requirement of good seamanship, Rules 3(a) regarding the definition of a vessel and its Canadian modification, apply to autonomous vessels. These questions relate to legal issues raised under COLREGs with respect to autonomous vessels. The study also raises ethical [31]questions present by the application of some of the mentioned COLREGs provisions to autonomous ships and examines the manner in which they may be addressed in the future. For example, the study reflects on whether regulation promoting ethics may be introduced in autonomous vessels promoting morally acceptable solutions. The focus of the present study is on Canadian law. However, the issues the COLREGs raise under Canadian law[32] are similar to those arising in other jurisdictions. As a result, the present study is of interest at both the Canadian and international levels. The study focuses on autonomy levels three and four (remotely controlled vessels with no crew on board or fully autonomous vessels) since for these vessels the legal and ethical questions become more obvious.

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27 On the methodology of the regulatory scoping exercise see IMO Doc MSC 100/WP.8, paras 9-10, IMO, 'Report of the Legal Committee on the Work of its 106th session' (13 May 2019) LEG 106/16, para 8. IMO Doc FAL 44/14/1 para-1-11. IMO, 'Autonomous Shipping' (2019) <www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx> accessed 8 January 2021 for the intended date of revision.

28 For a list of documents requiring revision see IMO, 'Provisional Agenda for the 108th session of the Legal Committee to be held remotely from 26 to 30 July 2021' (15 December 2020) IMO Doc LEG 108/1, item 7. IMO, 'Provisional agenda for the 103rd session of the Maritime Safety Committee, to be held remotely from Wednesday, 5 May, to Friday, 14 May 2021' (27 November 2020) IMO Doc MSC 103/1, item 5.

29 IMO 'MASS' (10 January 2020) IMO Doc 107/8/17 Annex 2. IMO, 'Report of the Intersessional Working Group on Maritime Autonomous Surface Ships' (25 September 2019) IMO Doc MSC 102/5/3 also noting (para 3.63-367) that COLREGs are currently under the second step of the regulatory exercise.
International Regulations Preventing Collisions at Sea (COLREGs) (adopted 20 October 1972, entered into force 15 July 1977) 1050 UNTS 16 (COLREGs).

30 International Regulations Preventing Collisions at Sea (COLREGs) (adopted 20 October 1972, entered into force 15 July 1977) 1050 UNTS 16 (COLREGs).

31 In order to accurately model the ethical issues regarding autonomous vessels, we will draw on a method used in bioethics, science, and technology: 'moral proxies'. This method is based on the premise that artefacts can function as moral proxies and provide material answers to moral questions. The use of moral proxies allows importing traits associated with human relationships to the machine-human context. On this discussion in general see J. Millar, 'Technology as Moral Proxy: Autonomy and Paternalism By Design' (2015) 34 (2) IEEE Technology and Society Magazine 47 48. If, for example, MASS is designed to make a decision in shipping such as avoiding a collision at sea, questions are raised as to how ethical and morally acceptable the decisions made by MASS in such a context may be.

32 The Canadian government is actively participating to the international work (submissions and discussions) undertaken by the IMO on autonomous vessels. In April 2019, the Government of Canada also launched the Canadian Forum for Maritime Autonomous Surface Ships (CFMASS) to establish a network of stakeholders to help guide the development of MASS technology in Canada for the benefit of Canadians. National Research Council of Canada (Workshop Presentation), 'The Canadian Forum for Maritime Autonomous Surface Ships (MASS): Sub-Committee on Test/Research and Development' (November 2019) <http://cismart.ca/wp-content/uploads/2019/12/CFMASS-SubCom-TRD-v3-Fraser-Winsor.pdf> accessed 8 January 2021.

This article proceeds as follows: in section 2, it analyses legal questions raised under Canadian law by key COLREGs provisions with respect to autonomous vessels. In Section 3, it extends its focus on ethical questions raised in this context of autonomous vessels and COLREGs.

2. Legal questions raised under Canadian law by key COLREGs provisions with respect to autonomous vessels

The COLREGs set out navigational rules currently in use throughout the world.[33] Its provisions notably focus on safe speed, signals, lights and rules on priorities for different types of vessels in different situations. [34] They cover both situation awareness (including lookout, lights and sound signal appliances on board the vessel) and operational decision-making in cases of collision avoidance (such as speed or priorities). [35] Their object and purpose is to prevent collisions[36] which, in Canada and worldwide, continue to feature prominently as a marine casualty.[37]

The COLREGs are widely ratified and, therefore widely and successfully applicable worldwide.[38] Canada has incorporated them into national law with the adoption of the Collision Regulations (CR), which apply to every Canadian vessel located within any waters.[39] However, Canada's implementing rules make some modifications.[40] These Regulations apply to every Canadian vessel located within any waters as well as every pleasure craft and foreign vessel located in Canadian waters and every seaplane on or over Canadian waters.[41] The Canadian modifications are important because they modify for example the definition of the vessel under Rules 3(a) COLREGs – a provision examined below.[42]

Under Rule 3(a) 'the word 'vessel' includes every description of water craft, including non-displacement craft, WIG [Wing-In-Ground] craft[43] and seaplanes, used or capable of being used as

33 Aldo Chircop and others, *Canadian Maritime Law* (2nd edn, Irwin Law 2016) 826-827.

34 ibid 827-832.

35 ibid.

36 Craig H. Allen, 'Taking Narrow Channel Collision Prevention Seriously to more Effectively Manage Marine Transportation System Risk' (2010) 41 Journal of Maritime Law and Commerce 1, 40.

37 Chircop, and others (n 33) 824-825 for Canada. Gouvernement du Canada, Événements de Transport Maritime en 2018 (2018) <www.bst-tsb.gc.ca/fra/stats/marine/2018/ssem-ssmo-2018.html> accessed 8 January 2021.

38 United Nations, 'Convention on the International Regulations for Preventing Collisions at Sea, 1972' <https://treaties.un.org/pages/showDetails.aspx?objid=08000002800fcf87> accessed 8 January 2021.

39 Collision Regulations, C.R.C., c. 1416 art 3.

40 Collision Regulations, C.R.C., c. 1416.

41 ibid art 3.

42 Other Canadian modifications to COLREGs include modifications to the light and sound signals required for various sized vessels in different weather conditions and those that specifically apply to the Great Lakes. Nautical Mind, 'Collision Regulations, and the Canadian Modifications' (2018) <www.nauticalmind.com/blog/2018/11/collision-regulations-and-the-canadian-modifications/> accessed 8 January 2021. In case of conflict between the Canadian modifications and COLREGs, the former prevails over the latter (CR art 3.3).

43 IMO 'Wing-In-Ground (WIG) Craft' (2018) <www.imo.org/en/OurWork/Safety/Pages/WIG.aspx.> accessed 8 January 2021.

a means of transportation on water'. Following this definition, Canadian case law[44] and doctrine, there does not seem to be a requirement for transporting someone or something deemed as 'separate' from the vessel.[45] In other words, autonomous ships represent no special category of ships according to COLREGs.[46] This is also supported by the fact that the COLREGs definition is designed to cast the broadest possible scope of application, for the very sound reason that the larger the pool of craft upon the sea to which they apply, the easier it is to predict their ship handling and navigational conduct, and thus to prevent collision between them.[47]

Following the Canadian modification of the definition of a vessel provided for by Rule 3(n) of the Collision Regulations, the above-mentioned vessel definition does not apply regarding collisions.[48]This is so because the Canadian Collision Regulations were adopted under the 2001 Canada Shipping Act (CSA)[49] and, consequently, they follow the CSA definition of a vessel. Article 2 CSA defines a vessel as: 'a boat, ship or craft designed, used or capable of being used solely or partly for navigation in, on, through or immediately above water, without regard to method or lack of propulsion, and includes such a vessel that is under construction'.[50] This equally broad definition of the term vessel focuses on the use of the vessel for navigation on water without regard to its propulsion or the fact that it is under construction.[51] As we have concluded in a previous study, nothing in the CSA definition of the term vessel excludes its application to autonomous ships.[52] Considering, however,

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44 Canadian case law discusses this provision without commenting on it in detail: *R. v. Snow* 1989 CarswellNS 634 (Nova Scotia Prov.C.) para 4. *Clark v. Kona Winds Yacht Charters Ltd.*, 1990 CarswellNat 791 Fed. C. Can. para 18.

45 ibid; see also Rob McLaughlin 'Unmanned naval vehicles at sea: USVs, UUVs, and the adequacy of the law' [2011] Journal of Law, Information and Science 112 under section 2. As authors have also noted, it does not seem that the use of the word 'transportation' in the definition of the term vessel - as opposed to 'navigation' - has any specific meaning. Reginald Godfrey Marsden, Simon Gault, Steven J. Hazelwood, A. M. Tettenborn, *Marsden on Collisions at Sea* (Sweet and Maxwell, 2003) 192.

46 The suggestion that an autonomous vessel should be treated as a vessel 'not under command' or 'restricted in her ability to manoeuvre' under COLREGs Rule 18 in order to comply with the rules does not hold much weight generally and under Canadian law. Danish Maritime Authority Report (DMAR), 'Analysis of Regulatory Barriers to the Use of Autonomous Ships' (2017) 18, 48-49 also stating that this rule may apply if the communication link of an autonomous vessel is lost. See also Canadian Maritime Law Association, 'CMI Questionnaire on Unmanned Cargo Ships' (2018) <http://comitemaritime.org/wp-content/uploads/2018/05/CMI-IWG-Questionnaire-Unmanned-Ships-CANADA.pdf> accessed 8 January 2021 at 11-12 (CMLA).

47 McLaughlin (n 45) under section 2. Craig H. Allen, 'Determining the Legal Status of Unmanned Maritime Vehicles: Formalism vs Functionalism' (2018) 49 Journal of Maritime Law and Commerce 477, 504. The author opines that the terms of the conventions under the scoping exercise should be reviewed with great caution.

48 Collision Regulations, C.R.C., c. 141 (CR) Schedule 1 (Canadian Modifications) rules 3(n) provides: 'For the purposes of these Rules, the definition of the word 'vessel' in paragraph (a) does not apply.'

49 CSA 2001 (SC 2001 c 26).

50 The definition adds: 'It does not include a floating object of a prescribed class (*bâtiment*)'.

51 For details on propulsion see Aldo Chircop and others, (n 33) 46s. On the broad definition of the term vessel see: *Cyber Sea Technologies, Inc. v Underwater Harvester Remotely Operated Vehicle*, 2002 FCT 794 (a remotely-controlled submersible constitutes a ship), *Salt Spring Island Local Trust Committee v B & B Ganges Marina Ltd.*, 2008 BCCA 544 (stressing the fact that a vessel should be used in navigation and that every ship is a vessel, but not every vessel is a ship), *TJ Inspection Services v Halifax Shipyards,* 2004 NSSC 181, paras 38-39 (a topside structure does not constitute a vessel).

52 Marel Katsivela, 'The Effect of Unmanned Vessels on Canadian Law: Some Basic Legal Concepts' (2018) 4 Maritime Safety and Security Law Journal 47, 53. See also CMLA (no 46) 13 reasoning on a cargo ship.

that the CSA reflects the current reality of a conventional ship with a crew on board, it would be preferable to adopt an interpretation of the CSA provision or a common understanding that such a definition is applicable to autonomous vessels. The conclusion is similar for the above-mentioned COLREGs definition of a vessel. Neither provision requires the adoption of a new definition of a vessel to accommodate Maritime Autonomous Surface Ships (MASS).

In practice, many collisions occur due to bridge team's non-compliance with Rule 5, which states: '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 of the risk of collision'. It contains a situation awareness task (maintain proper outlook) and a decision-making task (make a full appraisal of the situation and of the risk of collision).[53] Following Canadian case law, 'proper lookout' consists in the following: visual lookout; aural lookout; intelligent interpretation of data received from electronic navigational aids; and an unobstructed view.[54] Neither the rules nor case law refer to the subject of the look-out. It has, therefore, been suggested that all these requirements regarding situation awareness under Rule 5 could be met remotely by cameras, radar, audio technology and other technical solutions.[55] The same reasoning may also apply to the technical requirements prescribed by the Canadian modifications (lights, shapes, sound-signaling appliances, radar reflectors) of COLREGs.[56] This is so, provided that technological advancements are present to satisfy these requirements in an equivalent manner as manned vessels would. While automation has not achieved the theoretically possible feat of detecting every object in the water, it is moving in that direction as technological advances bring the new system very close to that of an officer on the bridge.[57] Such electronic devices are not subject to fatigue or attention deficit. If the situation awareness task of Rule 5 may be fulfilled by MASS, an interpretation of the COLREGs or a common understanding made, preferably at the international level (the IMO) to this effect seems like a real possibility and a positive step to take moving forward.

Regarding decision competence, it has been suggested that in order 'to make a full appraisal of the

53 Rolls Royce, 'Remote and Autonomous ships The Next steps' Advanced Autonomous Waterborne Applications Initiative, Whitepaper (2016) <www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawa-whitepaper-210616.pdf > accessed 8 January 2021 at 46.

54 As noted by CMLA (n 46) 11. See also *Atkinson (Guardian of) v. Gypsea Rose (Ship)*, 2014 BCSC 1017 para 150, *Baril c. Beaumier,* 2018 QCCQ 3111 para 28-31, *R. v. Escott,* 2012 BCSC 1922 para 99, *R. v. Ralph,* 2013 NLCA 1 para 19 on the absence of proper look-out. *Kwok v. B.C. Ferry Corp.,* 1987 CanLII 2535 (BC SC)(*Kwok*) where the court stated (para 47): …either he did not look out, or his lookout was inefficient. It is axiomatic that 'an inefficient lookout is equivalent to none'. *Turcotte c. Dufour,* 2015 QCCA 1914 para 11, 32 (proper look-out obligation does not apply). *Hogan v. Buote,* 2012 PESC 10. For the proper look-out explained see *R. v. Reinbrecht,* 2015 BCSC 1960 para 483 s. It is often the case that Canadian case law reasons on the basis of negligence with respect to collisions and CR.

55 CMLA ibid. Whitepaper (n 53) 46; DMAR (n 46) 18. COLREGs Annex III article 1(e) mandating placing sound signal appliance as high as practicable on a vessel in order to 'minimize hearing damage risk to personnel' do not seem applicable to unmanned vessels. This and equivalent provisions probably need to be repealed or amended.

56 It has been stated, however, that the Canadian modifications to COLREGs may be difficult to comply with for autonomous vessels in case of difficulty encountered without having anyone on board to tackle these difficulties. CMLA ibid. 10-11.

57 Prichett (n 1) 205.

situation and of the risk of collision' under Rule 5, the presence of human decision is needed.[58] On an autonomous vessel, a remote operator - physical person - will probably fulfill this role[59] provided that the appropriate technology is present to support such a task and that the remote operator will fulfil it in an equivalent manner as persons located on board.[60] This, however, will probably not be the case of a fully autonomous vessel.[61] The intuition, experience and the situational assessment that in-person monitoring provides counter the preprogrammed, automated responses of fully autonomous vessels in fulfilling this task (decision competence).[62] It has, therefore, been suggested that new rules have to be devised for fully autonomous vessels decision-making under Rule 5, taking account of the fact that the ships are not subject to human decision competence but will act on the basis of pre-programmed choices and considerations.[63]

COLREGs also gives precedence to good seamanship over its provisions (Rule 2a).[64] Good seamanship requires proof of conduct similar to that of a reasonable and prudent mariner put in the same conditions as the ones of the case at bar; the standard is not one of perfection.[65] There is no Canadian case law suggesting that good seamanship requires a ship to be manned.[66] On a remotely controlled vessel a remote operator will probably fulfil this requirement provided that he/she has

58 Whitepaper (n 53) 46, 47. DMAR (n 46) 18-19, 48.

59 ibid DMAR 47.

60 These conditions should be a prerequisite to the substitution of human outlook by AI. The need of an equivalency standard in the performance of MASS as compared to a manned vessel has been noted by the institutions of the IMO. IMO, 'MASS' (9 August 2018) IMO Doc 100/INF.3, Annex.

61 DMAR (n 46) 18-19, 48.

62 ibid.

63 DMAR (n 46) 18-19, 48; however, in general, in robotics there is a logical impetus for delegating some expert decisions to robots J Millar and I Kerr, 'Delegation, Relinquishment and Responsibility: The Prospect of Expert Robots' in R. Calo, M. Froomkin and Ian Kerr (eds) *Robot Law* (Edward Elgar Publishing 2016) 126.

64 Whitepaper (n 53) 46. Rule 2a provides: 'Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case'.

65 *Wolverine Motor Works Shipyard LLC v. Canadian Naval Memorial Trust*, 2011 NSSC 308 para 65, *Kwok* (n 54) para 54, 55. *Conrad v. Snair,* 1995 CanLII 4175 (NS CA) states that the Collision Regulations are an example of good seamanship. In effect, keeping a proper look-out and requiring the vessel which has another vessel on her starboard side to keep out of the way of that vessel [(Rule 15, *Brown v. Harvey*, 1992 CanLII 210 (BC SC)] are universally adopted rules prescribing conduct in accordance with good seamanship.

66 CMLA (n 46) 10.

followed appropriate training required for the autonomous vessels crew[67] and that the appropriate technology is present to support such a task being fulfilled in an equivalent manner to a crew member on board. However, the incorporation of good seamanship into an automated navigation program may be coupled with serious difficulties[68] as pre-programmed systems or AI do not encompass common sense, intuition and experience. Technology, algorithms, artificial intelligence can hardly be said to display any good seamanship or reasonableness standard. This is why new rules will have to be devised for these vessels regarding the good seamanship standard, taking into account that there is no human decision making capacity on board; rather, AI will have to fulfil this good seamanship obligation.[69]

Overall, if it is possible to achieve international support for interpreting COLREGs definition of a vessel, look-out and good seamanship requirements to accommodate remotely controlled vessels, it may be that no major changes will be required with respect to these provisions. On the contrary, for fully autonomous vessels, decision making under Rules 5 and 2 cannot be viewed, at this stage, as conforming with COLREGs. For these vessels new rules will probably need to be devised at the international level.

3. Ethical and Legal Concerns Intertwined

What seemingly goes unnoticed in asking whether COLREGs applies to autonomous vessels and in making some of the above-mentioned suggestions is that, directly or indirectly, we address ethical concerns raised by the use of AI in shipping. In effect, in deciding to replace a crew by AI we decide to what extent we 'trust' AI in shipping. This responds to the question of whether automation in this

67 DMAR, (n 46) 66. Training and certification of the crew will have to be revised to accommodate autonomous vessels. ILO, 'Conclusions on the recruitment and retention of seafarers and the promotion of opportunities for women seafarers' (2019) <www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_674553.pdf> accessed 8 January 2021. According to these conclusions the cost of upgrading skills should be borne by shipowners, labour-supplying States or maritime education and training institutions. Seafarers should be encouraged to understand their role in the importance of lifelong learning. E-learning, at sea or ashore, may be used to aid in this training, provided such activity does not reduce rest hours of seafarers. The present regulations STCW 1978 – International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, (adopted 7 July 1978, entered into force 28 April 1984) 1361 UNTS 2 (STCW Convention) and STCW-F 1995 – International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel, 1995 (adopted 7 July 1995, entered into force 29 September 2012) governing training and certification are part of the IMO scoping exercise. IMO Doc MSC 100/WP.8, Appendix 1.

68 Whitepaper (n 53) 47.

69 A significant challenge related to COLREG-compliant algorithms for navigation is that the COLREGs is writ¬ten for a human operator, and sometimes the require¬ments are qualitative and open to interpretation. If the COLREGs is to be embedded in an algorithm for making navigational decisions, there can be no room for interpretation, because two algorithms interpret¬ing the regulations differently may cause an accident. Efforts may, therefore, be made to make quantitative COLREGs with clearly defined rules to avoid different interpretations. Such rules can be developed and maintained by the industry. Group Technology and Research Position Paper, 'Remote-Controlled and Autonomous Ships in the Maritime Industry safer, smarter, greener' (2018) < https://maritimecyprus.files.wordpress.com/2018/09/dnv_gl_autonomous_ships_2018-08.pdf> accessed 22 April 2021 at 11.

field is ethically acceptable.[70] Based on mentioned suggestions made with respect to COLREGs and autonomous vessels it seems ethically acceptable to replace human monitoring by automation for purely technical standards (involving look-out, lights, sound signals) but a similar decision is more sensitive regarding decision making competence (good seamanship, look-out/decision making) due to fact that the human experience, intuition and (situational) assessment cannot be easily replaced by AI. In this way, legal amendments and ethical considerations are intertwined. Despite this fact, the ethical aspect of automation in shipping often goes unnoticed in devising new legal rules or in amending existing ones.

Ethical concerns regarding autonomous vessels make part of a larger query of whether and to what extent it is ethically permissible to replace human work by AI. Indeed, technological advances in other fields of activity have led to job and wage cuts.[71] This trend may also be present in shipping creating an ethical dilemma regarding the replacement of human work by robotics. Further, as perfect as an operating system may be, it cannot avoid every collision.[72] Accidents such as collisions caused by autonomous vessels will occur and – especially the high-profile ones – will trigger 'a crisis of confidence' in the public opinion that often perceives automation in fear viewing autonomous software as a recipe for premeditated murder.[73] The reason for this distrust is not the fact that automation increases the number of accidents and injuries but, rather, the fact that serious injuries caused by automation are perceived as 'different'.[74] This adds to the current ethical concerns in introducing AI.

To counter these ethical concerns, arguments have been made that automation and digitalization will create shore-based jobs in shipping which will appeal equally to men and women[75] eliminating the exposure of current on board mariners to the perils of the seas. Thus, job losses due to automation will be also accompanied by job creation.[76] Such jobs will require different training and qualification to which the work force will have to adapt.[77] Further, if, as predicted, automation in shipping reduces

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70 Millar J. and Kerr I. 'Delegation, Relinquishment and Responsibility: The Prospect of Expert Robots' (eds.) in R. Calo, M. Froomkin and Ian Kerr *Robot Law* (Edward Elgar Publishing Ltd 2016) 120, 127 commenting in other fields of study.

71 Don Pittis, 'Yes, computers really are taking jobs from humans — especially in banking' (2019) <www.cbc.ca/news/business/ai-compuers-jobs-banking-1.5305680> accessed 8 January 2021. On US data: Grome (n 4) 54.

72 Reasoning by analogy to unmanned vehicles: Noah Goodall, 'Ethical Decision Making During Automated Vehicle Crashes' (2014) 2424 Transportation Research Record Journal of the Transportation Research Board 58, 59.

73 Reasoning by analogy to unmanned vehicles: Bryan H. Choi, 'Crashworthy Code' (2019) 94 Washington Law Review 39, 49 (Choi).

74 ibid.

75 World Maritime News, 'In Depth: Shore-Based Jobs Big Opportunity for Women to Join Maritime' (2018) <https://worldmaritimenews.com/archives/246969/interview-shore-based-jobs-big-opportunity-for-women-to-join-maritime/> accessed 8 January 2021.

76 Nautilus International, 'Increase In autonomous ships will not mean shortage of jobs for seafarers' <www.nautilusint.org/en/news-insight/telegraph/increase-in-autonomous-ships-wont-mean-a-shortage-of-jobs-for-seafarers/ > accessed 20 april 2021.

77 It has been suggested that the cost of upgrading skills should be borne by shipowners, labour-supplying States or maritime education and training institutions. ILO, 'Conclusions on the recruitment and retention of seafarers and the promotion of opportunities for women seafarers' <www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_674553.pdf> accessed 20 April 2021.

human error and, therefore, collisions at sea, the 'crisis of confidence' that accompanies automation may be tackled through education regarding the benefits of automation in shipping and its contribution to reducing collisions at sea compared to manned vessels. In this regard, the argument has been made that if technology reduces collisions compared to the current reality, it should be introduced into commercial shipping even if it is imperfect.[78]

Specific fact patterns invite us, however, to reflect further on the validity of some of the above-mentioned arguments. In this scenario let us suppose, for example, that a manned cargo vessel is in a narrow channel navigating using Electronic Chart Display and Information System (ECDIS)[79] , radar and visual piloting techniques.[80] A jet-ski or other small boat overtakes the vessel at high speed and then abruptly stops directly in the path of the vessel at a distance of about 1000 feet in order to take a selfie in the vicinity of the enormous ship. The small boat remains out of sight from the bridge under the bow of the vessel. The bridge crew, that cannot see what the small boat is doing, reacts with five short and a long blast on the ship's whistle[81] signifying doubt as to whether sufficient action is being taken by the small vessel to avoid collision and the presence of an intervening obstruction in the channel. Once the jet-ski goes out of sight and does not emerge within a reasonable time, the master of the vessel brings the telegraphs to stop or minimum ahead to maintain steerage while deciding whether to initiate a crash-stop or deviate outside the channel. Further, in order to avoid the collision[82] and the subsequent loss of life or injury and while the jet-ski is out of sight, the master of the cargo vessel moves it to the outer edge of the channel, risking its grounding due to bank interaction, sending deck crews forward to standby the anchors in case the vessel has to crash stop[83] or leave the channel intentionally to avoid collision. The actions of the pilot follow good seamanship standards. The jet-ski eventually re-emerges visually for the bridge crew with the occupant waving merrily to the crew on the cargo vessel. No collision or grounding occurs and both vessels continue their voyage.

Following this scenario, the question is whether an autonomous vessel would be able to detect the jet-ski and react in a similar way to the captain of the manned vessel. Several considerations/questions, including ethical ones, have to be discussed. First, whether onboard sensors would be sophisticated

78 Reasoning by analogy to other driverless vehicles: Bryant Walker Smith, 'Slow Down that Runaway Ethical Trolley' (2015) <https://cyberlaw.stanford.edu/blog/2015/01/slow-down-runaway-ethical-trolley> accessed 8 January 2021. According to the author, as Voltaire has stated, 'we should not allow the perfect to be the enemy of the good'. What is important in this case is for the people and entities involved in the designing of data and operating systems to improve them with the main objective of minimizing harm. Julian De Freitas and others Doubting Driverless Dilemmas' (2020) 15(5) Perspectives on Psychological Science 1284, 1286.

79 The ECDIS is electronic chart system facilitating navigation in identifying locations and attaining directions. ECDIS complies with IMO standards.

80 We would like to specifically thank Captain Chris Connor (n *) for his substantial contribution in putting together this scenario and for commenting on it. Interview with Chris Connor, Captain Chris Connor Chair - V&P Committee Company of Master Mariners of Canada (8 November 2019). Many thanks also due to Jack Gallagher from Hammurabi Consulting for commenting on it.

81 COLREGs Rules 34(d) (e)-Manoeuvring and Warning Signals.

82 Following Rule 17 COLREGs (action by a stand on vessel to avoid collision) and Rule 2.

83 For a similar scenario (resulting, however, in loss of life and material damage) reasoning on COLREGs violations and criminal liability see *R. c. Cloutier,* 2007 QCCQ 13533. In this case, the pilot of a container ship was not found criminally liable based on COLREGs following a collision with a sailboat.

enough to pick-up and maintain in view the small boat under the bow of the vessel. It takes sophisticated sensors to detect a small vessel under the bow of the vessel.[84] Even if such sensors exist or may easily be developed and used on an autonomous vessel – especially if placed at the bow of the vessel - one cannot but wonder whether such a sensor would be able to make the difference between a jet-ski and another presence/obstacle such as a bird, in which case the reaction of the vessel would probably be very different. The presence of technological advances sufficient to ensure at least equivalency in the look-out effected by AI and by a crew on board constitutes, therefore, an important condition to an effective look-out performed by an autonomous vessel[85] and, subsequently, an important condition before allowing autonomous vessels to navigate the seas. Such a condition also addresses, in part, ethical issues that would be present in the case that AI would not be able to perform a proper look-out as a manned vessel would. In effect, if AI cannot perform an overall effective look-out as a manned crew would, it should not be ethically acceptable to place it on board vessels.

Second, provided that the AI present is sufficient to detect the small vessel and perform a proper look-out, would a remote operator sitting in a control room, accurately judge the distance and rate of closure of something as small as a jet-ski/small boat in order to evaluate and avoid the risk of collision and would he/she be able to accurately manoeuvre the vessel to the side of the channel with the support of AI as the master of the vessel did in our example? The answer to these questions depends, once more and to an important extent, on the level of technology present.[86] It would take a sophisticated operating system in order to accurately evaluate the distance of the autonomous vessel from the jet-ski or small boat and from the outer edge of the channel so as to achieve a similar reaction by the remote operator to that of the master of the manned vessel. This also stresses the point already made regarding the technological advances that need to be present in order to achieve equivalency in the reaction of the autonomous vessel and avoid, as a result, legal and ethical issues arising from the absence of such an equivalency.

Finally, the question arises whether a fully autonomous vessel would be able to react successfully as a manned vessel would, altering its pre-programmed speed and course. If a scenario or a response such as the present one is not pre-programmed accurately into the operating system of the vessel, it is not certain what an autonomous vessel would do and how effective its reaction would be. It may be that an autonomous vessel would try to steer away unless clearance prohibits it or it may try to do a crash stop following its COLREGs programming and its coded answers to similar scenarios. However, an automated system may struggle to match a captain's train of thought monitoring the progress of the small vessel, knowing its condition and ability to handle its 'dangerous' course, catching its

84 Sensors that can be placed on MASS and which are able to identify small objects in the water seem to exist. Wilko C. Bruhn, Hans-Christoph Burmeister, Jonas A. Moræus, Matthew Thornton Long, 'Conducting look-out on an unmanned vessel: Introduction to the advanced sensor module for MUNIN's autonomous dry bulk carrier' (The 10th International Symposium ISIS 2014 Integrated Ship's Information Systems, Hamburg, 4 September, 2014) <http://www.unmanned-ship.org/munin/wp-content/uploads/2014/09/MUNIN-ISIS-final-online.pdf> (accessed 6 May 2021).

85 COLREGs Rule 5.

86 We take for granted that the training of the remote operator will allow him/her to match good seamanship standards.

'last-minute' alteration of course, moving the vessel to the side of the channel where there is no bank interaction and being ready to correct its course at any time as needed. This scenario presupposes the exercise of good seamanship as explained above which cannot be easily replicated by an autonomous vessel and cannot easily be programmed in a system covering all possible at-sea scenarios.[87] Apart from the question raised earlier as to the conditions under which fully autonomous vessels may be subject to COLREGs, the question posed here is whether or not and, if yes, under what conditions, it is ethically acceptable to substitute the human presence on board a vessel by AI and preprogrammed choices on a fully autonomous vessel. The need for equivalency in the reaction of manned and autonomous vessels does not seem to be met by fully autonomous vessels raising further questions as to whether it is ethically justifiable to delegate to AI decision making under COLREGs.

The ethical questions raised regarding the reaction of autonomous vessels to the specific incident described above as opposed to the reaction of a manned vessel support the general ethical concerns discussed earlier relating to the substitution or degree of substitution of manpower by AI in shipping and other fields of activity. In the future, the degree of trust put into robotics in shipping will determine the level of automation present on a vessel. Although the IMO's regulatory scoping exercise intends to determine to what extent provisions in a list of IMO instruments may or may not be applicable to ships with varying levels of autonomy and determine the most appropriate way of addressing MASS operations, there are no ethical rules present to govern the delegation of human tasks to robotics in shipping even though ethical issues are omnipresent as the above-mentioned scenario and analysis reveal.

The ethical issues underlying the introduction of autonomous vessels in shipping and outlined, in part, by the scenario described above, highlight the importance of elaborating ethical guidelines to govern them. These guidelines will delineate the degree and the conditions of delegation of the vessel's control to AI if, or rather, when autonomous vessels will be used in merchant shipping.[88] For our subject matter, the ethical guidelines may determine to what extent decision making competence under the Collision Regulations will be delegated to automated systems and under what conditions (for example, based on the degree of technology present and equivalency considerations). In effect, such guidelines may provide that: 1) Situation awareness under Rule 5 COLREGs may be delegated to AI provided that the degree of advances in technology perform at least an equivalent look-out to that of a manned vessel. 2) Decision competence under COLREGs may be delegated to a remote operator or AI provided that the level of technology to support such decisions is present and that the collision prevention or avoidance effected is equal to or better than that of a manned vessel. Such guidelines, which may apply generally to autonomous vessels and not only with respect to collision avoidance, ensure that the advent of technology will not counter the beneficial effects of having a crew on board. These guidelines proclaim an equivalency principle noting that the advent of AI

87 As stated by Captain Chris Connor (n 80). See also DMAR (n 46) 18.

88 DMAR (n 46) 48-49. The report stresses the importance of developing ethical guidelines prioritising, for example, protective considerations as well as defining which types of decisions should be left to human beings.

produces equal or better results to the presence of crew on board.[89] If such equivalency does not exist, the substitution of a crew on board by AI is not ethically warranted.

Ethical guidelines to govern autonomous vessels may go even further and require engineers, manufacturers and programmers of operating systems and algorithms to prioritise, for example, safeguarding human life over cargo or the vessel in any given scenario (regarding COLREGs or shipping in general). In the above-discussed scenario, avoiding a collision and the subsequent loss of life or injury (for example, of the jet-skiers) constitutes an underlying consideration in the reaction of the master of the manned vessel. Thus, other ethical guidelines that could govern autonomous vessels and complement the equivalency guideline described above applying with respect to COLREGs or generally may provide that:[90] first, the protection of human life is prioritised over all other objectives (such as preserving the cargo or the vessel) in collision avoidance and, in general, in introducing autonomous vessels into shipping.[91] Second, the protection of human life does not discriminate based on age, gender, disposition, physical or mental state.[92] Third, automation in shipping is not ethically justifiable unless it protects human life comparative to manned vessels.[93] Fourth, manufacturers' or programmers' liability is subject to the above ethical guidelines which they are obliged to follow in continuously optimising technology and programming of autonomous vessels (including collision avoidance).[94]

Such guidelines governing autonomous vessels stress the need to promote ethics in introducing AI into shipping. They are also beneficial because they create a regulatory framework for programmers' or manufacturers' liability setting ethical priorities to be observed and not merely utility considerations or the minimisation of the programmers' and manufacturers' liability. At the same time, putting together ethical guidelines to govern autonomous vessels provides, in general, a sense of legitimacy in the use of AI in shipping.

Ethical guidelines may be developed domestically or internationally.[95] The latter is a preferred choice following the universal nature of ethical concerns present in autonomous vessels. It also ensures that all the industry players – such as government(s), ship-owners, crews and captains, naval architects, autonomous

89 For equivalency concerns expressed at the IMO level regarding the elaboration of legal principles see IMO (n 60) and accompanying text. The equivalency principle could, therefore, address legal and ethical concerns alike. Regarding ethical rules this principle would cover all levels of automation, not only remotely controlled vessels.

90 The mentioned guidelines were inspired by analogous work done in other modes of transport: Federal Ministry of Transport and Digital Infrastructure, 'Ethics Commission: Report on Automated and Connected Driving' (2017) <www.bmvi.de/SharedDocs/EN/publications/report-ethics-commission-automated-and-connected-driving.pdf?__blob=publicationFile> accessed 8 January 2021. See also Bryan H. Choi, 'Crashworthy Code' (2019) 94 Washington Law Review 39-117 in general.

91 Rule inspired by Federal Ministry of Transport and Digital Infrastructure, ibid.

92 ibid.

93 ibid.

94 ibid. See also Bryan H. Choi, 'Crashworthy Code' (2019) 94 Washington Law Review 39..

95 DMAR (n 46) 19. In this regard, it is interesting to note that the International Electrotechnical Commission (IEC) is the co-founder of the newly created Open Community for Ethics in Autonomous and Intelligent Systems (OCEANIS) which deals with the key ethical issues relating to artificial intelligence. As in the coming years ethical issues regarding unmanned vessels will be raised and will need to be addressed OCEANIS could provide a useful tool (forum) in addressing such issues. OCEANIS, 'About' (2020) <https://ethicsstandards.org/about/> accessed 8 January 2021.

vessels technology experts, insurers, cargo owners, shippers, maritime lawyers – will be involved in the discussion and elaboration of such guidelines. At present, the IMO has not addressed ethical issues raised by autonomous vessels. However, addressing such issues in the future is not excluded. This, along with the legal principles currently under way to govern autonomous vessels as well as the technological improvements regarding automation in shipping will enhance safety in navigation and fairness of the applicable rules.

4. Conclusion

The study examined legal issues under COLREGs and Canadian law such as whether an autonomous vessel may be qualified as a vessel under COLREGs and whether an autonomous vessel can meet the COLREGs look-out and good seamanship requirements. These questions related to COLREGs, which were looked at from a Canadian law perspective, are questions that need to be addressed by any state party to COLREGs. As a result, the present study is of interest beyond the Canadian context. It concluded that although the look-out and good seamanship requirements could be performed by remotely controlled vessels without making major changes to the existing rules, for fully autonomous vessels, decision making under Rule 5 (proper look-out) and Rule 2 (good seamanship) may not be viewed, at this stage, as conforming with COLREGs. Further, these legal issues under COLREGs and the solutions provided to them reflect ethical concerns raised by autonomous vessels and the degree to which we trust AI in shipping. In this regard, the present study identified the need for ethical principles to govern autonomous vessels. Guided by initiatives present in other areas of transportation it provided some direction in developing these principles. Further studies need to be undertaken in this area in order to expand and detail ethical rules to govern autonomous vessels. Overall, from the analysis above, the need for a legal and an ethical framework to govern autonomous vessels seems evident. In particular the ethical rules to govern these vessels must be explored further.