LEGAL STATUS OF AN ONSHORE REMOTE CONTROLLER OF MARITIME AUTONOMOUS SURFACE SHIPS ("MASS") UNDER THE CANADIAN MARITIME LAW AND IMO INTERNATIONAL CONVENTIONS[1]

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Introduction

Never before had technology pressured us to look from a different angle as autonomy is overwhelming in society. The Convention on International Civil Aviation of 1944, in its Article 8, allows pilotless aircrafts to fly with special authorization by a contracting state (ICAO, 2011) with anticipated amendments of its 18 Annexes in the coming days (Uniting Aviation, 2018). Also, the Convention on Road Traffic of 1968 amended its Article 8 in 2014 so as to explicitly allow automated driving technologies on the road, provided that a driver can override them (UNECE, 2016). Moreover, the International Standards Organization (ISO) released, on November 2018, the "ISO Draft International Standards for Drone Operations". Following the footsteps of the aircrafts and automobiles, the sea began to consider autonomy system at sea, that is, maritime autonomous surface ships (MASS). However, despite libraries of useful articles on autonomy at sea, there remains an absence of work which investigates the translation of remote controllers (RC) into law, and then through international and national policy. This article aims to clarify the status of RC by examining the technical and legal aspect of MASS, in the context of the United Nations Convention on the Law of the Sea (UNCLOS), the IMO conventions, and Canadian law.

Technical innovation and challenge: Adaptation of autonomy with maritime law?

Autonomy at sea and a smarter ship, but contentious

The global megatrends of the fourth industrial revolution suggest the maritime industry to be reshaped into 'Smart shipping, Smart port, and Smart yard' with sustainable environmental solutions. Not only do ships get bigger (*e.g.* 63% of the number of the world merchant fleet are big ships over 500 gross tonnages) (Equasis, 2017), but also they are becoming smarter (*e.g.* the electronic chart display and information systems (ECDIS) started to be mandatory for ships since 2008) (MSC ECDIS, 2017). The interface between autonomy and human increasingly sits at the very center of social and natural science, being expected to create a never-ending story about interoperability, risk, safety, and law. Since Rolls Royce, Yara Birkland and DNV-GL revealed their ambitious picture, 42 countries including Canada, Panama and United States have joined the Working Group on MASS (MSC Report of the Working Group, 2018). The movements behind autonomous ships share a common denominator with the other transports as the human error has been the biggest contributing factor that accounts for 57.8 % of accidental events for EU registered ships from 2011 to 2017, with 70.1% of those events representing shipboard operations (EMSA, 2018). In Canada, 278 marine accidents were reported to the Transportation Safety Board of Canada in 2017, and the proportion of shipping accidents vs. accidents aboard ship remains stable at approximately 83% over the past 10 years up to 2017 (TSBC, 2018). Having said that, there continually arises a doubt on whether the machine is able to outperform professional seafarers enough to fulfill safety navigation under the seaborne traffic rules like the International Regulations for Preventing Collisions at Sea of 1972 (COLREG).

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International level of involvement and critical issues at hand

The International Maritime Organization (IMO), which is the competent body to take international measures on ship routing under the Regulation 8 of Chapter V of the International Convention for the Safety of Life at Sea (SOLAS), started to address MASS, officially employing the term, 'MASS', with over thirty documents produced in the MSC 99th and 100th session during 2018. The involvement of IMO can be understood as acknowledging the undesirability of leaving the regulation of MASS to a flag state level only (Chircop, 2017; MSC Denmark, 2018). In the meanwhile, as Norway is expected to launch the world's first autonomous container ship of 120 TEU in a few years (Yara, 2018), legal research is largely positive toward this novel kind of ship's general adaptability with maritime law. With those maritime conventions' incredible flexibility for new technology revealed (Chircop, 2017), some suggest amendments for clarity (MSC Denmark, 2018; Karlis, 2018) and others support the status quo based upon the legal principle of impossibility under Article 61 of the Vienna Convention on the Law of Treaties of 1969 (VCLT) (Daum & Stellpflug, 2017). However, RC, although critical to analyze MASS under maritime law, have not been investigated yet, not to mention virtual reality bridges (VRB) as well as onshore remote control centers (RCC). Also, as RC in VRB of RCC are expected to increasingly play greater roles for MASS, the legal status of RC will likely be a controversial issue among public and private stakeholders including flag and port states, marine insurers, shipowners and shipyards. Clarifying the legal status of RC would benefit not only regulatory bodies but also private businesses.

Prerequisite issues – Different approach to an understanding of MASS and a ship

Understanding of MASS as a comprehensive system

There are two conceptual approaches to interpret MASS. Firstly, a progressive technical viewpoint regards MASS as the ship targeted at the final stage of development which is fully autonomous and can navigate without human interventions (MUNIN, 2016; MSC Denmark 2018). On the other hand, a safety-centered viewpoint sees MASS as a comprehensive system which underscores new human functionality (Korea MOTIE, 2017; Japan MLIT, 2018; LR 2017). With due regard to different approaches, IMO defined MASS on May 2018 in a short sentence - "a ship which, to a varying degree, can operate independently of human interaction"- (MSC Report of Working Group, 2018). In the meanwhile, the International Transport Workers' Federation (ITF) adopted the safety-centered approach, highlighting the human-centered automation and new safety risks in human/system interaction (MSC ITF, 2018; MSC IFSMA and ITF, 2018). It is a herculean task to interpret and then regulate technological phenomenon into law, which requires policies bridging the gap between the two. In the case of a ship, the pivotal connector is the safety of life and property at sea, which is not only a public interest but also an inherently governmental function in most modernized countries (US OMB Circular A-76), constituting a foundation of the entire fabric of the IMO conventions. Autonomy is decisive, but autonomy without safety is of no point. Even the very purpose of autonomy boils down to ensuring better safety and reducing human errors. In this vein, supporting the IMO's succinct definition, this paper enjoys further redefining MASS by coloring with a public policy of safety as below:

> *"A ship and her inseparable onshore navigation & operation system under the international law of the sea which partly or fully enable remote or autonomous navigation to be made in a manner to satisfy the regulatory requirements of safety and environmental protection."*

The underlying intent of this definition is to bring the onshore navigating systems such as RC, VRB, and RCC under the regulatory framework of UNCLOS and the IMO conventions, because MASS should be understood as *a comprehensive system* having RC, VRB, and RCC as integral elements of the advanced ship. This notion may be opposite to the conventional understanding of a ship as an object, but it will be a valid safety approach under the common sense because it is very RC on VRB of RCC who control, intervene, and supervise MASS. Thus, RC and MASS cannot be separated to such an extent that any separation of the two would make navigation of MASS highly risky, unseaworthy or unsafe. Accordingly,

IMO will have to study soon how to effectively regulate RC in a substantial way under the international law of the sea. In this light, IMO might be able to consider adopting hypothetically "*the International Code for Remote Controllers, Virtual Reality Bridges and Remote Control Centers for the Operation of MASS*" ('RC Code') in the form of the Resolution of the Maritime Safety Committee (MSC) under SOLAS (*e.g.* the Code for Recognized Organizations adopted on 21 June 2013), so that IMO may put them under the internationally harmonized and consistent standards of global quality, audit, assessment, and authorization. This probable RC Code would, while supplementing the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), be also functioning to elaborate the qualifications, roles and responsibilities, and manning and working conditions of RC, including the port state control (PSC) compliance procedure of RC. Since MASS, it is likely that a concept of a ship will be reshaped into a totality of system combining a ship and her operating systems outside the ship.

Understanding of a ship as a collective human labor system

Globally, despite huge technical improvements, fatal accidents at sea persist with 1,129 total loss of ships during 2008-2017 and 94 total losses in 2017 where a human error remains the main contributor, with a master and crews increasingly pressured by a tight commercial schedule driven by streamlined supply chains (Allianz, 2018). Conversely, this signifies that mechanically a ship is heavily dependent upon human elements no matter how advanced technology may be. In this light, some proposition that a ship is a human system is valid (Rothblum, 2000; Vasiliki, 2014). This paper posits that a vessel is a *collective human labor system.* No transport means shows such a collective human labor dependency and it is the unique feature of a ship. Functionally, unlike cars and aircrafts, a vessel is a unique machine where various functions happen at the same time restlessly in and out of a port that include navigation, carriage and store of goods, repair and maintenance, environmental operation, legal paper documentation, and search and rescue activities. Structurally, a ship makes seafarers perform their services in two divided areas. One is the deck side where officers are required to be familiarized with navigation equipment, the global maritime distress, and safety system (GMDSS), steering system, mooring equipment, lookouts, cargo handling equipment etc., while the other is the engine side in which engineers operate, maintain and repair propulsion and auxiliary systems (*e.g.* boilers, pumps, generators, fuel, steering mechanisms, feed systems, lube oil, etc.), addressing other tasks as well (*e.g.* standing watch, recording and reporting on the engine's performance, procedure of prevention of ship-source pollution, etc.). In case of a container ship with 8600 TEU, about twenty crews are on board. Normatively, numerous legal requirements engage a multiple of human labor: cargo carriage contracts, employment contracts, the duties against ship-source pollution under the International Convention for the Prevention of Pollution from Ships of 1973 and 1978 (MARPOL), the safety and security inspections by the port state controls under the International Ship and Port Facility Security (ISPS) Code and PSC regional MOUs, the duties to keep a vessel seaworthy under SOLAS, the duties of the ordinary practice of seamen under COLREG, the duties of 24-hour lookouts under STCW, and other protective measures against seaborne piracy. Therefore, functionally, structurally and normatively, a ship is a mixed entity of a series of heterogeneous features which are mechanical, contractual, regulatory, environmental, and humanitarian. These characteristics define a ship as a collective human labor system. In this light, since IMO adopted STCW in 1978, STCW has continued to amend itself to enhance the competence of seafarers (Jeon, 2006). In addition, IMO also started to even deal with the onshore management culture of staffs under the International Safety Management (ISM) Code in 1993. As observed in the ISM Code, IMO views a human element so extensively as to engage the entire spectrum of human activities performed by crews, shore-based management, regulatory bodies and others (IMO, Human element, 2019). Could possibly MASS eliminate this entirety of a human factor in the name of autonomy? It may be possible on board, but not *on the shore*.

Generic understanding of RC

When connecting MASS with a collective human labor system, this innovative ship equals to a comprehensive system incorporating a ship, her inseparable shore personnel, and facilities in the land.

MASS are a ship, but much more than a ship. As a ship, MASS won't lose the nature of a collective human labor system which nuances a critical function of RC in that comprehensive system.

Definition and role of RC in contrast with non-RC staffs

RC are those who collaboratively or exclusively operate MASS in replace of, or in supplement of, seafarers on board a ship. In this sense, they might be able to be called *remote seafarers* at the same time for the purpose of this paper. The definition of RC could be drawn as below:

> *"A licensed master or crew charged by a shipowner with duties essential to the operation of remotely operated or autonomous vessels who controls, intervenes, or supervises the navigation from a shore-based virtual reality bridge".*

Therefore, under this definition, RC are restricted to the personnel who is 1) qualified as a seafarer, 2) performs the essential operation of MASS, 3) is employed by a shipowner and 4) works specifically at VRB of RCC. For example, RC will be co-operators with seafarers on board for the manned remotely operated MASS, and they will be sole operators and intervenors for unmanned remote and autonomous MASS. In the meanwhile, non-RC staffs in RCC have no status of a seafarer, perform the services supporting the operation of MASS, may be hired by an independent contractor, and work in any locations of RCC other than VRB. With this stark distinction between RC and non-RC, this paper suggests the status of RC to be 1) a seafarer (member of a ship) and 2) an employee of a shipowner, the rationale of which is to be elaborated in the relevant paragraphs. Like seafarers on board, RC would consist of varying ranks of professional seafarers: A remote master-in-command (RM), a different rank of remote officers (RO), and remote engineers (RE) who are essentially compatible to those on board. The remote master (RM) is the person designated by a shipowner as being in command and charged with the safe conduct of a vessel, remote officers (RO) will be charged with directing, controlling, monitoring and supervising voyage, and remote engineers (RE) will work for mechanical maintenance and troubleshooting (*see also* MUNIN final brochure, 2016). Moreover, VRB will be required to maintain a mandatory minimum number of RC (*i.e*. RM, RO, and RE) at the reality bridge and manage the maximum work hours and minimum rest period for RC. On the other hand, the non-RC staffs of RCC are expected to be charged with general technical management of MASS, VRB and RCC including the physical ship at sea and her digital twin, sensor functionality, electronic lookouts, information analysis, the automatic identification system (AIS), the global positioning system (GPS), collision-avoidance algorithm, and wireless & satellite communication system, etc. Quite possibly, when MASS increase in their number, it is likely that the non-RC staffs can be combined with the function of ship managers (*e.g*. technical management and operation supports), professional programmers for a remote and autonomous system, and vessel traffic service (VTS) (*e.g*., traffic monitoring and information provider).

Mapping RC into maritime law

1) MASS as a ship under Canadian maritime law

For RC to be recognized as seafarers, as a threshold issue MASS need to fall within the definition of a vessel under the international law of the sea and Canadian maritime law because an object other than a ship has no legal link with seafarers. UNCLOS and the IMO conventions have not defined a ship, and there have been different state practices since before 1955 (ICJ, 1960). Canadian maritime statutes, interchangeably using a ship and vessel (Section 2 of the Canada Shipping Act, 2001 (S.C. 2001, c. 26); Section 2 of the Navigation Protection Act (R.S.C., 1985, c. N-22)), take a broad definition of a vessel which requires just "navigation in, on, through or immediately above water" (Section 2 of the Canada Shipping Act), having no clear requirement of a crew on board to be qualified to be a ship. On the other hand, a Canadian federal court decision, *Thibeault v. Canada (Attorney General),* 2015 FC 162, paragraph 22 held that "the intent is often the determinant" for the definition of a ship, ruling that a pontoon boat, which is a floating structure at the mouth of a river basin, is not a vessel for the lack of

intent. Accordingly, insofar as shipowners *intend* to designate MASS as a vessel for navigation in water, there are not found any specific obstacles for MASS to be recognized as a ship in the international law of the sea, Canadian statutes, and Canadian court decisions. Particularly, as no Canadian statutes and court decisions explicitly make a ship contingent upon seafarers on board, no amendments seem to be necessary to accommodate MASS under Canadian maritime law.

2) Policy perspectives: Status of RC

Sheer technical perspective – non-seafarer, restructuring seaworthiness and legal riffle effects

When MASS are ships under maritime law, how could RC be positioned? Apparently, RC are the same land-based workers as those staffs with a ship manager and shipowner who commute to an office, with all of them similarly, to a varying degree, involved with the operation and management of a ship. How could RC be differentiated from the ship manager and shipowner? One convenient policy option would homogenize the two into the same non-seafarers outside the duty and responsibility of seafarers under maritime law. This approach would save shipowners the increasing costs of manning, help them substantially avoid the human element of seaworthiness requirements under the international law of the sea like the Hague/Visby Rules, and liberate them from any administrative, private and criminal charges linked with seafarers' misconducts. In this setting, shipowners may still prove the possessive position of MASS by only a few seafarers on board (*e.g.* partly remotely operated mode) or land-based staffs controlling a communication link to MASS (*e.g.* unmanned remote and autonomous mode). These streamlined logics are unequivocally sweet to shipowners.

Even with the apparent benefits to shipowners, this technical view, however, will create huge legal ramifications to UNCLOS and the IMO conventions in their entirety, let alone a vacuum in safety. This non-crew status of RC, may, with regard to MASS, rip off the manning requirements from Article 94 of UNCLOS, the duty of the ordinary practice of seamen from COLREG, and the non-delegable authority of a master from SOLAS, not to mention making the qualification requirements of STCW useless. Simply put, the human element of seaworthiness and manning requirement would be inapplicable, or legally *impossible* to apply to MASS under Article 61 of VCLT. Also, although highly improbable for the purpose of the regime of the shipowner's limited liability and maritime insurance, this policy approach might make the possessive position of shipowners so vulnerable to a shift to other parties such as independent software contractors who take over VRB of RCC. With few seafarers or no member of a ship, not only does the fundamental foundation of seaworthiness shrink into the technical element only, but the shipowner's limited liability regime under the Hague-Visby Rules will likely be subject to the strong skepticism of its validity. Due to no crew functioning both on board and on the shore, the boundary between the land and sea will get obscure. Could it happen that a human element, a major component of the IMO conventions, would be gradually eliminated out of the international law of the sea in the future as MASS prevail? Any belief in the infallibility of the machine might support this sheer technical perspective.

Safety policy perspective – seafarer, member of a ship, and the last resort for safety

From a safety policy perspective, this paper views the opposite and suggests that RC must function as a master and crews, member of a ship and employee of a shipowner for the safety purpose. This is because as much as autonomy increases, so does the scope of management, and so do the risks involved (Cho, 2018). The safety management scope of MASS will expand into three spheres: On board a ship at sea, communication link between the sea and land, and onshore system of VRB and RCC. Admittedly, MASS are not accident-free as analogously evidenced by self-driving cars (*e.g.* California saw more than 30 accidents involving autonomous vehicles since 2014) (Galeon, 2018). Safety policy may require shipowners to factor in the MASS-specific risk factors including, but not limited to novel electronic and mechanical irregularities on board the advanced ship, the possibility of errors of the wireless communication link between the land and offshore, and any possibility of misjudgment and program

malfunction on the shore. It is not difficult to expect that there will be more expansionary safety concerns at sea involving situation awareness & assessment (Baker, 2004) and the application of the COLREG-traffic rules. More mechanical and software complexity, in connection with sensors, algorithms, and interfaces of human and machine (Vasiliki, 2014) will require the stringent risk management of MASS as a whole, which ironically can be eventually performed by the human replaced by the machine at sea. And the human is nothing but a seafarer, member of a ship and employee of a shipowner.

According to this safety view, human elements don't fade away in MASS, but rather get transferred to the shore, VRB of RCC. In particular, VRB will increasingly be under the exact same or heavier tensions, stresses, and safety risks as the real bridge at sea because any misjudgment of RC at VRB directly affects MASS at sea, exposing the vessel at the risk of disastrous maritime accidents. The most interested party, a shipowner, has to face and fulfill the super sensitive duties through his or her hired RC, which will be in line with the equitable interests of the stakeholders such as the cargo owners, marine insurers, investors, security providers, and ship financiers. Accordingly, each component of a comprehensive system of MASS will have to be examined, verified, supplemented, and corrected by the professional experiences of a master and crews in VRB of RCC who are fully equipped with the knowledge of the COLREG rules and situational judgment capacity. In addition, as MASS are expected to have mixed reversionary safety modes installed (LR, 2017), safety could require more standby crews in VRB who can be immediately dispatched to the ship in distress or timely deal with any internal and external system failures and irregularities. In case of a system breakdown, the last resort of safety will be a human, and the human means a seafarer under STCW, COLREG, MARPOL, SOLAS, and UNCLOS who can manually operate on board or remotely do so. In particular, given that the safety and environment protection constitute the inherently governmental function under public law, flag states would not take the risk of allowing non-seafarers to control MASS which could be navigating between numerous conventional manned ships in the jammed traffic water. The safety of MASS will hinge on the competence of RC which will likely be intensively evaluated and investigated by marine insurers and the port state controls. RC and RCC may trigger new hybrid job creations in the labor market. A number of departing seafarers would be able to nestle in VRB and RCC without abruptly disconnecting their careers. Moreover, the job of RC will be more split into, and expand into, various functions in connection with the algorithm, AI, data analysis, sensor technology, and other ICT-related state-of-the-art technologies.

3) Legal perspectives – conditions of seafarers

Land-based workers, but seafarers and member of a ship?

When taking a view of the safety perspective, the pre-existing human element of seaworthiness remains the same between a regular ship and MASS under UNCLOS and the IMO conventions. What is left is whether RC also could be legally recognized as a seafarer under the international law of the sea. The big hurdle is the fact that regardless of their work nature, RC's location of work is on the land, not the sea. This question requires investigation on what constitutes the status of a seafarer under UNCLOS and the IMO conventions. Authors argue that 1) the definition of a seafarer under conventions is contextual per purpose of each convention, 2) the rule of interpretations under VCLT and the principle of analogy (*i.e.* equivalency) are supportive of RC becoming a seafarer, 3) in the era of autonomy, the term, "on board" a ship under STCW should extend to "on *cyber* board" a shore, and 4) the contribution to the function of a vessel and connection to a vessel in navigation make RC eligible to be a seafarer.

Pluralistic definitions of seafarers

Firstly, under the international law of the sea and the Maritime Labour Convention (MLC), the definition of seafarers is pluralistic. Article 2(1)(f) of MLC defines seafarer as "any person who is employed or engaged or works in any capacity on board a ship." Likewise, Article III of STCW also provides that the "Convention shall apply to seafarers serving on board seagoing ships". However, the meaning and scope of a seafarer is different between MLC and STCW as the purpose of each convention aims at a different

public function, with the former protecting the minimum rights to decent conditions of work for any personnel engaged on board, and the latter imposing upon personnel the duty of care for safety in relation to the manning requirement of UNCLOS. As a result, the same musicians engaged on board a ship may be regarded as seafarers under MLC and in the protection context (*Metaxas v Galaxias* (The), [1989] 1 FC 386), but not under STCW and its related duty context conventions such as UNCLOS, SOLAS, MARPOL, and COLREG. Pluralistic also are Canadian maritime statutes and regulations (*e.g*. the section 1.1 of the Marine Personnel Regulation (SOR/2007-115) defines seafarers on board). Therefore, the language, seafarer, under maritime law is not hermetically sealed, but fluid, depending on the context.

Constructive interpretation of "on board" under STCW into "on cyber board"

Secondly, given the same role of RC with tensions as a seafarer, the status of RC is the matter of the lacunae in the international law of the sea occurring because of technical, economic and political transition in society. Thus, the way of accommodating RC into maritime law is either to amend to eliminate the "on board" requirement out of the definition of a seafarer under Article III of STCW, or to constructively interpret it into including "on *cyber* board", "*on virtual reality board*", or "*virtual reality bridges* (VRB)". When considering RC on VRB will, in principle, have to meet the requirements of the qualification, training, certification, and watchkeeping under STCW, which are specific to seafarers on board a ship, this paper argues in favor of maintaining, and expanding, the term, "on board" in STCW. This kind of gap-filling interpretation of conventions has been made by recourse to general principles of law, equity or analogy (Morita, 2017), and also been encouraged to make conventions to keep pace with the changes in society because a convention is a 'living instrument' unceasingly evolving and interacting with the present-day conditions (Sartori, 2014). The intents of the party nations to STCW would also be favorable to extend the provision beyond its original meaning of the year 1978 at the time of its conclusion for better ensuring safety at sea in the 21st century.

In light of enhancing the safety of MASS, as the preamble and Article I of STCW put its purpose on making seafarers qualified and fit for their duties for safety, the constructive interpretation is well harmonized with the general principles of law such as the rules of interpretation under Article 31, (1) and (4) of VCLT, which highlight the *purpose and intent* of a convention. Furthermore, with Article 31, (3)(c) of VCLT allowing to consider relevant conventions together, the *exemption rule* under the Chapter I, Regulation 4(b) of SOLAS for a novel technology may work to loosen the "on board" requirement of STCW in favor of RC. Also, VRB make RC member of a ship because RC are able to, through VRB, substantively perform the same functions as a master and crews on board a ship, including directing, speeding, and controlling of a ship. Given RC as member of a ship, equity urges to treat both the same. Most importantly, given the IMO conventions largely allow the equivalency rule (*e.g*. Chapter II-1, Rule 3-1 of SOLAS acknowledges other equivalent rules instead of the recognized organizations' standards of structural, mechanical and electrical requirements for ships) in the application of provisions due to their nature of extensive involvement with technology, the principle of analogy can be convincingly relied upon in the interpretation of RC and "on board" requirement. Even to the courts, analogy is not new under common law jurisdiction known as *Argumentum a simili valet in lege* (*i.e.* An argument from a like case avails in law) or *Ubi eadem ratio, Ibi idem jus* (*i.e*. Like reason doth make like law) (*O'Hara v State*, 448 So. 2d 524 (Fla: Dist. Court of Appeals, 1984), ft.13).

RC, meeting the manning and seaworthiness requirements under UNCLOS and other IMO conventions

Thirdly, with RC interpretively having a status of a seafarer, member of a ship under STCW, MASS would be able to, rather than exempted for impossibility, adapt with the provisions of the human element of seaworthiness and manning requirement under UNCLOS, SOLAS and COLREG. MASS will be deemed to be seaworthy if MASS are *reasonably fit in all respects* to encounter the ordinary perils of the seas (*Laing v. Boreal Pacific,* 2000 CanLII 16313 (2000-10-13)). The "all respects" include the following human aspects. Article 94(4)(b) of UNCLOS stresses a master and crews who possess appropriate *qualifications* and are appropriate *numbers* for the type of a ship, Chapter V, Regulation 34-1 of SOLAS

warrants a master's absolute *discretionary authority* for the safety of life at sea, Rule 5 of COLREG requires every vessel to at all times maintain a *proper look-out* by sight and hearing as by all available means appropriate, and Rule 2 of COLREG emphasizes seafarers' responsibility to take *the ordinary practice of seamen*. Likewise, RC can satisfy a master under section 2 of Canada Shipping Act (*i.e.* the person in command and charge of a vessel), the master's duty under section 109(1) of Canada Shipping Act (*i.e*. duty to take all reasonable steps to ensure the safety of the vessel and of persons), and a duty of crews under section 113 of Canada Shipping Act (*i.e*. as employee of a shipowner to carry out their duties and functions)

The nature of the service, *contribution to the function of a vessel, and connection to a vessel*

Fourthly, RC's status of a seafarer and member of a ship can be solidly founded by the RC's contribution to the function of, and connection to, a vessel in that VRB, in which RC perform services, are the exact replica of a real bridge on board a ship, and here RC directly contribute and connect to a vessel by commanding, controlling, directing, speeding, intervening, supervising and lookouts (*see also* US Supreme Court decision, *Chandris, Inc. v. Latsis*, 115 S.Ct. 2172 (1995)). Moreover, as the role of a master and crews are increasingly transferred to RC in VRB, the inapplicability to RC of STCW, COLREG, UNCLOS and SOLAS could incur serious risks at safety.

Employees of a shipowner – contractual relations

Lastly, the legal assumption that RC could belong to a shipyard or third independent programmer is highly unlikely because this hypothetical is against the shipowners' non-delegable duty of seaworthiness (*Sundance Cruises v. American Bureau of Shipping*, 799 F. Supp. 363 (S.D.N.Y. 1992)). With AI or the machine's limited capability of legal personality for criminal and civil liability, a regime of shipowners' responsibility will remain valid. Other than hiring RC, shipowners have no other way to meet their duty of seaworthiness under UNCLOS, the IMO conventions, and the Hague-Visby Rules. During the entire level of MASS, the ship is not only tethered to crews in a manual mode, but also to RC in the mode of remote and autonomous operation. When RC were part of a shipyard or programmer, legal liability from navigation would fall upon their heads who are obviously outside the umbrella of a shipowner's limited liability regime under the Hague-Visby Rules and the Convention on Limitation of Liability for Maritime Claims of 1976 (LLMC). Would shipyards be willing to, by hiring RC, take this unlimited maritime liability (*e.g*. involving oil pollution, collision, and cargo claims) on top of the already heavy product liability and contract liability? The same reasoning is applicable to any independent programmers.

Conclusion

MASS, this mixed entity of an iron-overlaid object and human is gradually on the verge of being transformed into an autonomous system. Most of the legal research seem to assume MASS as a ship "with no or fewer humans" in applying maritime law, leading to the legal principle of impossibility or exemption as a practical solution to adapt MASS with the international law of the sea. To the contrary, this paper looked from a different angle, approaching this novel ship as "a ship with humans". With professional humans, that is, seafarers, *on the shore*, MASS will better serve their intended navigational purpose without prejudice to UNCLOS and the IMO conventions. By interpreting RC as seafarers, there occurs less demand for amendments to UNCLOS and the IMO conventions while the key legal concept of seaworthiness maintains its legal effect the same as conventional vessels. Also, with both MASS and their inseparable human and technical elements on the shore regulated under the international law of the sea, MASS can be better fit for safety, being effectively incorporated into, and absorbed into, the maritime legal regime. This paper finds that RC are eligible to be a seafarer, member of a ship and employee of a shipowner. This analysis is supported by the technical nature of MASS as a comprehensive system, the functional nature of RC, and an intrinsic characteristic of a ship as a collective human labor system.

Abbreviation: MASS **(**Maritime Autonomous Surface Ships), RC (Onshore Remote Controllers), VRB (Virtual Reality Bridges), RCC (Remote Control Centers).

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