Future Technology In The Shipping Industry

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ΘΕΜΑ

FUTURE TECHNOLOGY IN THE SHIPPING INDUSTRY

ΤΗΣ ΣΠΟΥΔΑΣΤΡΙΑΣ: ΠΑΡΑΣΚΕΥΗ ΚΟΥΜΡΟΓΛΟΥ

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Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ:

AFFIRMATION

I certify that I am the author of this diploma thesis and that any help I will receive during the writing up of her will be mentioned in the thesis. I also certify that this diploma thesis has undoubtedly been prepared personally by me in compliance with the program requirements
of the Merchant Marine Academy of Macedonia with the support and guidance of my supervising professors.

ACKNOWLEDGEMENTS

First and foremost, this thesis entitled "Future Technology in the Shipping Industry" was developed over the last three semesters of my studies in the Merchant Marine Academy of Macedonia in 2019-2020. This thesis is a result of interactions with various individuals, which each one of them played a significant role in its development due to quality and productive conversation and experience. Moreover, I would like to dedicate this page to truly thank them for the help they gave to me. At this point I feel the need to sincerely express my warm thanks to those who contributed to the completion of this effort, and first of all, to my supervising professors of this thesis Paraskevi Papaleonida and Ioanna Katsikopoulou for their continuous guidance, the ruthless support, essential advice, and as well as for the support and encouragement they provided to me all this time with determination. It has been an honor to be their student.

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Considering all the above, I would like to thank all my family that supported me to achieve my dream and my goals. In addition, some remarkable people I met during my studies onshore and offshore I believe I should mention that they played a significant role in the evolution of my future career. The biggest 'thank you' to my loved ones, my parents, who accepted all my choices and supported me all the time.

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ABSTRACT

The main aim of this dissertation is the research, investigation, and presentation over some of the main fields in the merchant marine shipping industry considering their future evolution. I will focus mainly on autonomous ships, the future projects and the next alternative technologies being introduced. I chose to focus on these fields because they are some of the most current issues that concern the global shipping industry. Also, there will be problem and benefits identification where deemed necessary.

The dissertation is structured in eight main chapters: (1) Introduction, referring to background history, general discussion of the theme, pros, and cons of the dissertation subject. (2) Autonomous Ships, presenting a variety of different future vessels in general. (3) Autonomous Container Vessels, presenting the most unique future container vessels. (4) Rolls Royce Future Concept, including one of the most important project for the future of the shipping industry. (5) Wartisla's Future Vision, describing the second most important futuristic project. (6) Future 2025 Bridge, about the futuristic navigational bridge on both tugs and merchant ships. (7) Conclusions, presenting some final thoughts.

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CHAPTER 1: INTRODUCTION

1.1 HISTORICAL BACKGROUND

The past has a direct relationship not only to the present shipping industry but also to the upcoming navigational methods and ship structures. A fundamental connection between the ancient ship history and the future of shipping is the structure of the vessel and the method of navigation that I will be focusing on.

The first visual sailing boats were discovered in 5500 BCE, on painted discs for the Nile River with a sail attached to the mast. The first sea-going sailing ships were developed 10,000 years before that the sailing method was invented and the first navigators began to use animal skins or woven fabrics as sails which enabled their ships to sail for vast distances in the open ocean.

To give an illustration of what I mean, the case of NYK's Eco Ship concept shows the relationship of the shipping history with the future. A future autonomous ship for 2030 will be using wind sails as well.

Figure 1: Egyptian sailing ship, 1422 – 1411 BC

https://www.google.gr/imghp?hl=el&tab=wi&ogbl

Figure 2: Peace Boat Ecoship, ice class Type C vessel with wind energy system
https://www.google.gr/imghp?hl=el&tab=wi&ogbl

A second example is that one of the first trimarans existed in 8th century. At the present time, the trimarans are immensely popular and are mostly designed for recreation, racing and ferries or warships. Havin said that there are many future concepts based on them for the merchant marine and in the cruise ship industry as well as for mega yachts. In my mind, all these projects seem to have been inspired from the first trimaran ever made to the present modern ones.

Figure 3: One of the sailing trimarans depicted in Borobudur, 8th century AD

https://www.google.gr/imghp?hl=el&tab=wi&ogbl

Figure 4: Trimaran Container Concept
https://www.google.gr/imghp?hl=el&tab=wi&ogbl

1.2 FUTURE TECHNOLOGICAL EVOLUTION IN SHIPPING

The technology installed on ships nowadays has brought about many changes in a small period of time in the way the ships are operated.
Technological evolution is a theory of radical transformation of society through technological development. The evolution considering the technology of making, loading, unloading, and navigating a merchant vessel has changed fast enough and in a big scale. The first Electronic Chart Display and Information System installed on ships was in 1996, by Transas which is the first company in the world to receive an international ECDIS Type Approval Certificate. At this moment ships have the ability of "Auto Sailing" which means that they can turn on the waypoints and offset the weather conditions to keep the accurate course what will come next in the near future.

Indeed, the job of the Officer on the Watch could be replaced by the equipment on board merely, but not completely due to the fact that the automatic collision avoidance is not achievable yet. This raises a number of questions. What abilities will the ships have in the next few years? Will they be unmanned and able of mooring themselves? Will the officers be replaced? Will the ships automatically identify risks, avoid collisions, and safely navigate themselves? These are some of the most common questions that come along with the future evolution of the shipping technology that I personally believe that they will gradually be answered in the near future. Furthermore, it seems that there are not any references or regulation to give an exact answer to these "questions of the future" but only experiments.

In this light, I will not attempt to answer those questions directly. Rather, I will try to approach them indirectly by doing a bibliographical research and presenting every possible technology that is considered a technological evolution for the shipping industry. I will start with identifying the problems.

1.3 POSITIVE EFFECTS OF TECHNOLOGY

The evolution of autonomous ships aims to advance the maritime and shipping industry, by strengthening the efficiency of vessels and bringing forth advantages for the maritime corporations which invest in the technology.

Similarly, to every futuristic technology, autonomous ships do not only have drawbacks, but they also appear to have advantages and experience many challenges. Whether it comes to manned or unmanned autonomous ships in general there are some advantages that may apply for both categories of vessels.

Researches show that the repair and the maintenance expenditures are expected to rise by 2.5% to 3% every year for container ships.

Some of the most important advantages that appear to be resulting in a new improved industry from all the aspects are: lower emissions, less collisions, cheaper fuels, and there will not be a need to search for more seafarers.

In more detail, minimization of noxious emissions is a very important advantage. For instance, the Emma Maersk, the biggest container ship in service back in 2007, generates 40 tons of CO2 when transferring a full load – more than what a 5-member household in Germany generates in one year according to relevant researches.

Another benefit is going to be the reduction in human error risk; 80% of accidents that happen on the ocean are caused by human mistakes.
Moreover, there will be mitigation of fuel expenses. At 11,000 TEU, for example, the Emma Maersk burns 14,000 liters of heavy oil per hour according to relevant sources.

In contrast with the previous disadvantage of autonomous vessels concerning the significant reduction of the seafarer jobs comes the benefit that supports balancing in the expected shortage of seafarers in the future. There was a shortfall of approximately 21,700 officers in 2018. What is more is the decrease of overall operating expenses. For example, crew costs about 2,600 Euro a day, accounting for 44% of total operating cost for a large container ship.

Furthermore, in order to put into operation, the technologically advanced vessels that will be autonomous, there will be a need to install all the appropriate new machinery onboard and create the appropriate facilities and new infrastructure offshore. This implementation of the autonomous technology onboard ships will provide new job opportunities for highly educated and well skilled professionals. Hence, the fact that ships becoming autonomous does not particularly mean that people will lose their jobs. Rather, more and more young employees will be interested in entering the maritime industry.

Future ships will be monitored and supervised from ashore, especially from offshore control centers by specialized humans. This means that the belief that machines will conquer our job is not such a concern due to the fact that we will still be useful as seafarers with our experience the effective operation of the vessel from land in a different position that sounds really interesting to me. Also, the necessity for new positions will balance the situation.

Even if there is a significant number of listed advantages mentioned above there are also enough challenges that have to be taken into consideration because vessels will be sailing “alone” in the oceans and any damage or issue during their voyage can question their effectiveness. For example, the autonomous vessels might be an easy target for the pirates.

Lastly, accidents in the sea can occur at any time and responsibility is a major issue when it comes to autonomous vessels but there are still a lot of hurdles to be overcome. The question arises as to what if these unmanned ships became a reality. The vessels should somehow be able to completely block for example unauthorized access by third parties to their systems, and be so strong to never allow hackers taking over them. At the same time, they should allow the offshore control center to override the system at any time.

1.4 IDENTIFICATION OF PROBLEMS

As technology develops, countries around the globe have understood the immense potential automated systems withhold. The vision of unmanned ships has been around for decades, but only recently with the advent of new technology the concept has become more achievable. There are many companies worldwide that have announced their projects for automated and unmanned ships including cargo vessels and cruise ships. Having high expectations, they intend to powerfully join the maritime industry of the "future". For instance, Rolls-Royce announced their project for developing an unmanned cargo vessel which is monitored and controlled when such an action is required, along with other vessels, from a central location, and is expected to set sail by 2020.

Additionally, in Norway a virtual reality vessel bridge is being prepared by the Rolls Royce where captain will be able to manage the crewless vessels from the land.

Based on my information sources it seems that there will be some disadvantages, challenges for the real-life application of all these different projects and as well as the safety of the navigation and cargo procedures.

The main disadvantage is the fact that there will be a significant reduction in the seafarer jobs. Researches show that 610,000 officers will directly be impacted and hence lose their jobs onboard. Another negative effect of ship automation is the safety risks that are unknown. The electronic machines that are used in vessels nowadays, in the future and the machines in general are by no means able to replace the human element, at least in the first years in maximum.. The human factor may be the first cause of accidents but the experience, the reaction and the human "eye", (which is one of the main reasons the officers play an important role in today's maritime industry) of professional seafarers is what makes them a vital part of the ship. There is uncertainty about the level of vulnerability that the computers will display and the successful control of the hackers and of the hijacking.

All things considered, may these are the most important disadvantages that we sure know from the investigations that the experts will be called to face but the truth is that there will be even more unknow drawbacks and challenges that will appear during the process of applying high technology on ships.

CHAPTER 2: AUTONOMOUS SHIPS

2.1 INTRODUCING EIGHT SHIPS

In this chapter not quite I will present some of the most common and most popular futuristic ships. The number of ships that I will analyze will be eight and will be organizes into eight different sections respectively along with images. These are the following:

- Aquarius Eco Ship
- Color Line Hybrid Ship
- E/S Orcelle
- Black Magic Tanker
- Deliverance Supertanker

In other words, I will simply present some of the most interesting vessels of the future to provide a sense of an initial illustration on how the future on the seas is going to develop and look like.

In more detail, the vessels that will be included in the following sections are constructed with various technologies with the goal to be as eco-friendly and effective as possible while achieving the minimum harm that is possible to our earth an our environment. These technologies include solar cells, wind sails, sails with photovoltaic cells and more.

Lastly, the projects of future ships are not only limited merchant vessels but also in cruise ships as well. Some of them have minimum emissions but some other appear to be zero emission ships something that is very optimistic to be able for the industry.

I will start by providing definitions. After a lot of consideration on how I should start a thesis that is referred in the future of the maritime industry and what theme would be more suitable. I came in the most logical conclusion that it could not be anything else except than the realistic vessels of the future. In other words,

I will simply present some of the most interesting vessels of the future to provide a sense of an initial illustration on how the future on the seas is going to develop and look like.

2.2 DEFINITIONS

There is one pure definition for the autonomous cargo ships or in general future vessels and is called Maritime Autonomous Surface Ship (MASS). It is defined as a ship which, to a varying degree, can operate independently of human interaction. A second definition states that they are seaborne vessels that transport either containers or bulk cargo over navigable waters with little or no human interaction.

There are different methods and levels of autonomy that can be achieved. According to the Maritime Safety Committee (MSC) and the International Maritime Organization (IMO) there are four degrees of autonomy where a cargo ship can operate independently of human interaction. Those four announced definitions of varying degrees of autonomy are the following:

- First Degree: Ship with automated processes and decision support: Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.
- Second Degree: Remotely controlled ship with seafarers on board: The ship is controlled and operated from another location, but seafarers are on board.
- Third Degree: Remotely controlled ship without seafarers on board: The ship is controlled and operated from another location. There are no seafarers on board.
- Fourth Degree: Fully autonomous ship: The operating system of the ship is able to make decisions and determine actions by itself.

In contrast with the cargo vessel industry that supports an autonomous and unmanned future for their vessels, the cruise ship companies in the cruise ship industry are among the sectors that do not support the unmanned shipping approach for the future and it is very likely that there will never be unmanned cruise ships. In addition, perhaps they will always need crew on board only for customer service and officers for increased safety reasons, but their technology will be remarkably similar.

Finally, it is also likely that tankers and LNG carriers will stay manned due to risks and for safe operation. However, they are expected to adopt remote and autonomous R&A technology to make the operation safer and more efficient.

2.3 AQUARIUS ECO SHIP

The Aquarius Eco Ship is a Low Emission Green Future Ship with Rigid Sails & Solar Power which has been designed to be highly flexible so that the concept can be applied to most ship sizes and types. The ships that the concept can be applied to include bulkers, oil tankers, general cargo ships, survey ships, passenger ferries, cruise ships, Ro-Ro ships, car carriers and even unmanned surface vessels.

This concept design is an ongoing comprehensive study project focused on the design of a large ocean-going ship such as a bulk carrier, oil tanker, Ro-Ro vessel or cruise ship, to harness the power of the wind and sun. This green ship study project incorporates a range of technologies ranging from ship solar power to fuel cells and air lubrication.

The center piece of the Aquarius Eco Ship is Aquarius MRE (Marine Renewable Energy) - an innovative and patented fuel saving, and emission reduction system developed by Eco Marine Power in Japan. This system incorporates a variety of elements including solar panels, energy storage modules, computer control systems and an advanced rigid sail design known as an Energy Sail. Aquarius MRE technology will enable ships of all types and sizes to safely use renewable energy in order to reduce fuel consumption and lower harmful emissions in a cost-effective way.

In addition to Aquarius MRE, the vessel will be fitted with other fuel saving measures such as an advanced electrical propulsion system, low power LED lighting, air lubrication, an optimized hull design and waste heat recovery technologies.
Furthermore, Fuel cell technology could also be incorporated into the design.

What is the most important is that this combination of technologies could lead to fuel savings of 40% or more and also dramatically reduce the emission of noxious gases such as Sulphur Oxides (SOx), Nitrogen Oxides (NOx) and particulate matter (PM). In addition, the use of renewable energy and energy saving measures would reduce the vessels carbon (CO2) footprint.

Moreover, the ship can store up to 1 MWp of solar power with enough energy storage modules so that the ship would not need to use auxiliary diesel generators whilst in port. This could also enable the ship to operate emissions free when alongside or anchor.

The rigid sails can be lowered and stored when not in use or during extreme weather or emergencies. The automated control system will also lower or position the rigid sails to avoid injury to the crew or damage to the ship or sails.

The Aquarius Eco Ship is not only another example of a future vessel but a complete futuristic system that could be integrated into a new ship design. Also, it is suitable for existing ship designs and could be retrofitted to vessels already in service. This means that the main target of the project will benefit the environment and will involve in making steps forward to a better shipping industry and to lead shipping towards a more sustainable and zero emissions future.

Figure 5: The Aquarius Eco Ship

https://www.google.gr/imghp?hl=el&tab=wi&ogb

2.4 COLOR LINE HYBRID SHIP - THE LARGEST HYBRID SHIP

The world's largest plug in hybrid ship is built by Color Line and is already in operation today. First of all, in February 2017, Color Line has signed a contract with Ulstein Shipyard to build the world's largest plug-in hybrid ship. This hybrid ship is no more a future project because it will run between Sandefjord and Strømstad and was ready for the peak season since the summer of 2019. The hybrid ship will have full battery operation in and out of the fjord to Sandefjord inner harbor. This means that:

- the ship will have no emissions of damaging greenhouse gases into the air and noise will be considerably reduced.
- In addition, 100 meters from the ship, the noise is as loud as a normal conversation between two people.

Moreover, her basic characteristic includes the following:

1. The maximum number of passengers is 2,000
2. the total crew that is 100
3. the number of cars is 500
4. the overall dimensions are Length 160 m, beam 27.1 m, draught 6.0 m.
5. Battery information: About 5 MWh (megawatt hours) giving up to 60 minutes maneuvering and sailing at speeds of 0-12 knots
6. Good WHR (waste heat recovery) using a hot reservoir system
7. And extremely low noise emissions during both battery operation and when moored at night

Figure 6: Color Line Hybrid Ship
https://www.google.gr/imghp?hl=el&tab=wi&ogb

2.5 ECO SHIP E/C ORCELLE

Wallenius Wilhelmsen Logistics is a Scandinavian shipping company which operates from Sweden and Norway. WWL seems to be one of Europe's largest movers of cars from country to country, with clients, including Jaguar Land Rover, transporting some 1.7 million vehicles by sea every year.

E/S Orcelle is a concept of a world's first zero emission cargo vessel which represents the achievable goal of building an environmentally friendly cargo ship. It is still under development with the Wallenius Wilhelmsen group and will be ready to launch in the next 20 years, around 2025.

The vessels main goal is to be emission free, which means to be included in the future category of zero-emission vessels. It will be a hydrogen powered vessel that will

explore new ways to reduce the environmental impact of cargo shipping, cutting or even eliminating carbon emissions.

On the one hand, even if WWL points out that Orcelle is just a futuristic concept, and there is a high possibility that she will never be built in its entirety, it intends to use the components of its design to improve future forms of cargo shipping. On the other hand, if this concept becomes a reality company states that E/S Orcelle will require less energy than a conventional ship to push it through the water.

In more detail, it will be built to carry 13,000 tons of cargo on eight decks with a total area of 85,000m2. Furthermore, the ship could transport 10,000 cars 50 percent more than a conventional car carrier. What is challenging for the company is to achieve this by using only renewable resources, and without any need for ballast water.

In my opinion, the most interesting part of this concept, and my first reference in the thesis for this future aspect, is the technique of removing the need for ballast that it creating a ballast free vessel. Ballast is a major source of biological pollution, and in order for the vessel to be ballast free a pentamaran hull is used.

This means that it has five hulls that provide greater stability, less drag and improved utilization of energy.

In order for the hulls to be lighter, more fatigue-resistant, easier to shape, and more recyclable and to require less maintenance, they are made from aluminum and thermoplastic composites, rather than carbon steel. In this way, Orcelle requires less energy than a conventional ship to push it through the water. Also, 12 horizontal fins that are located underneath the ship move up and down as the ship moves through the water, with the movement converted into electricity by hydraulic motors.

Similarly to the previous ships presented herein, it has three rigid sails, each with an area of 1,400m2 and made from composite material, which can be rotated and positioned to catch the wind. Moreover, these sails would each incorporate 800m2 of photovoltaic panels to generate a maximum of 2,500kW of solar electricity; when not used for propulsion, the sails would be folded back against the upper deck of the ship to maximize the amount of solar energy they receive.

The solar and wave energy from the fins will be stored in the form of hydrogen. The hydrogen would be converted back to electricity in on-board fuel cells with a total output of 10,000kW. This would provide about half of the energy used to actually propel the ship.

The main characteristics of the Orcelle are the following:

1. Length: 250m
2. Height: 40m
3. Total height with sails erected: 95m
4. Beam: 50m
5. Draught: 9m
6. Design speed (max): 20 knots
7. Design speed (service): 15 knots
8. Lightweight: 21,000 tons
9. Maximum deadweight capacity: 13,000 tons
10. Pod propulsion: 2 x 4,000kW
11. Sails: 3 x 1,400m2
12. Fins: 12 x 210m2
13. Eight decks, three with adjustable height

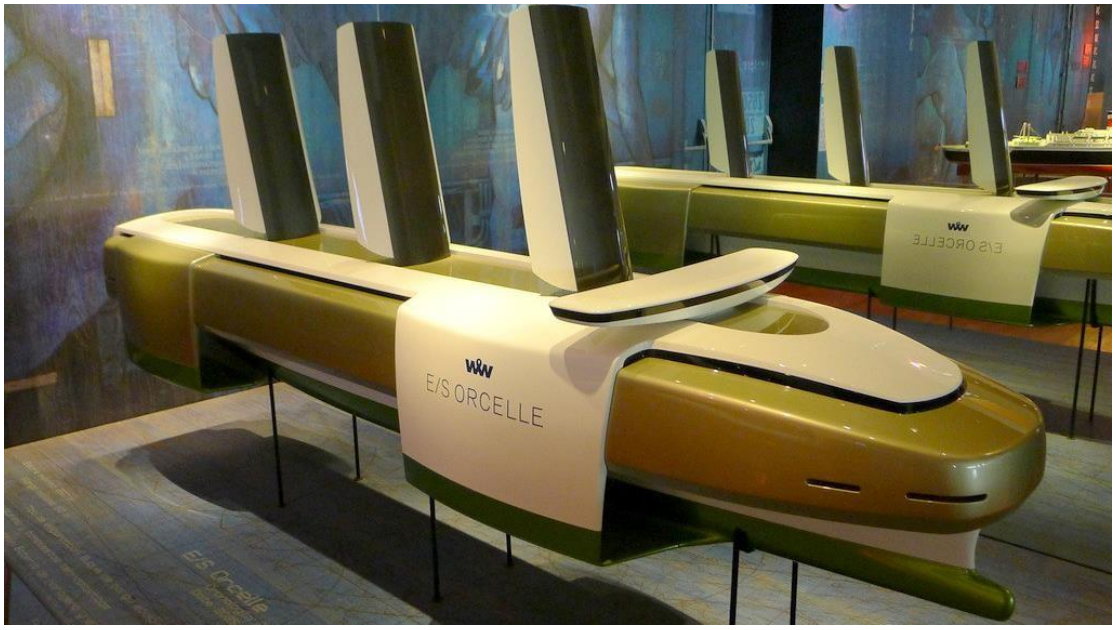

Figure 7: Eco Ship Orcelle

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2.6 BLACK MAGIC TANKER

Through my research on future vessels black magic from SCOD is one of the most exciting ships that I have come across. It seems like this vessel is the only realistic alternative to the extremely pollutant tankers that are currently in use and being built. It is a tanker of the future to be built that reduces green house gas emissions by 75 to 100% by harnessing energy from the sun, wind and waves.

She is a 4,000-ton Solar hybrid vessel that uses mercedes benz & daimler power plants to deliver the cleanest propulsion system to date. She combines every current

Green Technology in large ships to deliver the cleanest propulsion in the world. She includes the following:

- Mercedes Benz & Daimler DD16 Bluetec diesel electric power generation
- Hydro & Aerodynamic advances in wave piercing pentamaran hull design
- Azimuth counter rotating CLT high torque propeller system
- State of the art fully rotational wing sails
- KER & Power sailing regeneration.
- Maximum solar cell deployment (2,000 square meters)
- Energy efficient equipment; including
- AC and refrigeration waste heat recovery
- Computerized energy management, maintenance and guidance systems
- Lithium ion UPS

Solar cells, power sailing regeneration, ker and plug-in power sources charge a lithium ion UPS storage system. The same UPS that allows black magic to navigate harbors and inland water ways with zero emissions and achieving maximum speed of 16 knots, is used for all the services in an entire hotel. Combine the above with 300 to 900kws of wing sail propulsion to arrive at virtually unlimited zero carbon cruising at an average speed of 10 knots. 12 knots, with optional sky sails.

Her main particulars are:

1. Displacement 4,000 tons
2. Length 125m
3. Beam 21m
4. Draft 6m
5. Service speed 12knts
6. Max speed 14knts
7. Green power installed.
8. MB & Daimler Bluetec power generation 1,200kws
9. Wing Sail power generation 300 to 900kws
10. Solar cells 200kws
11. Ker & Power sailing regeneration up to 100kws

In conclusion, Black Magic is a zero-carbon vessel. She is the perfect example on how future tankers can reduce harmful greenhouse gas emissions by 6 billion tons over the next 20 years. The most promising part of the concept is that Black Magic is a 10,000 ton per year Certifiable Carbon Offset Project, equivalent, to the annual Carbon Footprint of 2,500 people across the globe.

Figure 8: Black Magic Tanker

https://www.google.gr/imghp?hl=el&tab=wi&ogbl

2.7 DYNA WING SOLAR HYBRID SUPERTANKER

During my research, I noticed that all the future projects available refer to medium size ships. Then, I came across this amazing concept that is presenting a Supertanker. Deliverance is made by the same company that has created the black magic tanker concept. SCOD or Sauter Carbon Offset Design created a Dyna Wing Solar Hybrid Supertanker that is characterized as the largest and by far the Greenest Post Panamax Vessel to be built and as such is the most Economical form of Crude Oil Transport to and from any part of the Globe.

In order to reduce fuel consumption and Green House Gas (GHG) emissions by up to 75%, she gets half of her power from LNG and the other half from the latest advances in Solar and Wind Power Technology.

The Emax Deliverance is a 2-million-barrel Supertanker, which means that she has a deadweight of 330,000 metric tons. She is designed specifically for the newly enlarged locks of the Panama Canal which will accommodate vessels that have a maximum length of 426m, a beam of 54m and a draft of 18 meters.

Her hull produces less drag which in conjunction with twin CRP Hybrid Propulsion Pods reduces fuel consumption and GHG emissions by 35%. An additional 20% to 30% reduction is achieved by her 5,000 sq. meter sails and another 15% to 20% reduction by her Solbian Solar Power generating array.

Admittedly, this has a result of up to a 75% reduction in GHG and emissions by Mitsubishi's Bubble Hull and Wartsila's Coded Hybrid power system. In general, her total power requirement is 30MWs, more analytically is 20MWs to 10MWs from LNG and 10MWs from the Sun and Wind.

The Dynawing Masts are covered in light concentrating film to magnify the light that hits the Solar panels below. The furled mainsail sheets may also incorporate a Fresnel film. This light concentrating feature raises the efficiency of the Solar cells from 22% to up to 35%. Also, the Solbian marine solar panels have the highest rated efficiency and come with a 25-year warrantee. The energy harnessed from the Sun is stored in a 5MWh Lithium UPS to allow for Zero carbon docking.

Furthermore, as a Certified Carbon Offset Project, the Carbon Offset or reduction in GHG emissions achieved by Deliverance is 110,000 tons per year or roughly a reduction of 3 million tons of CO2 over the Supertankers 25-year service life.

Taking the above into account, Richard Sauter of SCOD (Safety for Sea, 2011) has commented:

"A solar hybrid post panamax VLCC presents us with a major win win scenario, for apart from safeguarding the planet, oil companies can look forward to savings of up to 60 million dollars a year on the purchase of fuel, which at today's prices not only pays for the emax supertanker in under 4 years, but increases earnings over her service life
by over 1.5 billion US dollars.

Finally, her cost is approximately 15% above the cost of a conventional 330,000dwt Supertanker.

Figure 9: Dyna Wing Supertanker

https://www.google.gr/imghp?hl=el&tab=wi&ogbl

CHAPTER 3: AUTONOMOUS CONTAINER VESSELS

3.1 Introduction

In the shipping industry container vessels prove to be more and more effective as the years pass by. In this chapter, I will analyze the container vessels that play a major role in the future high technology industry of ships that will be created in the near future. I chose to present some of them that I personally find the most interesting.

3.1 Electric Blue

The first vessel that I will analyze is named Electric Blue. Electric Blue is a concept that is going to be materialized from the Company of Rolls Royce. Rolls Royce seems to be among the leading companies of future autonomous shipping industry, with interesting feasible and promising concepts for a more efficient and safer industry.

Given the fact that the main idea is to create a fully autonomous vessel they have divided this concept in three main stages. The first stage is the partial autonomy by 2020. The second stage is the remote operation ability with significant crew reduction estimated around 2025-2030. The third stage is the actualization of the main target which is an entirely autonomous vessel and is going to happen in 2035.

It seems that the whole design and construction of the ship is so smart that it provides the ability of a smooth transition from partial autonomy to a fully autonomous vessel.

This is because all the technology needed for the last stage is already installed and the crew accommodation as well as the navigational bridge is just a removable container.

In addition, some of the key positive features of electric blue are the following:

1. It is equipped with containerized accommodation in the aft next to the free

fall lifeboat.

2. It is designed to be ballast free.
3. In the aft part of the ship below the cargo and crew accommodations there is a virtual bridge to save valuable space for cargo.
4. There is continuous automatic look out with decision support system with intelligent based on advanced analytics.
5. Ready autonomous operation and remote control.
6. The accommodation containers are flexible, it means that they are able to adjust according to needs.
7. Lastly ability of flexible energy sources. It can use LNG, batteries, and hybrid technology.
8. The navigation bridge is replaced with the virtual bridge in the aft.

This container vessel with capacity of 1000 TEU constitutes a low-cost smart shipping idea that is efficient and adaptable to any future changes. The inspiration comes from the aviation industry and especially from researching the low-cost airlines.

If we can compare Electric Blue's building cost with a standard current ship we will see that it will save approximately according to Rolls Royce verified calculations 2.5 million dollars. A main sector that is going to contribute in saving is the ballast water treatment system that is going to be replaced because it costs up to one million dollars. The ballast free design will be accomplished with a wide steel hull that doesn't need any water ballast for ship stabilization.In conclusion, what excites me he most is that at any time the visual bridge that is located in a container on the ship can be entirely removed from the vessel by the owner and be placed on shore to control the vessel remotely from dry land.

Figure 10: Electric Blue Container

https://www.google.gr/imghp?hl=el&tab=wi&o

3.2 NYK’S ECO SHIP

The Vessel I will analyze herein is from Nippon Yusen Kabushiki Kaisha (NYK Line) that is a company focusing on marine transportation in a global level founded in 1885. Nowadays, has become a leader in global marine transport with a role to provide safe and reliable services.

At this time, it is obvious that they cannot avoid being leaders in the long future as well with their innovative future concepts for transportation with less emissions and carbon free ships.

Currently they are working on two main concepts. The first one is a vessel for the 2030 and is named as NYK Super Eco Ship. This concept is focused on achieving sixty nine percent reduction in carbon dioxide emissions. The second concept is a ship of the future that will be carbon free.She is also named NYK SUPER ECO SHIP but for the 2050. What is really interesting in this concept is that it is targeting the achievement of "zero emissions" by 2050 in combination with advanced future technology. Based on clean energy they are going to use solar power and wind sails as well as automation.

NYK SUPER ECO SHIP 2030

To begin with, NYK lines focus on improving the environmental friendliness and efficiency on shipping with a lot of research on the use of renewable energy sources which includes reduced power requirements as well as on the use of cleaner fuels and other innovative technologies for a greener future in shipping.

The result of all this work is the NYK super eco ship 2030 which constitutes a container carrier of the future. This project is going to be an example for what should be done in the industry for a cleaner planet by reducing carbon dioxide emissions, taking advantage of the green and renewable energy and by finding new and innovative ways to power vessels. Also, ships should be designed for the minimum power requirements and optimized ship operation for maximum efficiency.

The ship meets all these requirements and achieves seventy percent reduction in carbon dioxide emissions compared to a today's similar size vessel. These savings are achieved by most importantly reducing the ship's weight, by introducing a new loading concept and a new propulsion system. Also, the vessel has an efficient power plan concept with fuel cells and vast energy sails which they reduce emissions significantly. Finally, the vessel’s cargo hull is also used optimately for cargo storage.

The ship will be sailing between Europe and Asia in a broad belt of favorable solar radiation. She is designed to take full advantage of this clean solar energy. The solar cells cover her entire container area and surface of the sails saving sun energy and transferring it to power her along the route. There are solar panels in the side of the ship that adjust to the inclination of the sun for optimal energy saving. The lightweight large triangular sails and the retractable telescopic mast are useful along the route when conditions are favorable by taking advantage of the wind power.

The general arrangement of the ship is characterized by containers on the deck and in the hull, and there are two independent cargo areas. She has the main power in the fore part and electric motors in the aft. Power loss is eliminated by superconductive cabling and superconductive propulsion motors. The electric propulsion consists of two tunnel thrusters with padded drives that move the ship that also act us rudders named as contrarotating propellers minimizing propulsion loses. She also has multipurpose fore propellers.

The future is full of different alternatives on reducing the frictional resistance on power requirements. Air bubbles are rejected under the bow to lubricate the ship by reducing the power requirement by up to 10 percent.

The fore propellers allow her to maneuver flexibly in port. Also, she is completely independent and does not require help from tugs. There is an easy access to and from the vessel that had been taken into account. Innovating container arrangement and a new loading system reduced loading time by 50 percent. The containers are located in two different areas on the main deck and in the cargo holds. The containers that are located on deck are loaded and unloaded in a traditional manner with port cranes. On the other hand, inside the hold she owns a container handling system that ensures the smooth loading and unloading as well as container positioning by cranes. Inside the holds.

Liquified Natural Gas (LNG) fuel cells are the main power source of the vessel. The container size fuel cell units are easily loaded and connected. Compared to a conventional diesel engine they produce 30 percent less carbon dioxide emissions. The design of the ship enables faster loading and unloading. The mid part of the ship can be left at the port for loading and unloading while the fore and aft are reconnected for travelling to the next port. The NYK 2030 Eco Ship is the answer for greener future with the use of renewable and non-emission energy sources. Finally, with 70 percent less in carbon dioxide emissions she is a shining example for achieving a cleaner and better future in container ships.

Figure 11: Nyk Eco Ship 2030

https://www.google.gr/imghp?hl=el&tab=wi&ogb

NYK SUPER ECO SHIP 2050 - A CARBON FREE CONCEPT SHIP OF THE FUTURE - CHALLENGE TO DECARBONIZATION

In 2018, the IMO and the shipping community made a strong commitment: By 2050, greenhouse gases from shipping must be reduced by at least 50% from 2008 levels.

NYK Line developed an emission free concept ship that requires only 30 percent of the energy used on vessels today. In more detail, some of the most important characteristic of the vessel will include:

- lightweight materials will be used for the superstructure
- The weight of the hull is reduced through a dynamic, mathematical design combined with topology optimization. In addition, usage of new lightweight material for the structure will become common
- the hull is to provide buoyancy to carry the whole weight of the ship and its cargo and also to provide stability with minimal resistance
- Computer-controlled devices like gyro stabilizers will be installed on the vessel bottom to provide active stability
- In normal condition, pontoons are stored above seawater to minimize resistance. But in the event of high seas or abnormal conditions, pontoons will drop to the water to provide additional stability
- Conventional propellers are replaced by flapping foils that mimic the movement of dolphins to deliver greater efficiency than screw-type propellers
- The vessel is powered by hydrogen fuel cells (SOFC), in which the hydrogen is produced by renewable energy sources
- During sea navigation, air bubbles are delivered to the vessel bottom to reduce frictional resistance between the vessel hull and seawater
- losses in electrical power distribution are also minimized
- in addition to recovering waste heat from fuel cells coal power from the liquified hydrogen is utilized to maximize efficiency and reduce electricity demand

- The storage of liquefied hydrogen on board the vessel will be expensive and require significant space, so fully utilizing power produced on board is essential
- Holistic digital twins enable access to shore-based expertise for the crew on board. Several scenarios can be evaluated to optimize planned and corrective maintenance to minimize accidents and troubles on board
- Thanks to advanced weather and performance optimization, route planning is no longer a ship-level activity. It is done at the port and fleet level, which enables just-in-time arrival throughout the supply chain
- Simultaneous ship-to-berth and ship-to-ship cargo work will minimize port stay hours. Shorter port stays will allow for slower sea navigation and result in energy savings
- Thanks to improvement of shore facilities, automatic mooring and berthing will be possible to minimize port stay hours. Shore power is also supplied to the vessel

Moreover, a dirty hull can increase resistance by 60 percent. During port stays, automatic hull cleaning robots will clean the dirty hull to reduce resistance that could negatively affect vessel efficiency. These robots will also collect all debris to prevent pollution of ecological systems at port

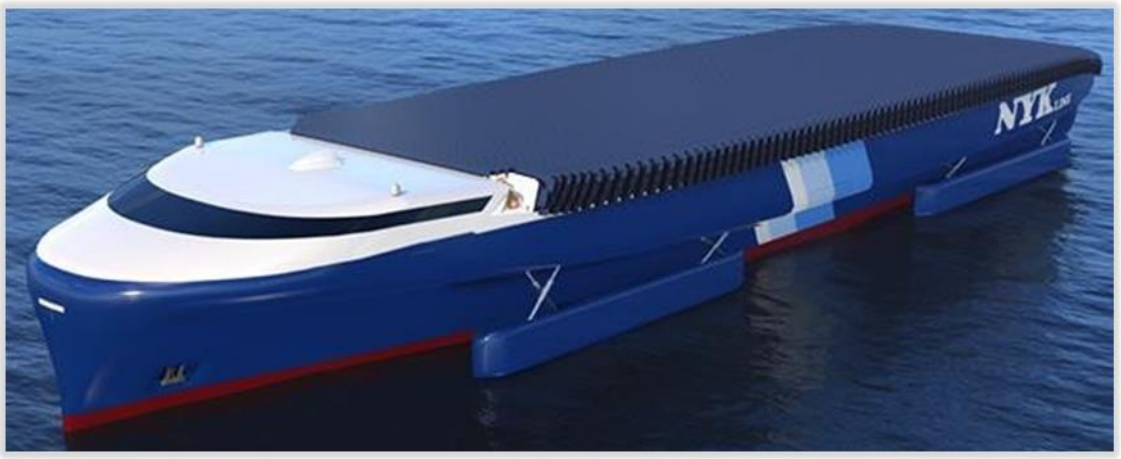

Figure 12: Nyk Eco Ship 2050
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3.3 M/V YARA BIRKELAND

The last vessel I will analyze herein is Yara Birkeland that is a container vessel and is the world's first autonomous and zero- emission vessel. This vessel is not for the long-term future like the previous one even if it looks and sounds like it. She will be ready for launch in 2020 at the earliest. Yara Birkeland will not be autonomous from the beginning but will gradually move from manned operation to fully autonomous operation during its first two years of operation. Yara and technology company Kongsberg have cooperated to build this game-changing vessel. It is true that she is replacing 40,000 truck journeys a year and as a result Yara Birkeland will reduce NOx and CO2 emissions and improve road safety in a densely populated urban area in Norway.

Main particulars:

- LOA 80 m, Beam 15 m, Depth 12 m
- Draught (full): 6 m
- Eco speed 6-7 knots
- Max speed: 13 knots
- Capacity: Cargo capacity 120 TEU
- Deadweight 3200 mt
- Propulsion: Azipull pods 2 x 1200 KW, Tunnel thrusters 2 x 700 KW
- Batteries Capacity: 7 MWh

This vessel is the answer to the main aim of the Yara, Kongsberg and Kalmar companies which is to reduce diesel powered truck haulage by 40,000 journeys a year resulting in zero emissions and improved road safety. It is important to point out that this vessel is not taking into consideration only the improvement of maritime industry but creates benefits for the shore in an environmental, safety and practical level

Today, the autonomous feeder, exports 20,000 containers to international markets from Heroya fully battery powered and ballast free for the marine environment.

Yara owns a production plant in Porsgrunn, Norway with a unique fully digitalized cargo handling solution for autonomous loading and unloading electrically powered. The cargo handling machines responsible for port operations are electrical and have the ability to be charged efficiently and fast in a special area. In conclusion, all the operations are conducted in a fully autonomous and cost-efficient manner.

Figure 13: Yara Birkeland Container

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CHAPTER 4: ROLLS ROYCE FUTURE CONCEPT

4.1 INTRODUCING ROLLS ROYCE

It is widely known that Rolls Royce is one of the world's leading industrial technology companies, especially known for her luxury cars.
However, to make their long story short, the business started back in the 1884 and was established by Henry Royce. In the present moment, they manufacture products that are referring to various fields and industries. In more detail, they are powering with their engine's helicopters, airplanes, ships, and submarines.
Likewise, it is important to point out that they are taking seriously into account the climate change and the increasing level of greenhouse gases with their main strategy focusing on low carbon.

4.2 ROLLS ROYCE MAIN CONCEPT

The world is changing at a pace never seen before. What we believe to be future technology actually exists today and is rapidly infiltrating our everyday lives.
Obviously, the same is happening in the maritime industry. From my point of view, this is confirmed with the most exciting and complete concept that is envisioned and recently tested by the Rolls-Royce in cooperation with Finferries known as the 'oX' operator experience concept. This idea was introduced by the company in 2014 and in with the following description it can be argued that back then it was too good to be true.

Apart from that, like the General Manager of Rolls-Royce, has stated: "We're living in an ever-changing world where unmanned and remote-controlled transportation systems will become a common feature of human life. They offer unprecedented flexibility and operational efficiency."

The main vision of the ox concept is the land-based control centers from which people will be able to remotely monitor and control a fleet of vessels across the world which will be consisting of the unmanned ships of the future.

Furthermore, the crew will be using interactive smart screens, voice recognition systems, holograms, and surveillance drones to monitor what is happening both on board and around the ship.

The ox local wall of the operator presents a place where vessels and traffic in the local zone are tracked and controlled, as well as port operations are scheduled, controlled, and managed.

In the shore control center, there will always be system specialists available on demand for problem analysis and assistance.

The ox collaboration table is a tool dedicated to teamwork and in-depth situation analysis and reviews allowing problem solving on a shared and flexible presentation platform.

It is incredibly significant the fact that, for the company, creating autonomous ships does not mean removing human beings entirely from the picture, as is sometimes stated. However, because of the fact that these vessels need to be monitored and controlled, they will require entirely new kinds of work roles for the shore control center professionals. This means that more people with families will take jobs in shipping and large amounts of time spent at sea will no longer be an issue.

The goal of the new AI vessels is to reduce human error, enhance safety, and improve the environmental footprint of large marine vessels. Like the company stated, they will be safer, more efficient, and cheaper to build and operate. Obviously, these AI systems will be rigorous cyber security mechanisms. The IMO is mandating that shipowners protect their vessels from hackers under the ISM code as of January 1, 2021.

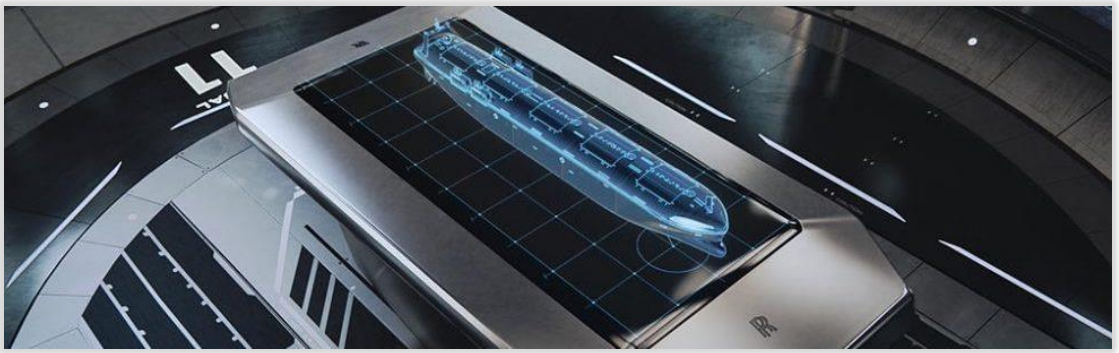

Figure 14, 15, 16: Shore Control Center

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4.3 PROJECT DEMONSTRATION

According to Rolls-Royce and the Finnish company Fin ferries, the world's first fully autonomous ferry was successfully demonstrated in the archipelago south of the city of Turku, in Finland in December of 2018.

The demonstration which proves that the autonomous ship is not just a concept, but something that will transform shipping as we know it was conducted by the world's first autonomous ferry named Falco which is a 53.8 meter double-ended car ferry and is equipped with twin azimuth thrusters from Rolls-Royce.

The testing was conducted in a car ferry Falco, with 80 invited VIP guests. The vessel conducted its voyage between Parainen and Nauvo without any human intervention from the crew. In addition, the vessel first conducts the voyage autonomously. The return journey was conducted under remote control from a shore based remote operating station.

During the presentation, the Falco:

- overcame multiple obstacles
- was under fully autonomous control
- detected objects utilizing sensor fusion and artificial intelligence conducted collision avoidance
- demonstrated automatic berthing with a recently developed autonomous navigation system
- used a combination of Rolls-Royce Ship Intelligence technologies to successfully navigate autonomously
- made the necessary adjustments in speed and course in order to avoid the obstacles safely and returns to the original planned route
- in the dock, the ferry was automatically held in position without the need for mooring lines

In more detail, the Falco is equipped with a range of advanced sensors which allows it to build a detailed picture of its surroundings, in real time and with a level of accuracy beyond that of the human eye. Furthermore, the situational awareness picture is created by fusing sensor data and it is relayed to a remote operating center on land, 50 kilometers away in Turku city center. In the shore center, in the

second part of the demonstration, a captain monitored the autonomous operations, and could take control of the vessel if necessary. What is more, during the sea trials, the collision avoidance solution had also been tested in various conditions for several hours of operation that are close to 400.

Finally, the Autodocking system that is successfully tested, enables the vessel to automatically alter course and speed when approaching the quay and carry out automatic docking without human intervention.

Mikael Makinen, Rolls-Royce, President, has stated that “Today marks a huge step forward in the journey towards autonomous shipping and reaffirms exactly what we have been saying for several years, that autonomous shipping will happen".

Figure 17: The Falco Vessel

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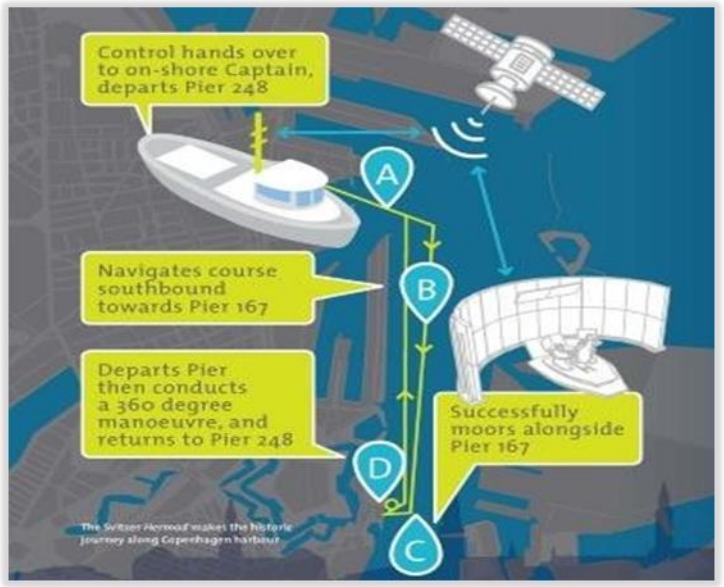

Figure 18: Falco Demonstration Voyage

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CHAPTER 5: WARTISLA'S FUTURE VISIONS

5.1 INTRODUCING WARTISLA

Wärtsilä was established in 1834 and is now a global leader in smart technologies and complete lifecycle solutions for the marine and energy markets. In the late of 2015, wartisla and a team of futurists created six marine concepts based on the trends of green energy, digitalization, and the sharing economy. The company's ultimate goal is an emission free transportation at sea and could be achieved in a maximum level with their following revolutionary concepts Exergo, Zero, Z3, Liitos, Bean to Cup, and Convoy.

5.2 WARTISLA'S CONCEPTS

With the implementation of the aforementioned six concepts we will discover the effect that these new trends will have in the market with a main target to reduce the cost as well as to use more renewable energy.

The six projects are the following:

- EXERGO – Unlimited energy storage
- Z3
- LIITOS
- CONVOY – Mastering the fleet
- BEAN TO CUP – Manufacturing during voyage
- ZERO – FLOATING DISTRIBUTION HUBS

I will present these six projects in more detail.

1. **EXERGO – Unlimited energy storage**

This project is about a future ship named Exergo. It is a remote-controlled, battery-powered ship with a hull streamlined for greater efficiency and a crew on-shore. It is only powered by batteries with energy density up to 20 times of the batteries that exist today. In this way, a voyage to Japan would be possible to be conducted only with batteries. The ship will create no noise and will be completely silent in the port without any emissions and will be leaving the harbor without sound or any visible exhaust.

The Excergo will be a true game changer in the Cruise Industry, by offering energy for propulsion as you go, through the whole lifetime of the ship with monitoring from shore. This would be a way to keep noise and emissions low as cruise ships are becoming larger, not least in ports where many residents have started to grumble.

Figure 19: Exergo Concept
https://www.google.gr/imghp?hl=el&tab=wi&ogbl

2. Z3

In Z3 vision, the main goal is to provide propulsion power that will be reliable and green and does require that customers come up with a huge upfront investment. This will be achieved with offering energy for propulsion as you go, and income will be secured through the whole lifetime of the ship. This business model requires of course Energy Sources with an exceedingly high reliability and monitoring from shore. For monitoring advanced connectivity is required.

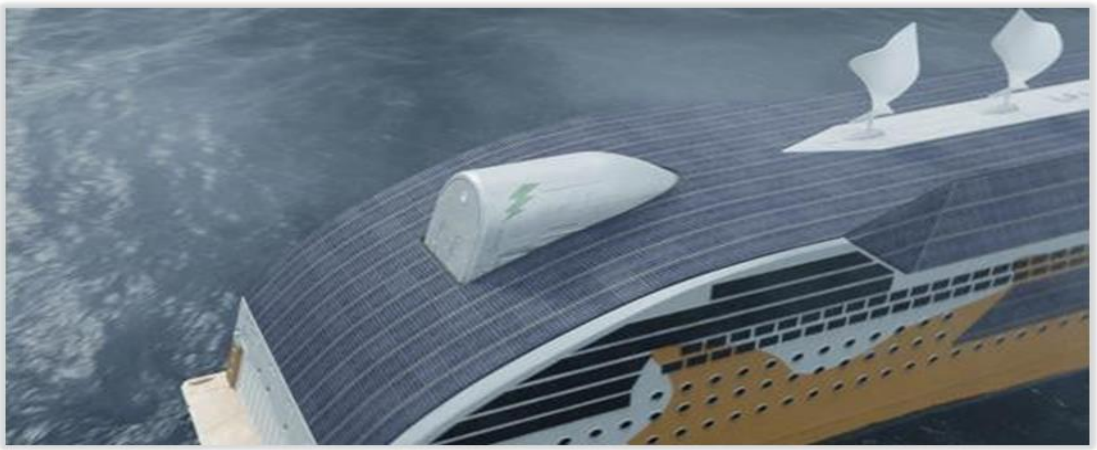

Figure 20: Z3 Vision
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3. LIITOS

From my point of view, in the past, it would have seemed ludicrous that an online bookshop such as Amazon would buy its own ships, but nowadays the only rule for the company is that there are no rules.

New Global Players has joined a new platform for shipping transportation, where the principles of everybody sharing the same information all the time apply. The middlemen will disappear, and the transportation on sea will be much more efficient. What this means is that joining up old and new ship operators (both Amazon and Huawei have plans to ship their own stuff) with a digital tool will ensure that no container ship will be sailing cargo-free. Of course, sharing assets saves money.

Figure 21: Liitos Concept
https://www.google.gr/imghp?hl=el&tab=wi&ogbl

4. CONVOY – Mastering the fleet

Another interesting point of view is operating fleets of ship in a convoy. In this way, up to 30% fuel could be saved by trailing in the wake of each other, of course with not any crew on-board. Furthermore, the ships will also be standardized, built in larger series at lower cost but at better quality and performance. The Convoying of crewless ships requires autonomous systems, Artificial Intelligence, and advanced connectivity. Travelling in a pelo-ton formation saves fuel because there will be less resistance when one tailgate the ship in front. The lead ship would probably be manned, including an anti- piracy crew, but would also carry spare parts.

Figure 22: Convoy Concept
https://www.google.gr/imghp?hl=el&tab=wi&ogb

5. BEAN TO CUP – Manufacturing during voyage

This project looks really promising to me because factory ships will be manufacturing while transporting raw materials which can save valuable time for the businesses. Also, it can increase the quality and profitability by starting sooner after harvesting, saving valuable transportation time.
An example of what this concept means is, coffee beans processed during the journey from Brazil to the market in Europe or Asia. These will be freshly made and ready for consumption at arrival in the port; a floating factory, in essence.
Wartisla has found out that "the salmon farmers in the North Sea have
already picked up the same idea," According to Wågen. "They are designing a ship that picks up the fish at the farm, prepares them on board, then starts to pre-process on its way to continental Europe, saving five days of transportation time and saving them millions of euros."

Figure 23: Bean to Cup Concept
https://www.google.gr/imghp?hl=el&tab=wi&ogbl

6. ZERO – FLOATING DISTRIBUTION HUBS

This project, in my point of view, is one of the most exciting to me, open minded and so futuristic. The reason why I find this exciting is that the ocean-going ship visualized in this concept is even submerged! This means that 30% of the fuel consumption can be saved. With the main goal being an emission free transportation at sea, this concept is examining if this can be achieved by an artificial Island located along the largest shipping routes. These artificial islands can also work as fueling stations along the main trade routes.

Admittedly, these ships must be designed for unmanned operations, nobody wants to be a sailor submerged for 30 days, as the company has stated.

The artificial island would run on seawater or on hydrogen produced from seawater with the help from solar and wind power. The remaining hydrogen can also be sold to visiting ships as fuel, keeping them clean and emissions-free

Of course, zero grumbling from residents is an important factor, if one is to move the operation of goods out to a nearby artificial island rather than keep large and noisy container ports on land.

In conclusion, local production of renewable and clean fuel could take place in the island.

Figure 24: Floating Distribution Hubs

https://www.google.gr/imghp?hl=el&tab=wi&ogb

Figure 25: Submerged Vessel

https://www.google.gr/imghp?hl=el&tab=wi&ogbl

CHAPTER 6: FUTURE 2025 BRIDGE

6.1 INTRODUCING SHIP INTELLIGENCE

Rolls-Royce and VTT, the Technical Research Centre of Finland believe that Ship Intelligence will be the next major transition for the shipping industry as ships are becoming more complex and will require high levels of data analysis to operate on- board systems to manage propulsion, navigation and potentially lead to autonomous vessels.

Moreover, they have presented their latest vision of Ship Intelligence, a futuristic ship's bridge concept which could become reality by 2025.

What is more, this concept has the same name as their previous one that I have included herein the thesis about the shore control centers, known as the Future Operator Experience Concept or ‘oX'. Secondly, Rolls-Royce has worked together with VTT's researchers and Aalto University to develop the new bridge.

6.2 FUTURE 2025 SHIP AND TUG BRIDGE

I will present the features of the futuristic bridge of tugs and ships. Firstly, it offers the crew smart workstations, which automatically recognize individuals when they walk into the bridge and adjust to their own preferences. The windows of the bridge serve as augmented reality displays of the vessel's surroundings, including visualization of potential hazards that would otherwise be invisible to the human eye. The system can, for example, pinpoint sea ice or tugboats and other craft that may not be visible to the crew, especially on large container ships.

In addition, they believe that ship intelligence will help with the fact that skilled crews are already in short supply, because in the future that will cause real problems for the industry.

In conclusion, the president of Rolls-Royce, Mikael Makinen, has stated:

"We are entering a truly exciting period in the history of shipping, where technology, and in particular the smart use of Big Data is going to drive the next generation of ships. Over the next ten to 20 years we believe Ship Intelligence is going to be the driving force that will determine the future of our industry, the type of ships at sea, and the competence levels required from tomorrow's seafarers".

And the Vice President of Rolls-Royce Oskar Levander has added:

"Many of the technology building blocks that will control the ships of the future are already available today, but there is still work to be done to develop marine solutions from them. We are investing in ship intelligence, which will be a major driver of the next transition era of shipping. Much in the way that sail gave way to steam powered ships, and coal gave way to oil, we will see increasingly sophisticated ships, highly automated and perhaps even unmanned remote controlled, plying the seas within the next two decades."

Figure 26: 2025 Vessel Bridge

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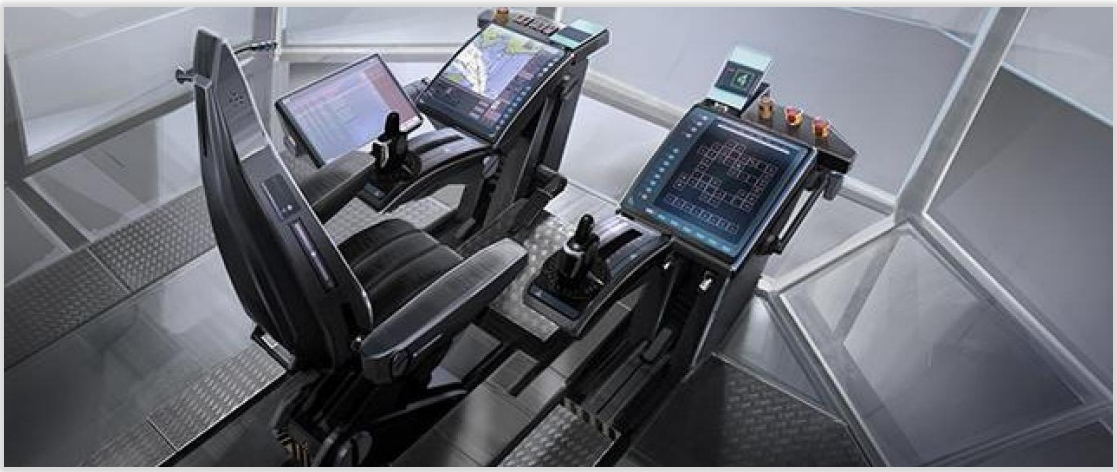

Figure 27: 2025 Tug Bridge

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CHAPTER 7: CONCLUSIONS

In this dissertation I have presented a variety of autonomous vessels of different kinds, from containers to super tankers. Moreover, I have focussed on projects from different companies that constitute fully integrated ideas. It is optimistic for the future of the maritime industry is that these futuristic ideas do not only correspond to reality but will happen in near future.

Admittedly, I have focused on both positive and negative aspects that the technological evolution will bring to the global maritime industry. Also, on the future on design of the vessels and their future characteristics and abilities in levels of operation and safety.

Based on the analysis provided, the following conclusions can be drawn:

- Firstly, these projects can be connected with each other and have as a common direction the evolution of the future technology in the maritime industry.
- Their main target is to create a better and more eco-friendly environment in the shipping industry, with less emission, and to reduce the environmental damage to zero percent.
- Also, to achieve a faster, easier, and safer transportation of cargo goods at sea.
- The expected results are the cost reduction on ship building, the safety of the people with completely unmanned ships, the environmental footprint, the use of renewable and sustainable fuel and power sources such as the wind, the reduction of collisions which most of them happen due to human errors and the higher profit in the companies.
- In my point of view, all these projects presented have as a common characteristic the fact that they are supporting the zero-emission idea for the better future of our world. These changes are eco friendly and act as a protection of the environment.
- It seems that gradually the ships will become fully autonomous. That means that more and more officers and crew will be losing their jobs on board. As bad as losing our job can sound because of the technological evolvement, I can see that more opportunities will be created for all crews on shore. For instance, the shore control centers will need system specialists all day long to remotely control the ships. Of course, the competition is expected to be higher which means that a further ability or education will be required. Also the seafarers will be able to work and live with their families.
- In my opinion, the companies, especially the big ones, need to invest and follow the

path that the leading companies of the field created for the future. Which means that if they do not apply these technologies that will come in the future they will not be chosen any more from the charterers that look for the fastest, cheapest and safest way to transport cargoes.

Taking everything into consideration, obviously, it is difficult to arrive at any safe conclusions with regard to what does the future holds for the maritime industry.

It is deemed important that every ship and every single project must be a step for creating a better planet.

Admittedly, the key drivers for the upcoming decades are decarbonization, digitalization and creating a safer more efficient maritime industry, while at the same time reducing the environmental footprint.

BIBLIOGRAPHY

1. https://en.wikipedia.org/wiki/Ship Retrieved 10/11/2019
2. https://www.ybw.com/features/10-top-innovations-in-the-history-of-sailing- 17358 Retrieved 10/11/2019
3. https://www.marineinsight.com/future-shipping/10-future-ships-that-would- change-the-face-of-the-shipping-industry/ Retrieved 12/11/2019
4. https://www.maritime-executive.com/article/peace-boat-and-arctech-sign-for- ecoship Retrieved 14/11/2019
5. https://en.wikipedia.org/wiki/Ship#/media/File:Maler_der_Grabkammer_des_ Menna_013.jpg 16/11/2019
6. https://en.wikipedia.org/wiki/Ship#/media/File:Borobudur_ship.JPG Retrieved 16/11/2019
7. https://www.maritime-executive.com/article/peace-boat-and-arctech-sign-for- ecoship Retrieved 25/11/2019
8. http://multihullblog.com/wp-content/uploads/12920286_963044890443892_2162363903032122037_n.jpg
   Retrieved 25/11/2019
9. https://en.wikipedia.org/wiki/Technological_evolution Retrieved 02/12/2019
10. https://www.transas.com/about/history Retrieved 03/12/2019
11. http://unmannedcargo.org/next-generation-unmanned-short-sea-cargo-ship/ Retrieved 03/12/2019
12. http://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99- MASS-scoping.aspx Retrieved 20/12/2019
13. https://eandt.theiet.org/content/articles/2017/02/rolls-royce-marine-unveils- electric-blue-modular-smart-shipping-concept/ Retrieved 25/12/2019
14. https://spectrum.ieee.org/transportation/marine/forget-autonomous-cars-autonomous-ships-are-almost-here Retrieved 25/12/2019
15. https://worldmaritimenews.com/archives/247204/interview-unmanned-ships- are-we-there-yet/ Retrieved 07/01/20
16. https://eandt.theiet.org/content/articles/2017/02/rolls-royce-marine-unveils- electric-blue-modular-smart-shipping-concept/ Retrieved 07/01/20
17. https://www.nyk.com/english/csr/envi/ecoship/ Retrieved 07/01/20
18. http://www.sautercarbonoffsetdesign.com/index.html Retrieved 09/01/20
19. https://www.rolls-royce.com/ Retrieved 10/01/20
20. https://www.rolls-royce.com/media/press-releases/2016/pr-2016-03-22-rr- reveals-future-shore-control-centre.aspx Retrieved 13/01/20
21. https://www.forbes.com/sites/jessicabaron/2019/01/07/rolls-royces- autonomous-ship-gives-us-a-peek-into-the-future-of-sea- transport/#56617d9e659f Retrieved 13/01/20
22. https://www.rolls-royce.com/media/press-releases/2018/03-12-2018-rr-and- finferries-demonstrate-worlds-first-fully-autonomous-ferry.aspx Retrieved 15/01/20

23. https://www.wartsila.com/about Retrieved 19/01/20
24. https://www.wartsila.com/marine/smartmarine/visions-of-future Retrieved 19/01/20
25. https://www.wartsila.com/twentyfour7/innovation/another-hundred-years Retrieved 20/01/20
26. https://phys.org/news/2014-03-envisioning-seafaring.html Retrieved 22/01/20
27. https://www.rolls-royce.com/media/press-releases/2014/pr-111214.aspx Retrieved 27/01/20
28. https://www.vttresearch.com/media/news/on-the-ship-bridges-of-the-future- mariners-will-see-the-invisible-world Retrieved 03/02/20