

RoPax, the layout history and analysis

Carmelo CASCINO ^{a,1} and Francesca ARINI ^b

^a*PhD University of Genoa, Knud E. Hansen*

^b*Ship Designer and Interior Architect at Knud E. Hansen*

Abstract. The research in question intends to investigate the sector of RoPax, or rather the ships destined to the mixed transportation of passengers and vehicles equipped with wheels. Moreover, today considered among the most exciting carriers in the field of Transportation Design thanks to the positive effects their use has highlighted in the area of trade and territorial cohesion. The ferry has spread in Europe since the second half of the twentieth century, an era characterized by a relentless post-war economic recovery that favored the development of trade routes and shipbuilding. The ferry is the direct extension of road and rail networks over water in the absence of land infrastructure. It is no coincidence that it derives from the “landing ship tank,” the ships built for amphibious operations that allowed soldiers and vehicles to land on the beach, from which it inherited its versatility and practicality as values of identity that distinguish the spirit of the journey. The study aims to bring out the most significant transformations inherent to the architectural form of the ship, through the analysis and comparison of selected unit drawings based on collective criteria, such as the type of cargo, the geographical area of service, etc. What matters most is reconstructing the evolution of the layout to understand the motivations that have guided the design choices to date. Among the many variables of a technical and stylistic nature, ferry design is extremely influenced by the social transformations and lifestyles of passengers. Recently, the use of the ferry has recorded a surge that has prompted shipping companies to increase the quality of services and entertainment onboard. Therefore, navigating on a ferry whose meaning has changed from a “spartan” journey to a comfortable one, almost as a cruise ship. The comparison between engineering and architecture has become more relevant than ever for the construction of good ships. Thus, the next challenges will be dictated by sustainable innovation and the digital revolution, opening the door to new scenarios in the shipbuilding industry, which will again change the RoPax layout.

Keywords. RoPax, design, layout, transformations, future

1. Introduction

RoPax is an essential component of the system for transporting vehicles and passengers by sea. The meaning of the word indicates the consistency of the load itself, or the combination of vehicles with wheels that can autonomously enter and exit the roll-on/roll-off vessel, and passengers. Throughout its history, it has contributed significantly to the development of transport networks not only locally but on a global scale. In Europe, the first units began to sail around the 1950s at the end of the Second World War, and they became widespread following the post-war reconstruction process that saw the renewal of port facilities and more generally infrastructure for transport by

¹ Carmelo Cascino, Knud E. Hansen, Lundegaarden Claessensvej,1 DK-3000 Helsingor, DK; E-mail: cca@knudehansen.com

sea and land. The economic recovery of the second half of the last century has stimulated the intensification of maritime and commercial routes, also aided by the need to move increasing flows of goods and passengers in a rapidly expanding international market.

Nevertheless, the affirmation of the car as a means of mass transport has favored not only the implementation of road networks but also the RoPax consolidation as a carrier for the mixed transport of passengers and vehicles on water. The importance of the ferry, which remains one of the most used and current means, consists in establishing a territorial continuity on a stretch of sea, where there is no other type of connection available. It represents the extension of the road and rail system, the link between the seaports of one or more countries. In some areas of the Mediterranean Sea, for example, the Greek islands, it is still today the only alternative that allows the inhabitants to remain attached to the mainland, overcoming the disadvantages of remoteness, inaccessibility, etc. In this sense, the ferry confirms the central role of transport in society in terms of territorial and social cohesion. The phenomenon of immigration, travel for pleasure, commuting, are just some of the effects determined by their use. In a broader view, the means of transport facilitate the exchange of information, dialogue, and the dissemination of culture. Bruce Peter, historian of the maritime industry, in one of his books dedicated to the 75th anniversary of the famous naval engineering company Knud E. Hansen, states: *“ships make a significant, but often hidden, contribution to modern life in general. If the ships had not existed, there would be practically nothing to buy. Ships, both merchant and military, make the modern world possible.”*

This consideration is supported by data from the International Chamber of Shipping ICS, according to which ships are responsible for the global transport of around 90% of goods, and no less critical, of millions of jobs. For this reason, the shipbuilding industry can be defined as the engine of the world economy. Concerning the RoPax segment, the British association Discover Ferries claims this is in continuous growth, thanks to the support of sustainable innovation, the launching of larger ships and the implementation of onboard services to meet the expectations of increasingly demanding passengers. Furthermore, it is worth mentioning that the cost/service ratio significantly guides the choice of end-users, representing one of the keys to the success of this market.

Today, one can see how traveling on a RoPax has changed its meaning; from a simple vector of transfer from point A to point B, to the experience of a cruise albeit in a reduced format. The shipping companies have engaged in a competition that has made it possible to increase the offer and quality of services and entertainment onboard. An example, on the Cruise Rome of Grimaldi Lines it is possible to train in the gym or relax in the spa, dine at the à la carte restaurant, or have a drink at the pub. The time spent on the ferry acquires value, divesting itself of the only meaning of waiting. The internal and external space becomes a place of interchange, socialization, and activity since “making the journey,” a concept expressed by the famous architect Gio Ponti, is what counts. Around the RoPax, the comparison between form and function acquires centrality. The goal is to determine an aesthetic language that is the compromise between technical-functional needs, budget, and comfort but even more, that can express freedom and flexibility as values of the identity of traveling on the ferry. In this sense, the project of a good ship requires engineering skills as much as architecture and design more linked to the organization of space for passengers and crew. It is a multidisciplinary approach that has marked the history and evolution of this means of

transport through the construction of increasingly safer and more performing ships, but also valid on an aesthetic and comfort level. The Naval Design, intended as a “form project,” has acquired over time a leading role in the strategic choices of the shipping companies, due to the positive repercussions on the market.

How did the ferry evolve? What shape will RoPax have in the near future? How much does the design affect the characterization of a ship? How much do social changes and passenger habits weigh in terms of services onboard? The objective of this research is to find answers that can be useful to understand the history and the ferry project and hypothesize the direction in which we are heading. The study is conducted through the analysis of general plans, literary and archive material of some units selected based on their architectural relevance, built over the last sixty years. As already mentioned, we tried explaining the evolution of the “ferry layout” by bringing out the dynamics that made change its shape. Among these, the technological field advancements, the alternation of Architecture and Design movements and the social transformations reflected in traveling, which has strongly marked the RoPax’s interiors and exteriors styling. Ultimately, reconstructing the past provides crucial information to understand the present of the ferry, also influenced by highly topical issues such as, for example, environmental sustainability and the digital revolution, which will drive passenger transport into the future.

“We need to know the past to understand the present and orient the future.”

(Tucidide 431 404 BC)

2. RoPax origins and the spirit of the journey; from military to civil vessels

Although the praxis of moving goods and passengers by water routes shows primitive forms of ships since the early years of the nineteenth century, this work aims to illustrate the design transformations of RoPax in its recent history. Emphasizing the central role of LSTs (Landing Ship Tank) adopted broadly during the World War II, concerning the evolution of ferries’ architectural form and functions, and the definition of the ‘character of the journey’ very distinctive of this type of vessels. Furthermore, RoPax developed in time, by the influence of various key-factors such as historical events, social changes, and last but not least, market dynamics.

The ro-ro ferry initial purpose was to serve the railway network since it reached the coast, making it possible to carry freight wagons from one port to another one across the sea. The paddle-steamer was first employed for short routes; for instance, in 1850 the *Leviathan*² enabled two trains to be loaded on and off on tracks arranged on its double-ended main deck. Later, the increase of sea routes due to the expansion of the railway network in Europe and America has encouraged innovation in maritime transportation, leading the transition from barge-type vessels to train ferries. The latter were of larger dimensions and capacity, resembling ocean liners in their layout. Differently, from the past, ferries were designed to accommodate an increasing number of passengers who could afford to travel for business or pleasure purpose. Therefore, on the side view, superstructures expanded above the train deck along the centerline, to

² *Leviathan*, built in Scotland in 1850, conventionally represents the first ro-ro ferry;

provide indoor space for recreational areas such as a restaurant, a dining hall, etc. Traveling on a steamer was meant to be a pleasant journey rather than a simple trip. There are several examples of train ferry in Denmark operated by DSB, such as Korsør (1927) and Nyborg (1931) on the route between the islands Zealand and Funen.

Overall, railway-owned vessels were widely employed during the first half of the twentieth century until cars slowly diffused. Prototypes of car ferries appeared in North America (Motor Princess 1924, Kalakala 1935, Princess Anne 1936) earlier than Europe due to the immense success achieved by Henry Ford, whose vision was to build a motor car for the '*great multitude*' (Model T 1908-1927). Since then, automobiles had a substantial impact on transportation and traveler habits becoming doubtless, the most adopted vehicle worldwide. Thus, besides the regular train service, enterprises started to operate in the newest market. In the old continent, although automobiles struggle to emerge because of the breakdown caused by the conflicts, pioneering vessels were transporting few cars at a time, usually loaded by crane and then manhandled by stevedores. It is after World War II that roll-on, roll-off ferries rapidly developed. By name, the major innovation was to provide hull-hatches to allow cars driving directly to the cargo hold, accelerating the flow in and out. This method reminds firstly the Leviathan loading system later implemented on military ships such as the *Landing Ship Tank* invented by British and Americans to engage amphibious operations (HMS Boxer, 1941 - LST (2), 1942). LSTs were designed to carry a massive cargo of tanks, vehicles, and troops across the ocean, and to deliver directly on the beach. The flat-bottomed hull along with protected propellers and rudders allowed a quickly a safe landing, while a large ballast was filled for the *deep-draft mode*, to ensure stability on an ocean passage. The ship was also able to retreat itself from the shore and rotate toward the sea by using a smart system of winches and anchor. The loading on-off was performed through a large door and a ramp at the bow, meanwhile weapons were covering during war operations. Vehicles were stored on the tank deck, at the entrance level, and on the main deck lifted by an elevator. In the post-war time, LSTs were converted for the civilian commercial market. In Britain, the Colonel Frank Bustard, founder of the *Atlantic Steam Navigation Company*³, had the intuition of reusing landing ships to build up a fleet of car ferries. Considering the scarcity of port facilities, LSTs qualities were crucial to land almost anywhere. The Admiralty agreed on the lease of three vessels which were renamed Empire Baltic, Empire Cedric and Empire Celtic. The maiden voyage of ASN took place on the date of 11 September 1946, with the Empire Baltic transporting vehicles for the Dutch Government on the route Tilbury to Rotterdam. However, the conversion from military vessels to civilian transportation required the fulfillment of technical specifications and the improvement of interiors such as the refurbishment of passenger accommodations.

The ASN enterprise, due to the reasonable costs of leasing and operating Navy ships, was successful and decisive for '*car ferry service*' to grow in Europe. Furthermore, the conversion project of LSTs enabled to explore the basic principles of '*ro-ro vessels design*' and to define some typical characters we can still observe on contemporary RoPax ships. For instance, '*high efficiency*,' '*flexibility*,' and '*ease*.' The first embraces the overall design approach toward functionality and space optimization, thereby increasing payload and profit in the civilian market. The LSTs dynamic system of on-off loading cars, still used, speed up the whole process, through hull-hatches and

³ *Atlantic Steam Navigation Company*, founded in 1934 was operating in the North Sea and Irish Sea.



Figure 1. The RoPax Empire Celtic previously a Landing Ship Tank. Source: www.shipsnostalgia.com

ramps, affecting positively time-saving. The second is a peculiarity of RoPax vessels capable of transporting any vehicle, freight, and passenger. The third concerns comfort and services at a basic standard, allowing navigation companies to moderate prices and to, therefore, rise accessibility. Ferry user analysis describes that indeed a wide range of profiles and needs, including drivers, camper enthusiasts, foot passengers with a deck or cabin class tickets, etc. Such qualities of ‘versatility’ and ‘pragmatism,’ inherited from landing ships and transmitted over time, are still ‘impressed’ on the plates of any ferries; they also truly characterize the ‘spirit of the journey.’

In the second half of the XX century, ships gradually transformed, leaving behind the conventional look of deep-sea ocean liners, acquiring instead, a new charm by innovation and rationality (Julle 1960, Canguro 1965, Stena Nautica 1973).

3. The layout. An overall historical description.

The evolution of the RoPax layout goes hand in hand with the transport revolution and starts from the early 1950s. Originally used as an extension of the railway line, it appeared at that historical juncture as a relatively small ship, for short journeys and used for the transport of people, trains, and goods on wheels. The layout was, therefore, characterized by a large cargo area and a bridge dedicated to passengers, usually located in the highest area of the ship. This collective space was, usually, divided into external and internal areas, in a percentage that still varies according to the geographical area of navigation. In general, the services onboard were limited as the journeys were relatively short.

With the spread of the car, around the end of the 1960s, the RoPax changed. Shipping companies began offering services that allowed passengers to bring the car onboard. The demand proliferated, the ships became larger, and the routes opened up to allow travel on longer routes. Consequently, the spaces onboard acquired a new configuration. The layouts clearly showed bridges entirely intended for cabins, while others showed public areas. The first ships of those years also highlighted evident design legacies deriving from cruise ships such as, for example, the division by classes, first and second, over the entire development of the ship. Starting from the cargo decks,

the routes for first and second class passengers branched out, to separate the bridges in two well-defined areas between the stern and the bow, from the lower decks to the higher ones to create two very distinct flows. Usually, the stern areas were dedicated to the first-class to guarantee more space, while the bow areas were for the second. The services were repeated for both, but obviously, the standard was very different. The first-class cabins were distinguished between the basic layout with two passengers and Delux, while the second-class ones could accommodate from two to four passengers with shared external bathrooms. The internal and external public areas were also divided and included restaurants, lounge bars, and cafes. In principle, this was the organization on board the ferry between the 1960s and the 1970s. In the following historical period, the evolution of RoPax was oriented towards improving onboard comfort in public areas. The separation between the first and second class almost completely disappeared, and the flows became more homogeneous. The variety of services expanded, and next to adult entertainment such as bars and casinos, areas for children began to appear. Particular attention was paid to track drivers due to the frequency with which RoPax was used to transport goods by roads. From here on, the RoPax took on the character traits that still distinguish them, and place it in-between cruise ships and cargo, with a layout increasingly geared towards passenger comfort.

4. Layout analysis of various types.

4.1. The Modern Layout of the RoPax

The modern RoPax vessels takes many elements from the cruise ship. In a sense, it can be viewed as a simple version of a cruise vessel, with the addition of a vehicle cargo space and a reduced number of crew members per passenger.

The layouts can vary dramatically accordingly to the routes and duration of service for a particular vessel. The '*short service*' is usually the simplest layout. These vessels are the ones sailing on short routes with reduced number of passengers and cargo and with no cabins and simple public spaces. A '*long service*' RoPax is typically larger and more complex, including large cargo spaces, more services in public spaces, and cabins for overnight passages. The overall length of the vessel can range from 50 to 200 metres with the average for a typical long service being around 190 metres.

The graphic in '*Figure 2,*' shows a typical long service RoPax of 150 metres for operation in the Mediterranean. The ship can carry around 60 crew and 1500 passengers (ratio of 1:25) with 1980 lane-metres of cargo. The ratio between passengers and crew is a very important factor that varies based on the complexity and operating profile of the vessel. A high number of crew members is typical for a high-standard luxury vessel. This range increases towards cruise vessel standards which is typically characterized by a very high ratio of crew to passengers, 1:3 in some cases.

The typical layout of a long service RoPax is characterized by the cargo decks on the lower part of the ship which permit the carriage of wheeled cargo, such as cars, trucks, semi-trailer trucks, trailers, and railroad cars, all which are capable of driving on and off the vessel under their own power. The operations are facilitated through the use of built-in or shore-based ramps that allow the cargo to be efficiently loaded using interior ramps. The decks can be designed and built to meet flexibility requirements in order to carry different types of cargo. Furthermore, deck heights can be adjusted to allow for varying heights of vehicles by employing hoistable decks.

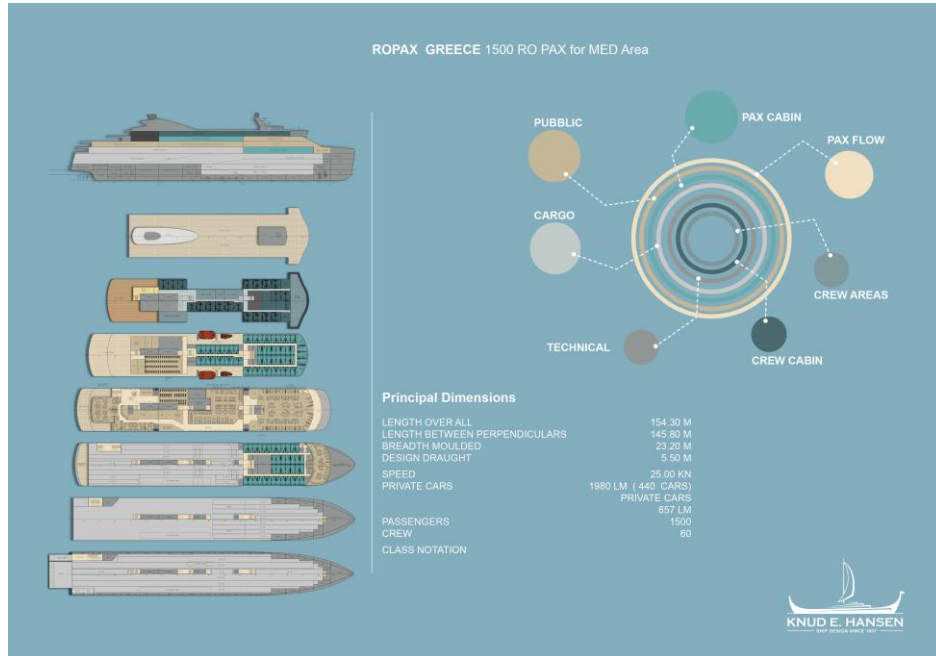


Figure 2. Layout of a RoPax for the Greek market designed by Knud E. Hansen.

Passenger cabins are normally located above the cargo space and are often divided by class and level of outfitting such as standard, premium and luxury. Standard cabins can be in the range of 14-16 square meters and are intended to accommodate up to 4 people (2 single beds + 2 pullman beds) and include a toilet. Passengers can book a single bed in a shared cabin or book the entire cabin for themselves. Premium cabins can be 16-18 square meters, and usually have a double bed plus sofa bed (for kids or friends) and toilet. Occasionally they have private balconies. Luxury cabins are usually much bigger and include a king size bed, proper living area with sofa bed, and a larger bathroom. The position of these cabins is usually towards the forward part of the ship on one of the higher decks. Traditionally, cabins were designed only as a place to sleep and not a space that passengers would enjoy spending time in. As a result, cabins were smaller and passengers spent more time in the public spaces on board. This was financially beneficial for the ship owner because the more time passengers spend in public spaces, the more money they are likely to spend.

Even though some vessels offer cabins for a more comfortable overnight passage, it has been observed that many passengers prefer to purchase a basic fare and end up sleeping wherever they can in the public spaces, either inside or on open decks (especially on routes in Southern Europe). Ferries have become makeshift campgrounds with passengers running for the best spot trend is not only against the rules but can be dangerous in many cases. In fact, passengers sleeping in emergency areas and escape routes put everyone in danger in the event of an actual emergency. Despite signs on board that prohibit camping, it has become the norm. A possible reason for this is that the ships are so old and outdated, passengers feel the public spaces have already been abused and further disregard for their surroundings is acceptable. The services offered on board, in public spaces, generate a great deal of



Figure 3. The long service ferry Cruise Roma, Grimaldi Group. Source: www.bairdmaritime.com

revenue for the ship owner. Usually distributed on one or more decks close to rescue stations, the public areas generally include the following: receptions, a-la cart restaurants, self-service restaurants, bars, spa and gyms, videogame areas, kids' areas, cinemas, lounges, open areas with bars and a swimming pool. The choice of on-board services is closely linked with the quality standard of the ship and the marketing strategy. The public area is not only important for their ability to generate profit but must also adhere to specific requirements with regards to emergency evacuation. The assembly stations are where passengers must gather in an emergency. These are usually situated on public areas on upper decks close to the rescue stations. As a result, one of the most important factors that impact the design of the layout is the mustering and evacuation procedure. Another very important element to consider on RoPax vessels is the division between passenger and crew flow. On a cruise ship the number of crossings between the crew flow and passengers is zero. This also applies to RoPax ships and is achieved by the presence of corridors lifts and stairwells totally dedicated to the two entities. The crew area is usually on the upper deck of the ship, close to the wheelhouse. Alternatively, it may be divided between the upper decks and lower decks, close to the cargo decks. The crew areas are usually served by dedicated service lifts and staircases which, ideally, never interferes with passenger flow.

The ship is divided in transverse sections, or fire zones, so that any outbreak of fire can be easily contained. Openings in the bulkheads between fire zones are fitted with fire doors. Under normal conditions the doors will generally remain open. The car deck is isolated from the rest of the ship as a separate fire zone. Every fire zone is also designed according to "Safe Return to Port", or SRtP regulations (in accordance with SOLAS) which state: *"passenger ships shall be able to proceed to a safe port under their own power after a fire or a flooding. During this "safe return to port" period, all persons onboard shall be accommodated in a "safe area" where basic services for their safety and health are available."* This new rule has changed the modern layout of passenger spaces. Every fire zone has a dedicated lift, staircase, toilet, and food provisions in order to provide a safe haven for passengers.

4.2. *Smaller Ferries*

The busiest short-service ferry route is between Elsinore, Denmark and Helsingborg, Sweden. These vessels operating on this route are the first double ended ferry in Europe that is fully electric, charging for 4 minutes per side and departing every 15 min. The journey is 2 nautical miles and the crossing takes 22 min. The ferry is equipped with restaurants, bars and kiosks, with passenger often purchasing a ticket just for the on board experience and disembarking in the same port where they boarded. This is completely new concept, giving the ship a new function, which is to not just ferry passengers but provide an enjoyable experience for individuals who do not wish to travel to another destination (M/F Tycho Brahe 1991, M/F Aurora 1992).

4.3. *Fast Ferries*

Is in the late 90's, high speed catamaran ferries emerged and began to revolutionize the ferry industry, replacing hovercraft, hydrofoils and conventional monohull ferries. The industry is mainly centered around two or three shipbuilders, primarily located in Australia. Incat of Hobart specializes in large vehicle ferries between 60 and 120 meters with wave-piercing hulls to provide a more comfortable ride (HSC Tarifa Jet, 1997, HSC Express 1, 2009).

5. **Conclusions**

The layout of the ferry has evolved radically over time, adapting to the historical context and the needs of a continually changing society. The ships of the 40s were custom designed for the market of the time and could load around 500 passengers and 50 cars onboard. Overall, vessels were based on functionality, characterized by limited dimensions and services due to the short routes. Passengers on board were able to enjoy a cup of coffee while sitting on benches on the outside areas during the sailing. On the exterior design level, the first RoPax vessels were aesthetically similar to the ship designs of that period, characterized by a low and elegant silhouette with a strong emphasis on practicality.

Today, concerning the route for which the unit is designed, the tendency is to build ultra-large ferries; Cruise Roma can carry approximately 2,700 passengers and 200 cars, in other words a capacity five times greater than the previous ones. The ships' tonnage has grown proportionally to the goods' moving increase but mainly to the flow of cars, assigning to the ferry the role of '*ship of the motorists.*' In this sense, the revolution initiated by the car on the habits of travelers has been decisive. Along the lines, between the 1960s and the 1970s, the spread of well-being as a catalyst for innovation led to the gradual disappearance of travel classes and consequently to a new organization of layout, circulation and previously clearly separated functions. From this point on, the typical characteristics of the RoPax distribution and structural system began to emerge as we know them today. '*The passenger at the center of the project*' is, instead, the trend that has characterized the layouts of the most recent constructions, and is preparing to guide strategic choices of shipping companies for a long time to come. In other words, it was understood that investing in the quality of travel, and expanding services and entertainment is essential for remaining competitive in today's market. Moreover, due to different 'spontaneous' ways of traveling and change on

passengers' habits, sometimes characterized by an improper use of public zones such as sleeping in emergency areas and escape routes, new layouts and services need to be implemented to keep up with the times.

Ultimately, the study of the layout made it possible to understand the evolution of this means of transport through the most significant social transformations, and to elaborate food for thought regarding the challenges that the maritime industry will have to face soon.

"If design is about changing behavior", as designers we have the responsibility to help through the next transformations we will face, in order to provide more ethical and sustainable products and services and provide to passengers the best traveling experience.

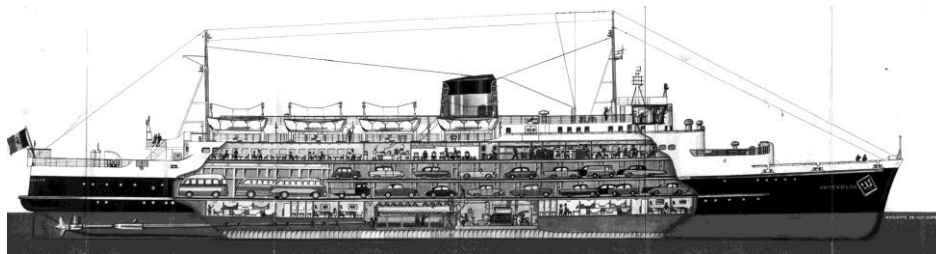


Figure 4. Cargo distribution diagram of a RoPax ship. Source: www.hhvferry.com

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