USER CENTERED DESIGN CHARACTERISTICS OF OFFSHORE RACING YACHT DESIGN

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USER CENTERED DESIGN CHARACTERISTICS OF OFFSHORE RACING YACHT DESIGN

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Approval of the Graduate School of Social Science

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Design.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Design.

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ABSTRACT

USER CENTERED DESIGN CHARACTERISTICS OF OFFSHORE RACING YACHT DESIGN

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The sailing activity can be thought as an organized work system defined by a related group of elements which are organized activities, riggings and people, working in unstable environmental conditions and positions for sustaining the main object of "sail" with efficiency. A sailing yacht is a medium of this system. Performance, effectiveness and efficiency of sailing yacht and pleasure of users are most important things for design, because success is directly related to them.

On board, each user has different defined roles and tasks. These tasks are performed by interacting with specific riggings in specific "spaces" of the sailing yacht. However, these sailing elements do not always derive from user-centered design criteria. They often develop from arrangements, which usually are aesthetical, technical or organizational installations on board. Actually, the most efficient design that can serve the whole system contains each of them. And these elements should be designed considering the user-centered design criteria.

This thesis outlines the results of an evaluation referred to the analysis, contains interrelation of “tasks of users’”, “distribution of space” and “designs of tools” in regarding with user-centered design methods. The target of the evaluation is to indicate the most important aspects of users’ displeasure and problems that are affecting their performance in races and in order to define a guideline referring to different operative situations (organizational, positional and effective usability) as well as to different sets of rigging.

The study started from some methods referred to user-centered design: in order to analyze the different user’s performance taken up in rapid succession, in comparison with each tasks connected to the most important riggings and work area of a sailing yacht. This analyze has been done in considers to different kinds of cockpits and uses of riggings.

Primarily a theoretical analysis has been applied, referring to some suggestions got from the literature on user-centered design (UCD). Afterward an evaluation with different methods has been applied by registering the types of maneuvers and the different taken up movement of users’ on board.

The experimental results allowed providing some guidelines to favor and to guide design choices for users, work areas and riggings referred to the users’ roles. At the end, guidelines will be forced in a solution of usable and functional user-friendly racing yachts.

Keywords: User Centered Design , Offshore Racing Yacht Design

This work is dedicated to;

Sema BORVALI *and* ***Sezai BORVALI***

for the precious love and support they have provided…

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CHAPTER 1

INTRODUCTION

1.1. Definition of Research

Organized work is the collaboration of more than one person where the work is taken with a feeling of shared goal and direction. It contains “teams” and “team based organizations”. Every collaborative organized work who has a primary goal, focuses to succes and adapts to the work environment.

The sailing activity can be thought as an organized work defined by a related group of elements which are organized activities, riggings and people, working in unstable environmental conditions and positions for sustaining the main object of “sail” with efficiency. A sailing yacht is a medium of this system. Performance, effectiveness and efficiency of sailing yacht and pleasure of users are most important things for design, because, success is directly related to them.

On board, each user has different defined roles and tasks. These tasks are performed by interacting with specific riggings in specific “spaces” of the sailing yacht. However, these sailing elements do not always derive from user-centered design criteria. They often develop from arrangements, which usually are aesthetical, technical or organizational installations on board. Actually, the most efficient design that can serve the whole system contains all of them. And these elements should be designed considering the user-centered design criteria.

1.2. Purpose of Research

The main purpose can be defined simply with that question: How can we design successful and unique offshore *sailing practices for users* on board considering their needs and problems (rather than just designing sailing yachts?) As a matter of fact, answering that question requires not only understanding the theories on user-centered design in this context but also defining different design characteristics of offshore sailing yachts that focus on racing practices and later that defining some guidelines referring to design of a users' emplacement on board.

This thesis outlines the results of an evaluation referred to the analysis, contains interrelation of "tasks of users'", "distribution of space" and "designs of tools" in regarding with User Centered Design methods. The target of the evaluation is to indicate the most important aspects of users' displeasure and problems that are affecting their performance in races and in order to define a guideline referring to different operative situations (organizational, positional and effective usability) as well as to different sets of rigging.

Yacht design is very young research area within the design field. So, using user-centered design approach accessible to yacht design field is also one of the important points of the study.

1.3. Methods of Research

There are a lot of approaches are using for the successful design process with different names like user-centered design, emotional design, experience design etc. In fact, each of them tries to give an explanation and understanding for the design and user from different point of view. This variety in the approaches world is quite confusing for designers. The best design approach for this research is user-centered design because, it can be define as a multi-stage problem solving process that not only requires designers to analyze and predict how users are likely to use a product. User involvement develops design quality through a more truthful and complete definition of user needs and knowledge about the organization. As we said before, sailing activity is organized work system that completely works with manpower. That's why, users and their tasks requirements can be examined clearly using this approach.

There are four important principles for user-centered design:

- A clear understanding of users and task requirements
- Integrating user feedback to refine requirements and design
- Active involvement of users to evaluate designs
- Integrating user-centered design with other development activities (Inuse 1999)

The principles of user-centered design are important to perform. Designers concentrate on the user requirements and try to get information from the user as much as possible. They actively work with users in design development or renovation process so that they have a better understanding of users' behavior, problems and needs. On the other hand, user involvement enables users to achieve a more realistic expectation about design efficiency and capacity and allows users and designers to solve problems about the design issues during design process.

In this context, this research was organized into three phases that are referring to user-centered design methods: during the first phase data and information were collected concerning both in races with "different offshore sailing yachts and the roles", "the riggings and the tasks of users"; in the second phase user-centered theories and methods were examined in order to analyze tasks, space and riggings of subjects working together in organized sailing system and to apply these methods in an original way to the theoretical evaluation of users' tasks, space and riggings; in the third phase a direct observation was planned in order to verify the correctness of theoretical data of the preview steps and in case to point out any critical points. The study was completed with a comparison of data collected during the different phases: this allowed defining some guidelines referring to design of a users' emplacement on board.

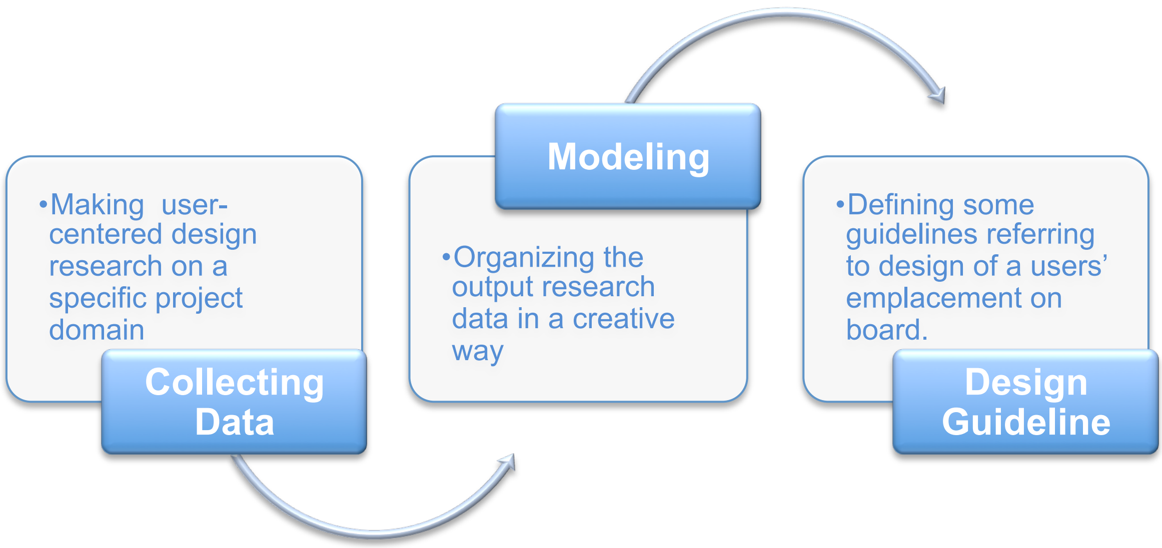


Figure 136: Phases of the Study

1.4. Limitations of Research

My research is concerned with offshore racing sail yachts and teams that have been racing according to IRC rules for the past two years in Turkey. There were two reasons for choosing this group of yachts and users as the focal point: The first one is easy to achieve their information, needs and problems and the second one is the importance of effective usage of sailing yachts during the racing activity. Races does not accept the errors, that's why users should use all rigs and spaces very rapidly, active and efficiently during the races. They should be able to move very rapidly in cockpit and should be able to use all rigs very efficiently and active on deck.

Racing condition is the most measurable condition for sailing activity, which includes fixed users, fixed tasks, a limited time period. All teams that should perform at their best during a limited time period in same route have different type of racing sail yacht. As we said before, one of the main reasons to choose Turkish racing teams and their racing sail yachts for this research is about the attainability of them directly and variety of racing sail yachts in IRC handicapping system supported to extend and categorize the project groups of this research. Many country and Turkey are using IRC system since 1996, which is open to all types, sizes and ages of boats. It is a system to handicap different designs of keelboats allowing them to race together. In next chapter, more information will be given about IRC system.

Depending on the development of the technology, designs of yachts are constantly improved. In this direction, racing sail yacht owners immediately adapt these developments and they are constantly replacing their boats with new one for improving their race performance. When documents of race fleet of Turkey are examined year by year, it showed many changes about racing sail yacht ownership. Hence, the last two years chosen to be the time period of this research for achieving true information.

These real limitations shaped the structure of thesis. In user-centered design context, all information was evaluated with different quantitative methods based on user observation. This observation as a method is to develop a holistic understanding of the fact under study, which is as objective and correct as possible given the limitations of the method.

As we said before, in this study, user observation methods defined as interviewing, document analysis, user surveys, video recording, photo shooting and additional quantitative methods. User surveys were made separately for each user of yachts who has different task on board. And the other hand, I observed some yachts in their cockpit during races, did interviews with their user one to one, took photos and recorded videos. Other yachts observed with their own video records of cockpits and photos. Firstly, Users' positions, movements and related rigs were defined for each maneuver (tacking, jibbing..) and then problems and needs were marked on related original plans of yachts for each user. Also, all races were examined and race results compared with observation data with regard to problems that affect the performance of teams. These all observations helped me to answer descriptive research questions, to build theory, to generate hypotheses.

BACKROUND OF SAILING YACHT DESIGN

2.1. Background of Sailing

Two thirds of the sphere is covered by sea. The majority of all people on the World live near the coast. The striving of man to explore and extend his environment has always been constrained by the sea and the wind was the only source of energy that would allow them to pass long distances over seas. We don't know how the first sailing boat discovered but the earliest watercraft were probably simple rafts made of bundles of reeds or papyrus, Some researchers have pointed out that these were adequate by 7000 BC to fish. This chapter aims to investigate the history of sailing and sailing yacht design that, in fact, are the history of people who pushed the world's horizon.

2.1.1. Birth of Sailing

The use of boats and in particular sailing boats has been instrumental in the development of human civilization. Throughout history, they had been used for transportation, fishing, commerce, or as warships, for as long as we can trace the history of people living near water. Starting from the most primitive vessels, people quickly improved their skills in navigation and the construction of boats. As most highly developed civilizations especially settled around the Mediterranean, naturally favored an interest in navigation, astronomy, construction and all other disciplines concerned with sea.

The earliest representation of a ship under sail appears on an Egyptian and the Mesopotamian from about 3500 B.C. They used early primitive boats for transportation on the Nile, Euphrates and Tigris. Sail and hull designs have varied according to coastal conditions and the availability of local materials. Early boat-builders in Egypt had raw materials, easy conditions for travelling on the Nile. Some evidence indicates a regular trade between Upper and Lower Egypt. Its current flowing from south to north, and its steady winds blowing from north to south facilitates the movement on the Nile itself.

Figure 137: Location of Major Sites mentioned in the Text

Probably Egyptian boat builders thought that these boats could be driven only downwind that's why early sailing yachts were built to go downwind. So, a simple square sail was used on them. Going upwind was more complex for their time. Then this ability was steadily developed over centuries. A simple square sail rigged before the mast is probably the earliest design, and is found in ancient records from the Mediterranean, the Aegean, the Red Sea, and the Persian Gulf.

Figure 138: Ancient Egyptians Buried Model Sailing Boat

The Egyptians used their boats on the Nile in early times and then they constructed larger boats which known as “Byblos boats” for long-distance sea voyage. Byblos where these boats were constructed was also the important port of Egypt on the Mediterranean. 'Byblos' boats revealed the Egyptians’ trade with the eastern cost of the Mediterranean. One of the earliest known 'Byblos' boats, hidden beside a pyramid at Giza and dating from around 2500 BC. It was made from planks of cedar that was special wood of Byblos. Length of boat was 143 feet (44m) and width of boat was 20 feet (6m). It had a simple square sail rigged as illustrated below.

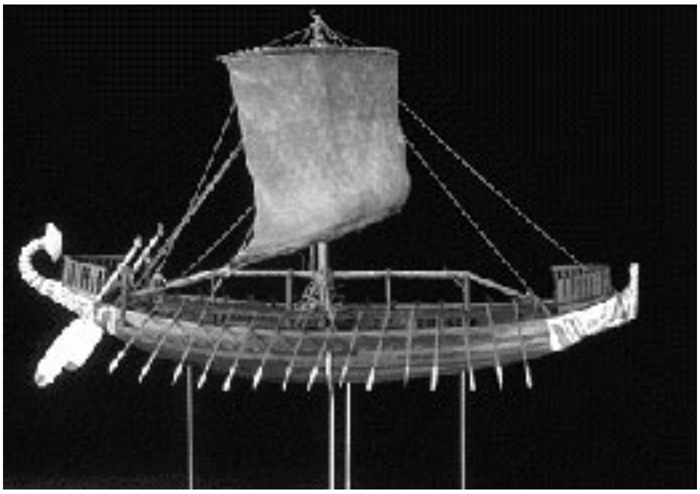


Figure 139: Byblos Boat, 2500 BC (www.marinersmuseum.org)

By around 1200 BC Byblos was a Phoenician port. The Phoenicians were regarded as rulers of the sea, occupying what is now modern day Lebanon and the coastal parts of Syria and Palestine. Phoenician boat builders were more advanced in the art of boat building than other civilizations. They were the best seafarers of the ancient world. The Mediterranean Sea has characteristically light variable winds during much of the year and this encouraged the development and long term use of the rowing galley. The ancient Egyptian boats were barely more than big and large canoes that were paddled. However the Phoenicians experienced that boats moved faster by rowing, with the rowers facing the stern and the Mediterranean Sea was very suitable for this type of boat.

Phoenician fleet contains two important different designs of boat. One of them was a merchant vessel that was the mainstay of Phoenician trading activity over a period of a thousand years. The other one is war ship. Both war and merchant ships were made with foresails, the sail hung on the forward mast or stay, with the mainsail in the center of the boat. The keeled boat or ship is very likely a Phoenician invention. And The history of the Phoenicians spans centuries From primitive dugout canoes through keeled oared boats and on to keeled ships with both sail and oars.

Their merchant boats depended principally on rectangular sails rather than oars. It was rowed when the wind died or when maneuvering in port. This boat was a "rounded boat" which was used for carrying both goods and passengers. It provided a much larger cargo space.

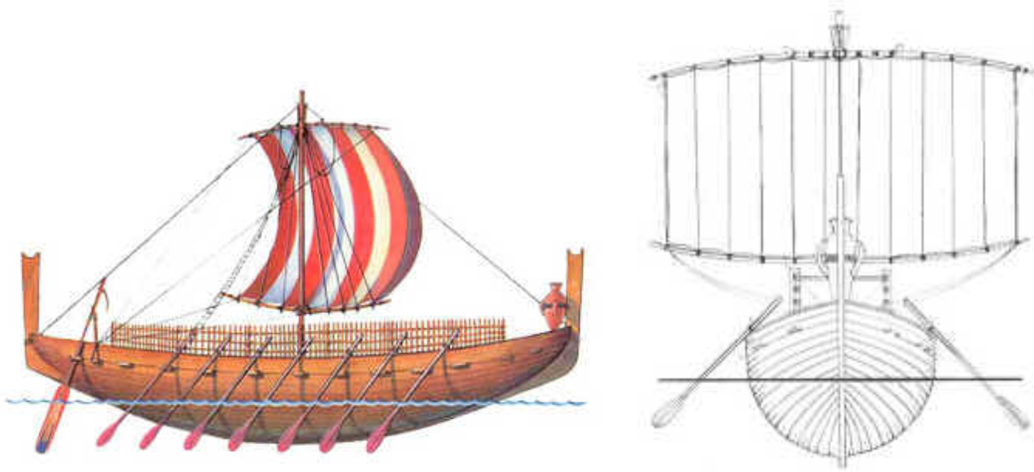


Figure 140: Phoenician Merchant Boat, 1500 BC

A later Phoenician merchant boat is depicted below dating to around 850 BC. As we see on picture, the hull of the boat was low in height; the low strong mast bore a big rectangular sail. These boats were used extensively for both naval wars and transportation purposes.

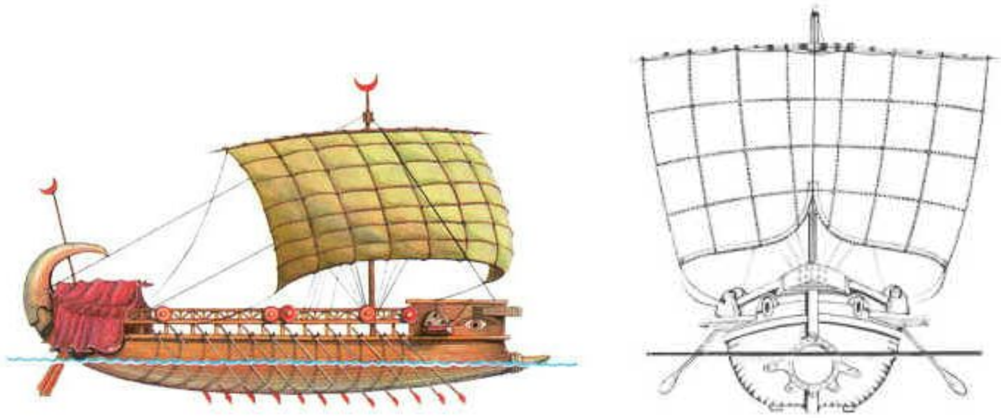


Figure 141: Phoenician Merchant Boat, 850 BC

Other important boat design of Phoenician fleet is war ship. The Phoenicians are the forebears of the Carthaginians, and they invented double decked war galleys called biremes whose bronze beaks or rams were greatly feared by enemies. Technically, both Bireme evolved from a type of ship known as the Unireme. Unireme, as the name suggests, had only one row of oars located on either sides of the ship. The design and construction of these boats were similar.

The early Bireme was narrow and strong war ship with broad bottoms and shallow draft. Length of the ship was from 25 to 35 meters, and the width about 4 to 5 meters. It has two ranks of oars allow us to refer this ship as a bireme that is of the type used from 1500-1000 BC. The significant features of bireme were the large square sail, which helped in its propulsion and removable rigs and mast.

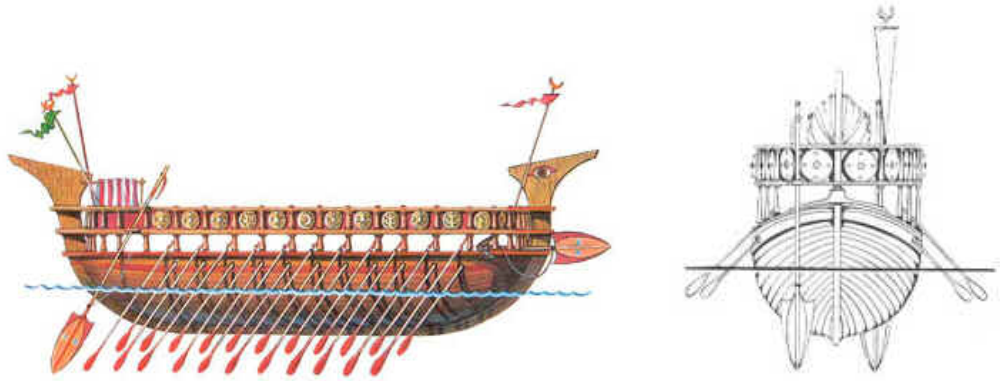


Figure 142: Phoenician War Ship, 1500-1000 BC

The bireme had been the leading warship in about 700 BC. It has improved significantly and became very large, some reputedly having as many as 40 banks of oars and consisted of two floors and the upper one that was for the helmsmen and warriors. The traditional removable mast and rig were typical and the length was about 30 meters with a width of some 5 meters.

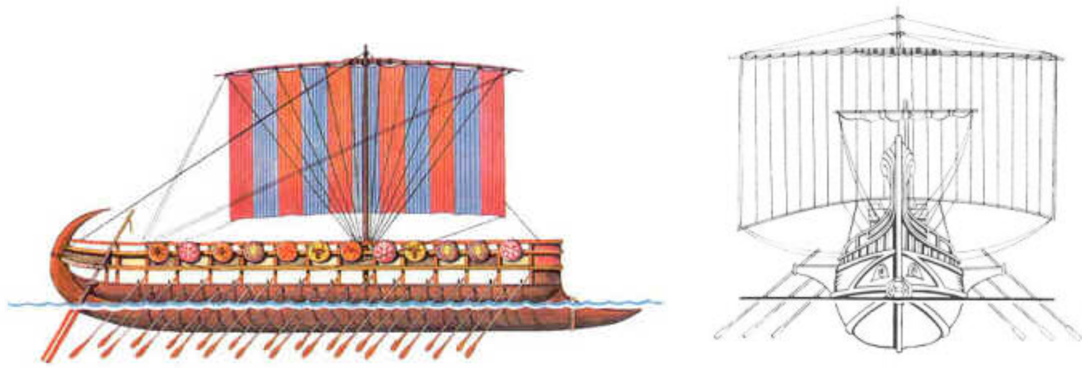
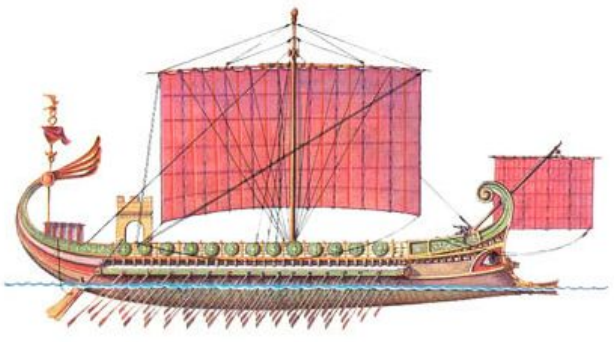


Figure 143: Bireme Phoenician War Ship, 700 BC

From the 4th century BC on, Biremes became a naval war power of the Mediterranean Sea. The Phoenicians invented them and Greeks and Romans developed this idea. Biremes were developed to make triremes, which was much lighter in weight, fast and maneuverable. They also had a narrow hull and an outrigger that was wider than the biremes. Its unprecedented propulsive power was achieved by the arrangement of 170 oarsmen in three tiers along both side of the boat. Everything about the trireme was lightweight. This enabled triremes to attain a speed of seven knots just with the sail and nine knots along with the oars. Square-rigged sails were used for power. Triremes were supposed to be the most advanced ships using naval technology at that time.



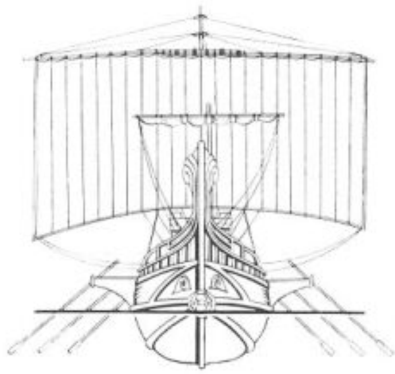


Figure 144: Figure 145: Trireme Greek War Ship, 5th century BC

It was used in the Battle of Salamis, which were between Greeks and Persians in 480 BC. By the time of the Punic Wars, triremes became increasingly bigger and stronger. These developments were spearheaded in the Roman Republic and Carthage (Phoenicia) who were in the furious naval aggression during The Punic Wars. The Punic Wars were a series of three wars from 264 to 146 BC. These fleets also used Quinqueremes that were bigger and heavier than Trireme; rowed by more men and larger oars.

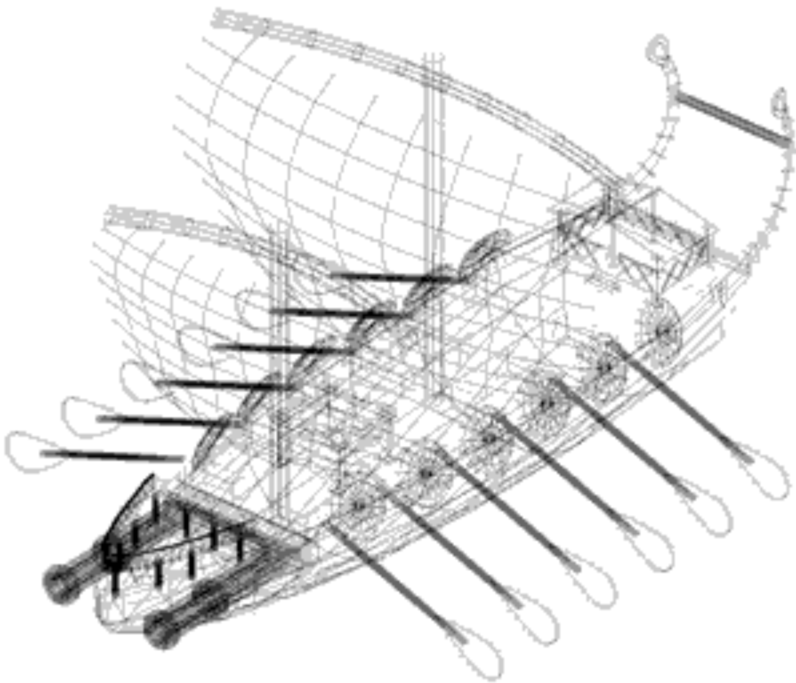


Figure 146: Trireme War Ship with Foresail, 1st century BC

The main elements of merchant and war boats remain basically the same through the Classical and the Middle Ages. In the ancient world the square sail was applied universally in the Mediterranean Sea on the ships of the Egyptians, Phoenicians, Greeks and Romans. In early Hellenistic and Roman times, a foresail was sometimes set on a small raking foremast, in order to sail with head wind. This was a beneficial element, but it was still a square sail.

Much of the knowledge of the Phoenicians, Egyptians, Romans and Greek disappeared and was forgotten during the Middle Ages. Only the Northern Europe knew the square rig until late in the Middle Ages. Vikings of Scandinavia continued using the square sail on their long-ships with the power of men at oars. Viking long-ships were ships primarily used by the Scandinavian Vikings and the Saxon people to raid coastal and inland settlements during the European Middle Ages. Their ships were also used for long distance trade and travel out of the Baltic, in to the Mediterranean and across the Atlantic. Design of Long-ship evolved over several centuries and was fully developed by about the 9^{th} century. The character and appearance of these ships have been reflected in Scandinavian boat-building traditions until today.

The long-ship was characterized as a graceful, long, narrow, light wooden boat with a shallow draft hull designed for speed. The ship's shallow draft allowed navigation on the waters only one-meter deep and permitted beach landings.

Long-ships were also double-ended, the symmetrical bow and stern allowing the ship to reverse direction quickly without having to turn around and they were fitted with oars along almost the entire length of the boat itself. Later versions used a rectangular sail on a single mast, which was used to augment the effort of the rowers, particularly during long journeys. Long-ships were the symbol of Scandinavian naval power at the time.

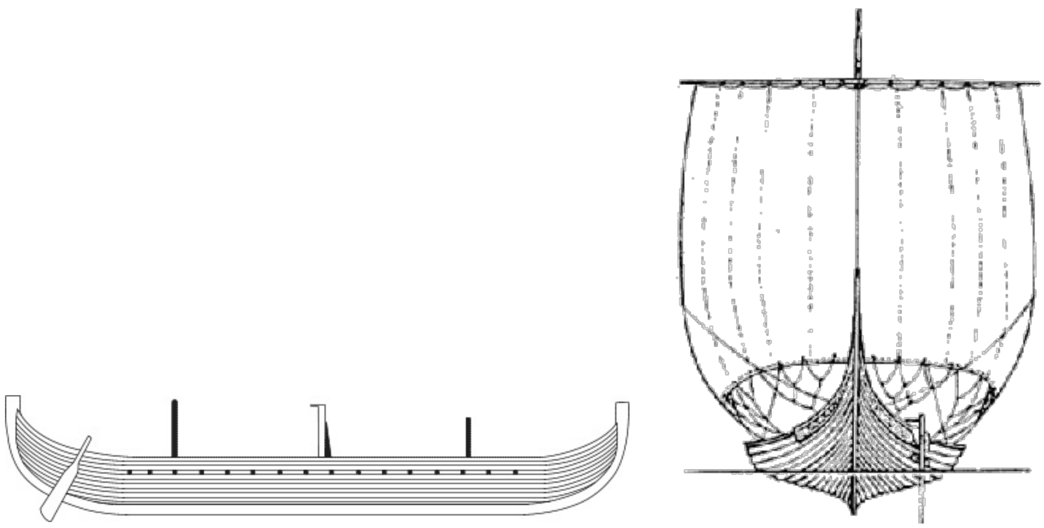


Figure 147: Gokstad Viking Ship from about 900 AD.

The long-ships had square sails, which measured perhaps 35 to 40 feet (12 meter) across, and were made of wadmill (rough wool), which was woven by looms and was not stitched. The long-ship had two methods of propulsion: oars and sail. On the way, the sail enabled long-ships to travel faster than by oar and to cover long distances overseas. Oars were used when near the coast or in a river, to gain speed quickly, and when there was an adverse wind.

Figure 148: Gokstad Viking Ship from about 900 AD, The Viking Ship Museum Bygdøy,Oslo, Norway

In Scandinavia, the longs-hip was a master of trades. It was wide, stable, light, fast and nimble and the usual vessel for war even with the introduction of cogs in the 12th-13th century by the late 14th century.

The long-ship was unique for centuries, until the arrival of the great “Cog”, which was a type of ship that first appeared in the 10th century and was widely used from around the 12th century on. They were generally built of oak that was an common timber in the Baltic and were fitted with a single mast and a square-rigged single sail. Even though this type of rigging obstructed sailing into the wind and a smaller crew could handle it. These vessels were mostly related with seagoing trade in medieval Europe, particularly in the Baltic Sea region.

Figure 149: British Cog with Square-Sail, about 12th Century

Even in the 15th and 16th centuries the some European civilizations continued to use square rigged on their ships but other Mediterranean civilization had already started to use triangular sails on their ships. Because they discovered the advantages of using triangular sails which were the possibilities of going to upwind. Triangle sails are fundamentally different from square sails in functional principles. A square sail catches a following wind and is dragged along by it and they had the advantage of providing stability on large ships and in heavy seas. But, the triangle sail provided better maneuverability and ability to tack. The triangular sail was known as the fully developed lateen sail, which set on a yard but applied fore-and-aft the mast had flexibility and an advantage. Because it creates a curved surface to the wind and gets its motive force from the pressure difference between the upwind and downwind sides of the sails.

Maritime historians have claimed over where this sail was developed and how to use of this type of rigs expanded. The lateen sails are one of the first and important samples of the fore-and-aft rig system. It was used on early Arab “dhows” and Polynesian “outrigger canoes” long before it became common on European and North American boats. In historical arguments support that the lateen sails originated from the square sail. The Indian Ocean is a more likely home for them because a variety of sails, including all steps between square sail and lateen sail, were found near the Indian Ocean.

The earliest indication of the existence of lateens sail on the Mediterranean was Byzantine Emperor Justinian’s (Dramon) Fleet in the late 6th Century that was shown on drawings of Byzantine documents. Before this, only the square sail was used in Mediterranean Sea. Historians think that the triangle sails came to the Mediterranean after the Arab expansion.

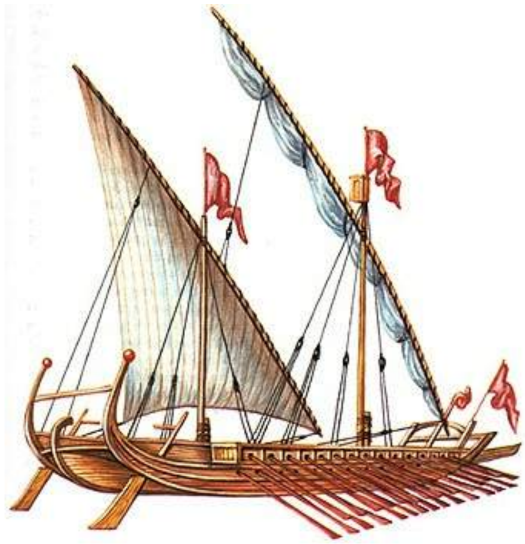


Figure 150: The Dromon, Byzantine War-Ship with Lateen Sail, 6th Century AD. [1]

The Arab lateen is a very effective sail that developed in Indian Ocean since the 1st Century AD. These types of sail made dhows were very functional and significantly different than the boats that developed on the Mediterranean. Arabs would have used to travel on the hard waters of the Red Sea and the Persian Gulf area and the Indian Ocean from Madagascar to the Gulf of Bengal. So, they need to developed their sail and rig system according to environmental and weather conditions.

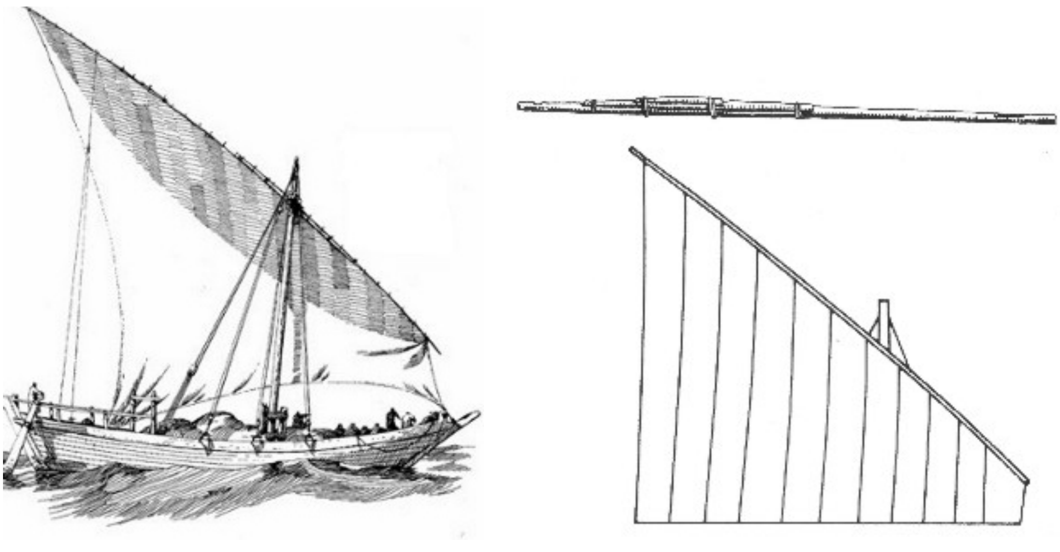


Figure 151: Early Ocean-Going Arab Dhows and a Lateen Rigged Sail

[1] Firstly the Dromon was launched about the 6th century A. D. and was used in different variants up to the 12th century. Their length was varied from 30 to 50 m, the width from 6 to 7 m. (xx)

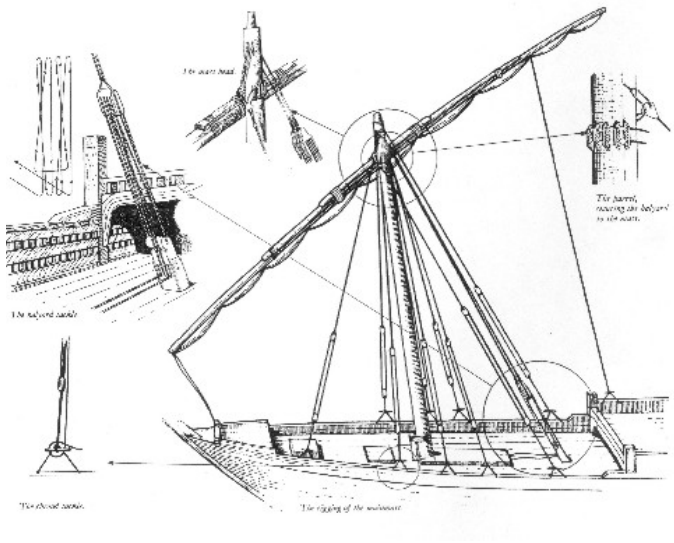


Figure 152: The Lateen sail rigging of a typical dhow

The lateen sail on dhows looks triangular but actually it is quadrilateral. And its yard was normally very long in proportion to the mast and hull. Over the years this sail turned the lateen sail into a triangular sail. The dhow was known for two individual characteristics. First one is its triangular or lateen sail, and second one is its stitched construction. In addition, they had long keel, thin hull design, shallower draft and lighter weight, which provided to be fast. Larger dhows have crews of approximately thirty, while smaller dhows typically have crews of around twelve.

Figure 153: Ocean-Going Arab Dhows and Triangular Rigged Sail, 20th century

Dhows, which had lateen or triangle sail dominated the Indian Ocean right up to the fifteenth century when the arrival of the Portuguese opened the area to European methods. Among all the different types of great sailing ships in the world, the dhow holds the longest continuous tradition of commercial seafaring and they are still using in today.

In Europe, especially those of the 15th century Spanish and Portuguese great ocean traders started to use a combination of square and triangle sails on their ships. A variation on these two designs is the “lugsail” (a four- sided) sail that were rectangular shape, set ahead of the masts at right angles to the length of the ship and supported at the top by yards. The lugsail was the earliest of the fore and aft rigs. This type of ship could sail not only directly downwind, but also across the wind and all angle in between.

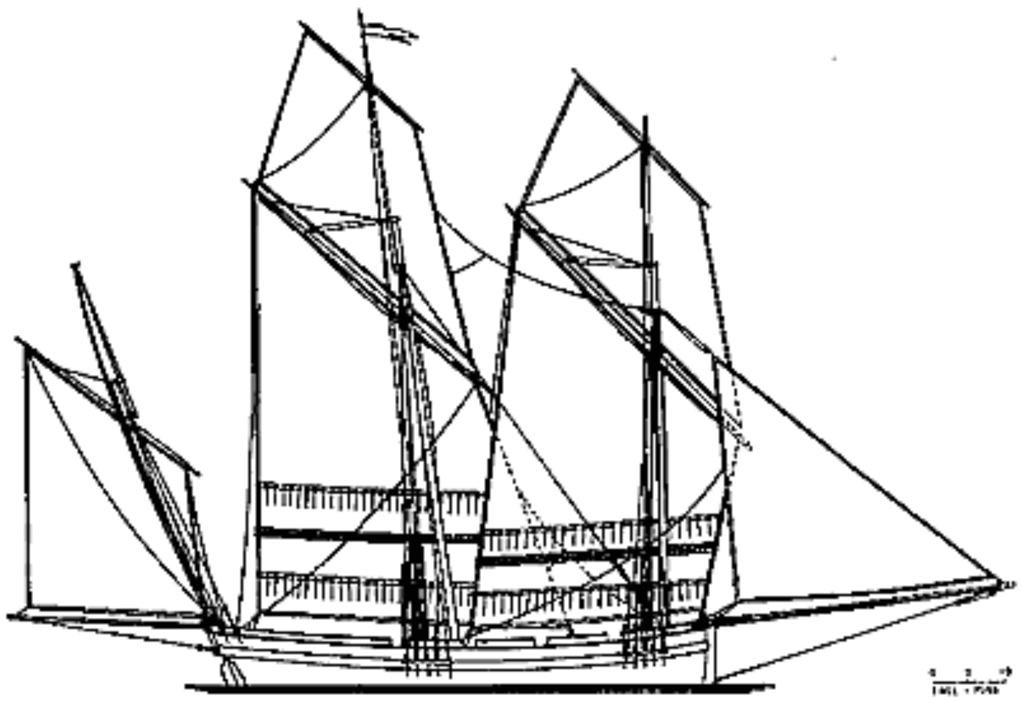


Figure 154: Lugger Ships and Lug Sail , 15th – 18th Centuries

While these developments occurred in Mediterranean Sea and Indian Ocean, Chinese civilization had built “junk”, which originally developed during the Han Dynasty in between the 2nd Century BC.- 2nd Century AD. and had own different characteristics. They developed it in later and were used throughout Asia for long distance ocean voyages. Unlike a traditional square rigged ship, the sails of a junk can be moved inward, toward the long axis of the ship, allowing the junk to sail into the wind. The Chinese junk used a lugsail with multiple horizontal members, called “battens”, which provide shape and strength.

About a fourth of the sail was set forward of the mast and complex sheeting system allows almost boundless adjustment of the sail. Another important innovation on the Chinese junk was multiple masts, which were made of bamboo because of its strength. Hull material of junks was teak and its stern shape was horseshoe-shaped. Because of the violent typhoons, strong hull was essential for ships, so its deck was very high and had bulkhead, made the hull rigid. Junks bottom was flat with no keel and it has very large rudder for stability of ship.

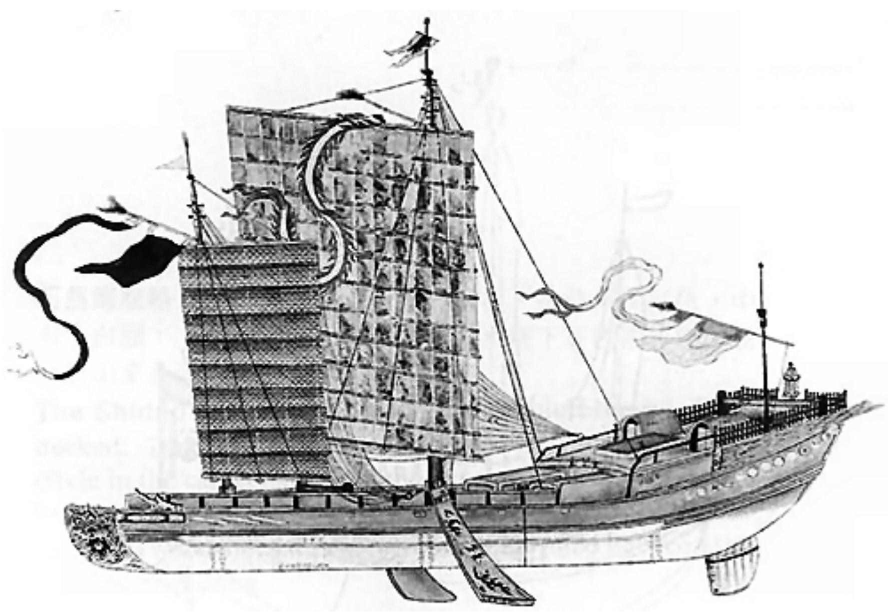


Figure 155: Chinese junk from a 13th century

These ships were huge. Historical evidence point out that by the 15th century a large merchant junks were about 450 feet (135 meter) from the bow to the stern. At the same period Europeans realized that the importance of the multiple masts. By the end of the 15th century there were ships with four masts, carrying between them sometimes as many as eight sails. The most effective sailing ship of the 15th century is the caravel, which developed in the Mediterranean but later adapted by the Spanish and Portuguese in the Atlantic. Both lateen and square sail was used on multiple masts. The mizzen (the back mast and sail) carried a lateen sail and the fore and main mast carried square sail.

Figure 156: Caravela Redonda, European Caravel, 15th century

Many of these traditional rig systems and variations on all the traditional sail shapes are still in use all over the world. Usage of multiple masts, combined sails and rig systems and traditional materials continued until today. The physics of modern sails are more like Bermudan sloop sail that developed in the 17th and 18th Centuries. It is a newer sail shape, which is a triangular sail, set with the luff attached directly to a tall mast. It is the most common sail shape on modern yachts. The development of the fore-and-aft rigs made it possible to use sailing boats very efficiently for determining the best routes according to environmental conditions. Bermudian sloop rig is one of the most important types of rigs, which is completely perfect set on the fore-and-aft rig system. And the other one was schooner sloop that used especially in America.

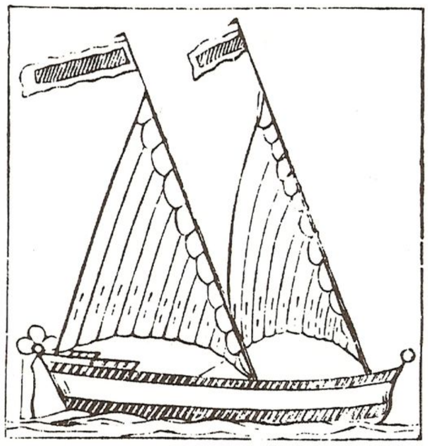


Figure 157: A Woodcut of a Bermudian Sailing Vessel, displaying the triangular sails, 17th Century

If we were to examine all the different rigs of the different ships of the history, of whatever size and nationality, we should find that they divide themselves broadly into two separate classes according to their rig systems. First one contains the ships, which are with yards and square sails; and second contains usually smaller ships, which are rigged fore-and- aft system.

Early fore-and-aft rigged boats were often “Gaff” rigged that was the main sail and the mizzen (the back fore-and-aft sail). Later, more fore-and-aft rigged systems were developed. “Cutter”, “Ketches” and “Yawls” which ideally suited its specific environment used on the coasting trader, the fisherman, the pilots, and the yachts. Bermudan and Schooner rigs apply on these types of fore-and-aft systems and sea vessel that are defined above according to their activity.

2.1.2. The Evolution of Modern Sailing Yachts and Early Races

The term "*yacht*" can be traced back to the late 15th Century. It is derived from "yagd", "yagt" or "yat" that originated in Northern Europe mean to hunt, rapid and fast. In late 16th century, the Dutch used the term "jacht " for war ship, which was used for different purposes like as transportation of goods or pleasure. The word "yacht" as it spelt today is used firstly in Danish texts in 17th Century. It was defined as a slim, active and nimble boat. In 17th century, the British applied the "yacht" term in a marine literature as a pleasure sea vessel and it has been accepted universally. Even today it is using all over the world. The early pleasure crafts resembled smaller versions of naval ships of that time and they were large by today's standards of yachts. History of recreational sailing has been started with acceptance of its status within the social manners and social life. Young Prince Charles of England (Later Charles II.) spend his time in exile in Holland. Before he return to England, the Dutch East India Company presented him with the 52 feet (16 meter) Mary, complete with gilded fittings, in 1660 as a farewell gift. The Mary inspired similar vessels. The Mary was the first yacht that conceived completely for recreational activities and racings represented her owner's features and style. Her task was pure pleasure during cruises.

Figure 158: The Mary, Painting, AD.1660 [1]

1

The Mary was a typical Dutch yacht. She was 85 ft (25,5 m) and had fore-and-aft rigged with a spanker gaff sail and jib that was very efficient when sailing close to the wind.

Following royal yacht, the Catherine, built in England considering the design features of The Mary. The Catherine was similar to The Mary but had better handling characteristics During the 25-year, Charles II, reign approximately twenty-eight yachts were build in England. Among of Charles II.'s many yachts one of the most important yacht is the Fubb which was 80 ft (24 m) long and built towards end of the 17th century at Greenwich. The Fubb had ketch rig that was the first ketch yacht in England. The Fubb's performance was matched by the luxurious standard of her finish. Like the Fubb, all other king's yacht had similar luxurious features. At the same time, recreational sailing began to spread beyond the royal circle and a most of wealthy men in England started to build their own pleasure crafts. Of course, the aristocratic and wealthy men did not do all the hard work required on their boats. They employed large numbers of crewmen to handle the heavy sails and spars.

Figure 159: The Fubb, L de Man, Painting, AD. 1707-1720, National Maritime Museum

The First race began with a challenge between Charles II of England (the Catherine) and his cousin (the Anne) on a upwind-downwind course. It was like today's races. From the 17th century onwards some pleasure boats specifically produced for racing and this type of competitive sailing created a challenge of ultimate performance that was named as regatta.

The first yacht club of the world, was founded at the south cost of the Ireland in 1720, It was the Water Club of the Harbor of Cork (and it is still exist as The Royal Cork Yacht Club.) They used the first recorded regatta of sailing boats. Rather than race, they took part in waterborne training, which involved performing complex maneuvers according to signals. So, the sport of yachting was born.

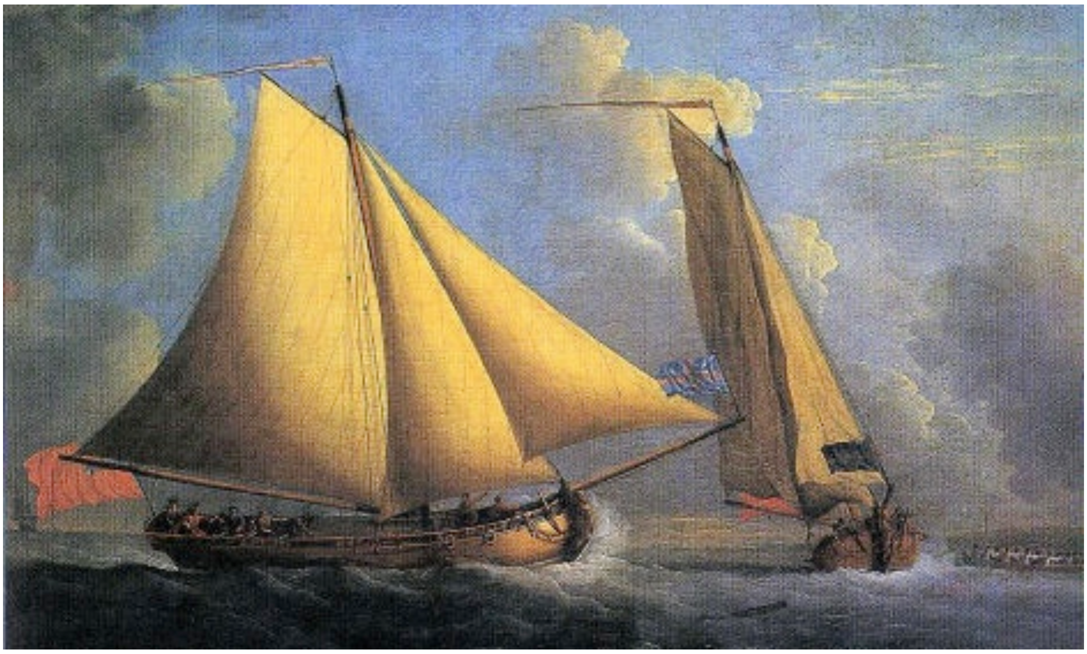


Figure 160: A History of the Royal Cork Yacht Club, Painting, 1720

There were two clubs whose history was closely linked with the early development of yacht racing and yachting maneuvers under the support of royalty. One of them was the Royal Cork Yacht Club as mentioned above and the other one was the Royal Thames Yacht Club. In 1775, the Cumberland Fleet was founded in England. It was an organization formed by a group of aristocrat men to promote recreational yachting and yacht racing on the River Thames, which was called the Cumberland Fleet .

The Cumberland Fleet was the first yacht club in that country. Their first race was organized on the River Thames in July 1775, for a silver cup that was the first Cumberland Cup put up by the Duke of Cumberland. And the Cumberland Fleet organized various regattas from the 1780's onwards near the London.

Figure 161: English School, Yachts of the Cumberland Fleet starting at Blackfriars, London

Through the 18th century, yacht racing gradually took hold among the wealthy and the aristocrats and the culture of recreational sailing spread to Europe. Yacht clubs established around the world in the first decades of the 1800's. In England in 1826, the Royal Yacht Club of Cowes, later (1833) the Royal Yacht Squadron organized a race that was the start of what became Cowes Week.

While yachting appears to have originated in Europe, much following development occurred on the east America. American yachts derived from working boats that were generally schooner type of boat. These types of boats were seen firstly around the end of the 18th century. Americans have the reputation of developing some speedy craft. The first American yacht was the Francy that based on Dutch model with spanker gaff sail and very short jib. After That The Crowinshields who was Dutch origins started to build a sloop rigged yacht in 1801. This rig system was very faster than the others and Cleopatra's Barge, the Diver, the Trouble and The Double Trouble followed the Francy.

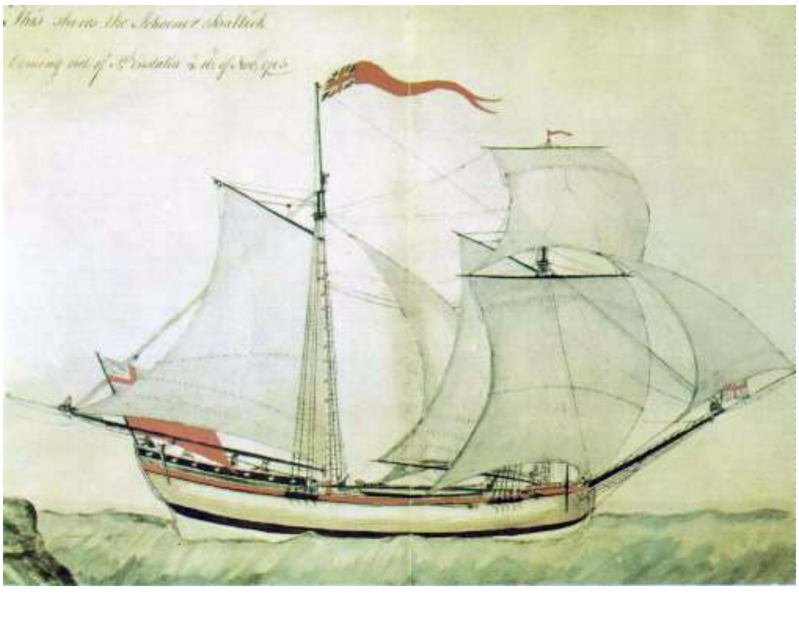


Figure 162: Typical of Coastal Topsail Schooners

Cleopatra's Barge was especially important because she was designed and build as a complete pleasure boat. And she rigged a s brigantine-schooner which means she has square-rigged on fore mast, fore-and-aft spanker on the main mast. In 1817, her owner crossed the Atlantic Ocean with her. It was the first because she was a recreational yacht that had derived from design of French working boats. She was the first American ocean-going yacht. The keel was straight and the hull had very full sections at the prow that tapered towards the stern.

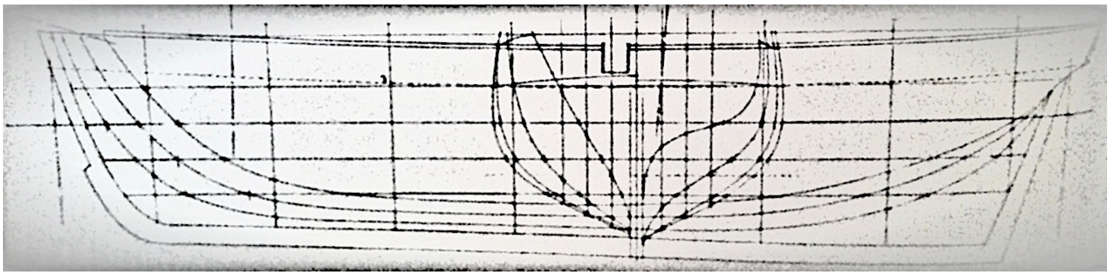


Figure 163: The Lines of Cleopatra's Barge, AD 1817[1]

Yachts developed during the first half of the 19th century in America. New ideas, new lines and new technologies was increasingly developed. In 1811 new centerboard system developed by Brothers Swain. They wanted to improve a boats' ability to sail into the wind. After this invention, the best designs of the American yacht history were the Onkaye and the Maria that designed and built by the Stevens Family. Stevens used "centerboard" system for these two yachts and they were in deep differences with Cleopatra's Barge.

The Onkaye, which was the first centerboard yachts in America, had different and innovative modern line. Her form was like a wave through the water. Ballast was very

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[1] Cleopatras Barge's hull was over 101 feet (30 meter) long, 23 feet (6,9 meter) wide and displacement of 192 tons.

[1] The United States won every America's Cup (the event is irregularly held) between 1851 and 1983, when it was won by Australia. In the 1980s and 90s radical changes in boat design and charges of

low so it provided great stability. It was located in the lower part of the U shaped section of the hull. She has long keel and only traditional part of this design was her schooner rig, which was added a boom on foremast. Main idea of this design was to create a fast recreational yacht.

The Maria was the fastest boats in American waters. She was the second design of the Stevens Family. They developed their researches and ideas and created an advanced model of yacht, which was inspired by The Onyake but had different sections. She was also the centerboard and her stability due to the wide of her sections. The Maria was designed to be light including all spaces, tools and rig. She had a sloop rigged and hollow mast, bowsprit and boom used firstly in the history of yacht design. The Maria has been renewed after her first voyages because she lost her forward part of daggerboard with a part of ballast. Stevens created her daggerboard again and he applied the ballast externally for the firs time in the history. It was a big challenge for yacht design history. Historical Reports indicate that even in light wind, her speed had reached seventeen knots.

Figure 164: The Sloop Maria Racing the Schooner Yacht America by James E Buttersworth, Painting, 1817-1894

During the 19th century, the types of yachts had been developed in America that was derived from fishing "sloops", but in England, many British yachts derived from pilot boats, "cutters", that was very common yachts in British waters. "Cutter" and "sloop" were used to define boats, which carried by big ships. The common point of these boats was their origin, because both of them were Dutch. But they have different characteristics. Main characteristics of sloops were very broad hull with a very low draft and centerboard provided and ability to sail against the wind. The large spanker sail applied on a single mast with no gaff-topsail and boom jib. The sloop's stability was stronger due to their rig system, width of hull and ballast at the keel. On the other hand, British cutters were quite narrow and they had deep draft. Cutters had single mast with two or more foresail and a long bowsprit for carrying more than one jib. Their hull shapes developed to make them faster and maneuverable but they still were not extremely fast .

2.2. Modern Racing

2.1.1. The Advent of Modern Racing

Europe began sailing for pleasure, especially racing throughout the 18^{th} century, but Americans had to wait until 19^{th} century to race between yachts because of their war of independent. Through the 19^{th} centuries, racing spread throughout the world owing to yacht clubs. And it was common for sport sailors to join together for social and recreational purposes in groups known as yacht clubs.

The world's first such club was founded (1720) at Cork, Ireland. The oldest club in the United States is the New York Yacht Club (NYYC) was founded 1844. By the 1870's, influential clubs had been established in all over the world depending on development of yachts. Yacht clubs was a social phenomenon. They were not only the club, which organized a sporting activity but also the supporter who contributed the spread of recreational sailing and racing. Gibraltar, Stockholm, Hobart, New York, Bermuda, Mumbai, Ostend, Toronto, Nova Scotia, Rotterdam, New Orleans, Auckland, Hamburg, and Genoa Yacht Clubs generated high standards of racing. By 1880's, there were lots of serious sailors involved in racing for the formation of the Yacht Club in England.

Yacht racing is an hard and extreme sport, especially in long-distance events, began in 1851 when the New York Yacht Club (NYYC) built a 102 ft (30m) schooner was named America. In 1851, the America came to England and raced British yachts around the Isle of Wight for the One Hundred Guineas Cup. After the rout, they revolved their race to the NYYC. It became the America's Cup, giving its name to the oldest and prestigious race in international sailboat racing. And the America's Cup was born.

The America was seen as harbinger of the period of modern offshore racing. She was designed by William Brown and built for New York Yacht Club (NYYC). She has perfect bows, low freeboard and raked masts and beamy hull form and was really fast yacht because of her individual features. The concave bow section was very innovative. Another innovative touch was about to location of the maximum wideness of the hull. It placed the middle of the hull's length and steers placed the America's widest section well aft.

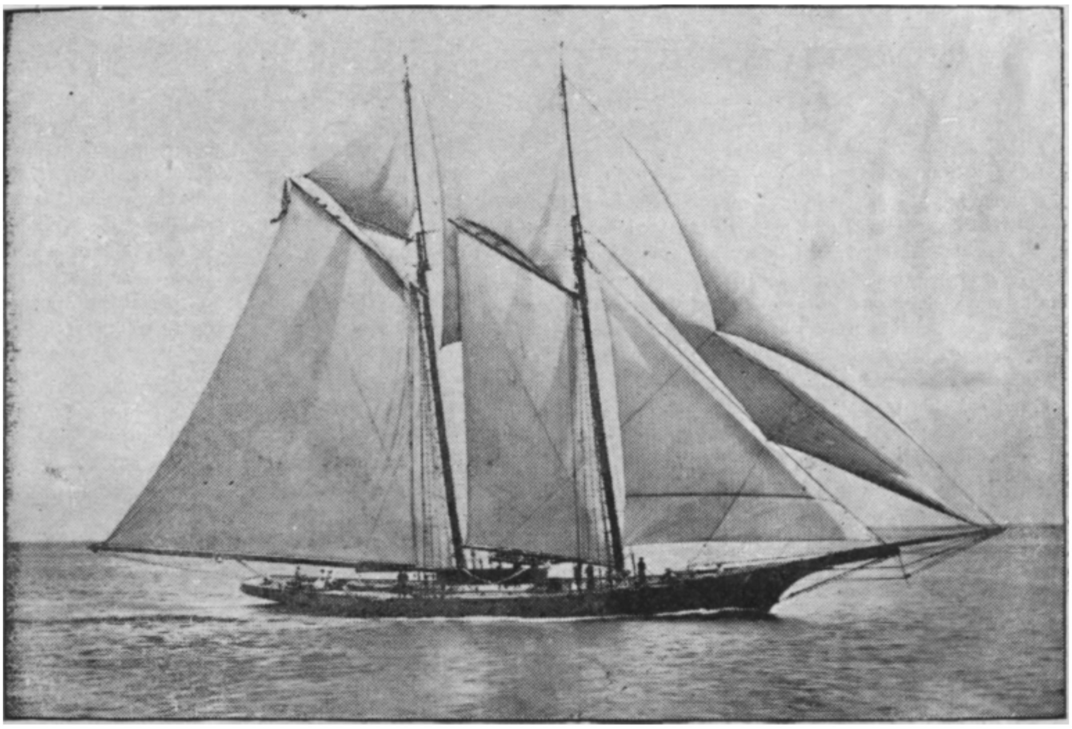

Figure 165: The America, designed by William Brown, 1851

All new design features of the America, which related with her speed, did not lead any tangible change in yacht design in Europe when the America won the One Hundred Guineas Cup in England. It was the first race between America's schooners and Europe's cutters. Despite all new design innovations, which European designers seen about the America, they continued to build their bluff-bowed yachts. But she influenced the British cutter the Alarm, which was passed by the America in that race. The Alarm was re-rigged as a schooner because of the equality. For the One Hundred Guineas Cup, an individual handicapping system allowed and different designs of yachts raced together under specific calculation methods.

After this race, the “One Hundred Guineas Cup” was retitled as “The America's Cup”. The United States kept it until 1983 when an Australia put an end to the New York Yacht Club's 132 year-long invincibility.[1]

In connection with the establishment of “yacht clubs, organizations of regattas and their rules” influenced to design of offshore yachts. In 1876, more than 400 races, which included classes of schooners and yawls and cutters, were actualized. There was a plethora, because in 1856, there were only 63 races actualized.

Yacht design saw rapid development after these expansions and some rules and measurements applied to the racing activities for equality of different types of yachts. This sport was started to conduct on a uniform system, the Yacht-Racing Association, founded in 1975 and drew up simple rules for the regulation of the races. These regulations were accepted by yacht clubs. And designs of yachts were adapted or prepared according to these rules. 1886 was foremost a time of increasing competition between designers. Some yacht design offices were founded in Europe. And America. One of the important people was George Lennox Watson who established the first

[1] The United States won every America's Cup (the event is irregularly held) between 1851 and 1983, when it was won by Australia. In the 1980s and 90s radical changes in boat design and charges of espionage and even sabotage roiled Cup competition. The United States regained the Cup in 1987, then lost it to New Zealand in 1995. New Zealand successfully defended in 2000 but lost to Switzerland in 2003. Since 1992, a new class of longer, lighter boats carrying more sail on a higher mast have been used in America's Cup races.

drawing office designed purely boats for pleasure and sport in Glasgow, Great Britain.

A Scottish Royal Clyde Yacht Club chose George Lennox Watson, to design an America's Cup challenger in 1887. His pleasure yacht the “Britania” was one of the most successful British yachts of all time. She built for Commodore Albert Edward who was the Prince of Wales and served him and his son, King George V for their long racing career, in 1893. She was a successful racing yacht. The “Britania” was designed according to the “length and Sail Area Rule” as the first class cutter and was launched on April 20th, 1893. By the end of the first year’s races, she had got thirty-three wins out of the forty-three starts. In her second year, she won all seven big class yacht races on the French Riviera. After the European races, she beat the 1893 America’s Cup defender “Vigilant” in her first America’s cup race on Vigilant’s home water.

Figure 166: His Majesty's Yacht Britannia (George Lennox Watson, 1893 - photography: Frank William Beken, circa 1920s)

After that, in Europe, Charles Pole Clayton, Arthur Edward Philip Payne, John Beavor-Webb, Jr., Alexander Richardson, the William Fifes and Joseph Manston Soper were all ambitiously working on their yachts according to new race rules. As we mentioned before some rules and measurements applied to the race activities for equality of different types of yachts starting from 1875. It was the “Length and Sail Area Rule” was specify by Yacht Racing Association. The rules and the measurement were named the “1730 rules” which used in small-boat racing. Both Europe and America used this handicap system for racing activities.

The new measurement enabled vessels of extreme length, depth, and design. Characteristics of design started to chance after this system. Greater width and less depth entered into the design literature. The yachts of this period were often six times longer than she was wide, with ballast often placed outside the keel, a concept first developed to great effect by Watson with his Majesty's Yacht Britannia.

Figure 167: *lines, sections, interior plan of the Britannia*

During this time, American racing fleet increasingly developed. In 1863, John B. and Nathanael Herreshoff, who founded the Herreshoff Manufacturing Company in Rhode Island in America, were also specialist brothers. Between 1893 and 1914, the Herreshoff Company designed seven racing sloops, which were advanced, fast and powerful yachts. Five of them won the America's Cup. In summer 1891, The "Gloriana" that has to be considered one of the first American Modern racing yachts slipped into water.

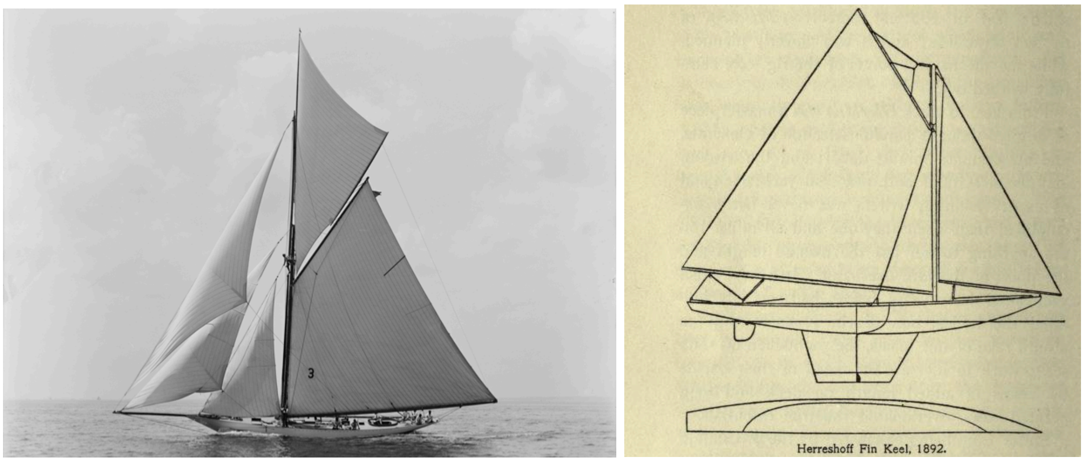

Figure 168: the Gloriana, British Cutter, 46ft (13,8m) sloop, (Nathanael Greene Herreshoff), 1891

She exactly was not cruising yacht, only an steel structure and double planking in pine to save weight and enable %60 of the displacement to take the form of very short ballast set low down. But she carried more canvas than the other boats as soon she began too heel very pronounced overhangs at both side stem and stern dipped and increased buoyancy. In light winds Gloriana had very small wetted area but in hard winds she settle in the sea. Her overhangs provided to propulsion at both side . She had stability of form but her draft was like a British cutter. These different specialties were won her seven races out of seven.

After “the America’s uptrend and improvement of Gloriana, similar yachts which were the Reliance, and the Atlantic were added to the modern offshore racing fleet of America. They designed for wealthy men, in the mid 19th and early 20th century. All of them were innovative and successful yachts. They were very extreme designs by their period.

The Reliance was longest and most important America’s cup yacht. She was 144 ft (43.8 m) overall but had very short, 89 ft (27.3 m), waterline. Her length considered bowsprit and very long bow, long-hangig stern was about 50 ft. (15.2m). The Reliance was an exactly racing yacht, created to represent and win the America’s Cup in 1903. She needed a crew of 66. Her topmast sprit was 189 ft (56.7 m) above water and had low hull form, which was made from steel frames.

Figure 169: The Relice,The Worls Largest Sloop 1903

After the Reliance, “the Atlantic” designed by William Gardner in 1903 that was the 187 ft (60 m) American schooner. She had three masts and 18,500 sq-ft (1719 m^2) sail area. She raced in the Kaiser’s Cup Transatlantic Race of 1905 and set the record of “fastest transatlantic”. In one 24-hour passage Atlantic, she sailed 341 nautical miles (642 km) and finished the race in only 12 days 4 hours. It was an amazing distance that clocked until that time.

Figure 170: The Atlantic , Three masted American Schooner,

In Northern Europe, in 1905, king of Germany, Kaiser Willhelm II, organized a race across the Atlantic Ocean, named Kaiser’s Cup. Eleven yachts attended the race including Kaiser's yacht Hamburg and The Atlantic. The Atlantic won this race with a speed record as mentioned above. In 1910, important German designer Max Oertz had been responsible for design of his new and last yachts which name was Meteor IV.

After that Oertz designed, in particular, between 8 and 10 m. boats that started to popular in the world. Small boat racing has gained more importance. Also in America, in addition to the all-majestic yachts, Herreshoff created a range of small yachts starting from 1891. Right after the majestic yacht Gloriana, first finn keel yacht of world, “Dilemma” which has ideal form of launched by him in October 1891. During the design process of Gloriana, he realized three functions about the design, speed and stability of yachts like as; relation between weight and volume (supporting the weight with suitable volume), countering the leeway with a keel and balancing the heel introduced by the wind on the sail with ballast. All these functions combined into one single form according to him. He created ideal form with a minimum wetted surface and minimum friction. In addition to that he added a sheet of steel to counter healing and hung a bulb which shape was like torpedo in the lead from this as low as possible to act as ballast. Her over all length was 11.58 m., waterline length was 7.72 m., beam was 2.23 and draft was 1.75m.

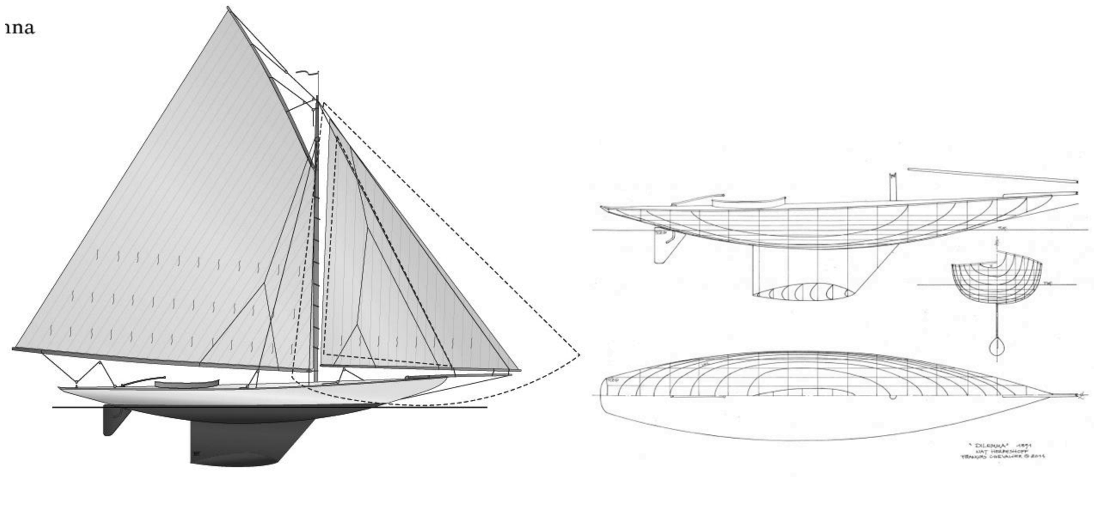

Figure 171: lines, sections, profile and sailplan of Dilemma (Nathanael Greene Herreshoff design, 1891)

As can be seen above, at the end of the 19th century or in other words beginning of century of modernity, the racing yacht became identified as science of hydrodynamics which laid the basis for a scientific approach to hull design and new materials, like as duralumin (light alloy of aluminum and magnesium) and some special steels. New materials were so important and available for designing lighter hulls and structures capable of absorbing the stress, which imposed by the first revolution in the field of sails, the disappearance of the Gaff topsail and adaptation of triangular main sails. These new spankers were named Bermudian rigs because the new masts strengthened with a system of shrouds, which no longer had the single task of keeping them upright but also of conferring form and rigidity. At the bow seemed a big overlapping foresail, the Genoa, which was beyond the mast and was superimposed over the mainsail. The genoa took the place of three foresails, which were carried before the main mast on many yachts. It has great aerodynamic efficiency. The use of the genoa was also to lead to the disappearance of the bowsprit. At the same time mechanical equipment started to use for handling of the sails. The winches used to adjust sheets. As it is seen, new materials, rigs and technology were complete engineering system at the service of modern yacht designers.

After world war I, offshore and ocean racing developed quickly. The 650 *nautical*mile Fastnet Race (Admiral's Cup) from Cowes to Plymouth via the Fastnet Rock off the coast of Ireland) was first sailed in 1925. This racing didn't cover long distances across an ocean. But, the race quickly developed due to the popularity of ocean races in England. First race was held with 7 yachts lining up for the start. It was won by the Jolie Brise, which a traditional pilot cutter. She won the fastnet again in 1929 and 1930. The Fastnet race was definitely established by the 1930's and soon became known as the most important competed ocean racing event in the world. This race as one of the toughest ocean racing challenges. The 1927, 1930, 1949 and 1957 races went down on record as being the toughest Fastnets ever.

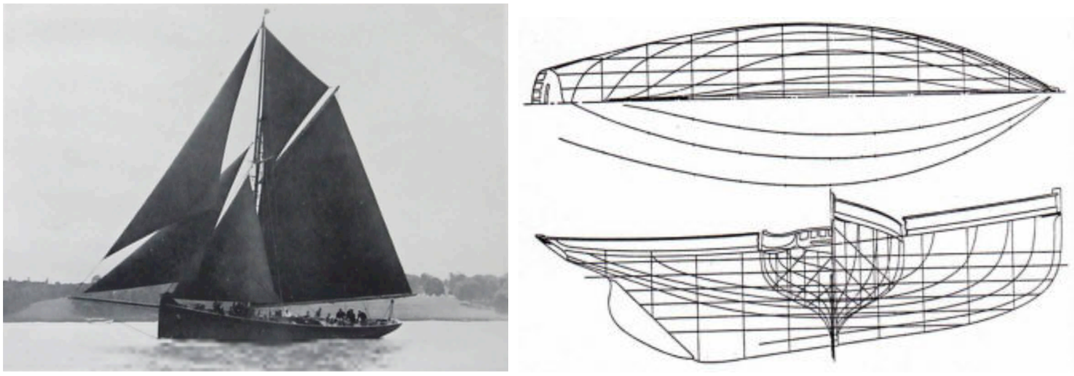

Figure 172: Jolie Brise , Gaff-Rigged Pilot Cutter , by the Albert Paumelle Yard , 1913

The 1930 race saw six American, two French and nine British yachts. But the 1931 Fastnet race saw gale force and many problems occurred for participating yachts, because of their old features. It was the end of an era for them, which were outclassed by the new yachts. The British were convinced to design and build several new yachts in order to keep the Fastnet alive. Several new competitive yachts were built to meet the American challenge and they raced in the 1935 Transatlantic race.

From 1930, Olin Stephens who was another important yacht designer of 20th century began to design all new boats with exact pointers to the future and no significant ties with the past. He was another American and his reputation was established by the 51-ft (15.5-m) yawl Dorade, was the winner of the 1931 and 1933 transatlantic races. Before that he was an assistant of Kenet S.M. Davidson who worked at the Stevens Family and worked at their company and their build process of yachts (the America, the Onyake, The Maria) He developed a system for analyzing the thrust provided by sails and coefficients essential to calculate the quantity of force to be used to pull the models in tank. In this study, he was helped greatly by studies being conducted in a new scientific field, that of aerodynamics. He only worked with Olin Stephens in that work. In future, Stephens started to do his design works.

First one was yawl Dorade. Influential on two counts, she rated well under the handicap rules used both in Europe and America, and heralded the dominance of the single section Bermudan mast over the two-section gaff rig for offshore boats. She was strikingly slender and her beam just 10-ft (3m.). Dorade was extremely lightweight. Her stability came from a different source a long lead keel that put the ballast far below the waterline. The combination of a aerodynamic-shaped hull and "outside ballast, were made Dorade faster. It was also strikingly beautiful.

Figure 173: The Dorade, by Olin Stephens 1930

Next design of Stephens was the Stormy Weather, which was 53 feet (12 m.) and was rigged as yawl like Dorade. She was completely racing boat and designed according to International Rule and she was radically different to other yachts. The Stormy Weather won Transatlantic and Fastnet races in 1935 and after she won the Bermuda race in 1936.

Figure 174: The Stormy Weather, by Olin Stephens 1934

The Bermuda Race was the oldest regularly scheduled ocean race, which started and finished in different countries. It promoted a year before the Transatlantic race that organized by Kaiser as we mentioned before as a Kaiser's Cup. It was founded in 1906 and was sailed yearly through 1910 and inspired the Port-Huron-Mackinac Race, the Fastnet Race. In 1923 Yachting magazine revitalized this race with this aim: To inspire the designing, building, and sailing of small yachts, to make popular cruising, and to develop in the amateur sailor. In 1923 race, there were 23 yachts at the start line. From 1926 Bermuda Race co-organized by the Cruising Club of America and the Royal Bermuda Yacht Club. By 1930, the fleet had become 42 yachts. Ocean racing found enthusiast where it started to spread.

During the World War II, yachting also used as a humanitarian support for the prisoners of war locked in camp in Germany. In France the Stalag Yacht Club was founded and organized regattas for yacht models built by the prisoners. And The Royal Ocean Yacht Club organized a competition for the design of a yacht of a 30 ft and 35 ft in length. (only blueprint)

In the post war period, Australian Sydney to Hobart Classic was initiated in 1945 and is sailed annually. The Cruising Yacht Club of Australia hosted it. First race, like as all those which have followed, started on Sydney Harbour, 26 December 1945, before heading south for 630 nautical miles (1,170 km) through the finish line in Hobart, Tasmania. 9 yachts was at start line in this race and 8 yachts completed the race. The Rani, which was built in 1940, won the race in time of 6 days, 14 haurs and 22 minutes. This race still continues today.

In the 1950s, Ricus van de Stadt who was an innovative yacht designer, open for new building methods and new material usage in Netherlands. He used his hydrodynamic knowledge to design a spade rudder in combination with a fin keel and trim tab. On his design the rudders were hung on the trailing edge of the keel for reducing wetted surface and redound performance. He applied this system to a 39ft (12 m.) ocean racer the "Zeevalk" which was constructed of plywood. The combination of separate hydrodynamically efficient keels and rudders coupled to the light plywood construction of the Zeevalk. Van de Stadt was one of the first user of glass reinforced plastic (GRP) as a means of volume production.

Figure 175: the Zeevalk, by Ricus van de Stadt, 1952

His knowledge of the new material carried him to the design of good sailing yachts and he continued searching for new developments. In 1955 he designed Europe's first series-built cruising yacht which was the “Pionier”.(30ft/9m.) He applied the new material of glass-fibre reinforced polyester (GRP) to the building process and he became a worldwide success. The Pionier class was a breakthrough in Europe.

Figure 176: the Pionier, by Ricus van de Stadt, 1955

After the Pionier, French designers added to a couple of ideas, especially Jean Berret, Jean-Marie Finot, and Michel Joubert-Bernard Nivelt, who preferred beamy-stern sections. Interior spaces of yachts were increased and this enlargement provided to grow small cabins, which were settled under the cockpit area.

We can summarize all developments of yacht design and production technics for 1950's: Light displacement meant lower hull weights, which cut material costs. Small jibs meant easier handling as the need to change headsails was much less. Broad sterns (from the French designers) gave more living space. In addition to that in the post war II period European designers adapted their yachts the RORC rules in Europe. Because the rating systems always affecting the performance of yachts. From 1957, the Fastnet was included among the races of a new event organized by the RORC, The Admiral's Cup, a kind of world offshore racing championship for national terms. First Admiral Cup had two national team, America and Britain. In 1959, original two team joined by France with Eloise II., Marie-Christine II. And St. Francois and Holland with Zeevalk, Zwerver and Olivervan Noort.

As we mentioned above, the early 20th century could be defined as the Herreshoff Company era, the 1950's new production technics discovered by Ricus van de Stadt. The early seventies were still dominated by a great designer Olin Stephens. Early 1960's another designer Dick Carter who designed the Tina. The Tina dominated lots of regattas. She was a wider and lighter than designs of Stephens, with a rudder set well back. This feature that was to become widely adopted on the leading yachts of the following decade. After that he designed enlarge version of Tina in 1971. This yacht's name was the Gitana V that raced in Admiral's Cup in same year. Stephens bring up his students German Frersand he designed evolutionary lines for racing yachts.

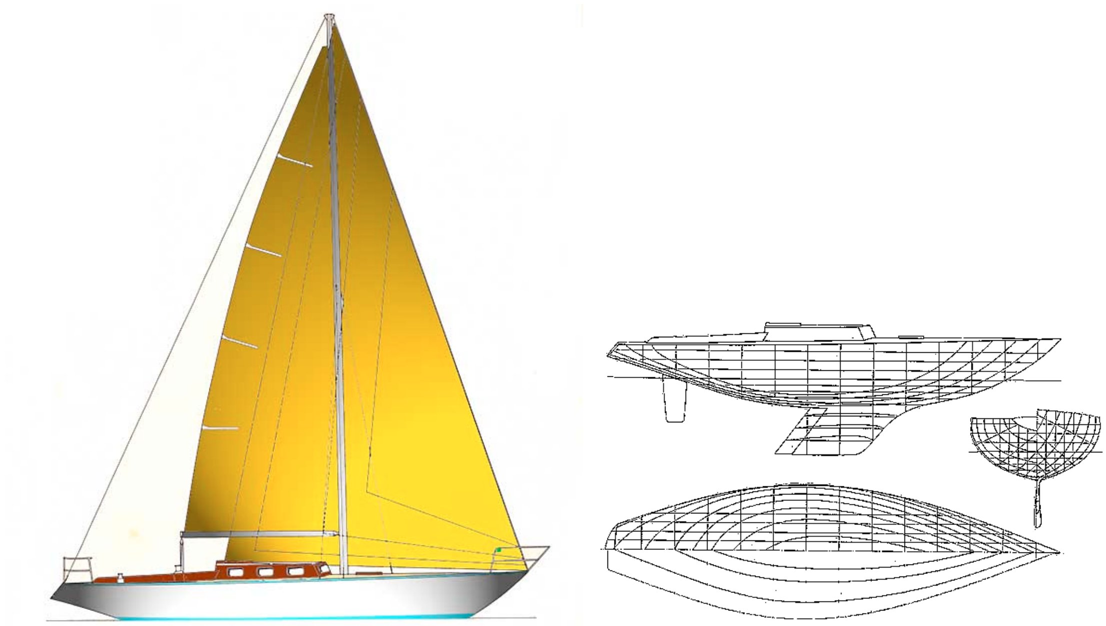

Figure 177: The Tina , by Dick Carter, 1966

Frers designed the “Recluta” in 1970,Bob Miller designed the ”Ginko” and Gery Mull designed the “Improbable” in same period and mid-point of their designs were external rudder, flush deck and flat bottom.

The 1970’s had seen evolution on hull, as we mentioned above, conditioned by the application of IOR regulations. According to tis rules; the classic yachts had given way to light displacement boats with considerable width at the mid-ship section, load bearing stern exist and hulls flat under the keel. The yachts of Carter firstly and then the French with “Finot” and “Revolution” and lastly the New Zealanders such as Farr and his “Gerontius”

An ever increasing range of materials and designs has seen sailing develop rapidly over the last 100 years, with mass-produced boats which was named one-design helping the sport spread into all corners of the globe The development and popularization of all types and class of yachts have pushed back the boundaries for sailing's thrill seekers, while the Olympic Games, the America's Cup and increasingly the great ocean races and record breakers continue to provide the sport with new designs. Modern racing boats, such as dinghies, smaller and larger keelboats, and multihulls, fall into two broad categories: one-design classes and development classes. Classes specify factors such as hull dimensions, construction materials, boat weight, and crew weight and number. One-design boats within a particular class have a virtually identical design governed by strict rules. Good examples of one design boats are the Laser singlehanded dinghy, the 49er two-man skiff, the Melges 24 keelboat, and the Farr 40 keelboat. In one-design racing, results depend largely on crew performance. Development-class boats vary in design and construction within a given class, according to specified parameters. And the other hands major ocean racing events include the Newport-Bermuda Race, the Transpacific Race, and the Volvo Ocean Race (formerly the Whitbread Round the World Race) and the Golden Globe. Today's ocean racers sail advanced yachts and are aided by such modern technology as sophisticated communication devices and satellite-generated weather reports.

2.2.2. Offshore Sailing Race Management Systems and Rules

Speed is the most important things for racing yachts and many design elements have large impact on speed. These elements are size of a boat's sails, length, weight and shape of yacht’s hull and material. Because of all these difference elements, comparing the yachts is difficult in a race. In early times this plurality created a lot of problems when yacht clubs wanted to race each other. Today, lots of yacht racing are being organized and they were categorized by certain yacht clubs in history. They solved this problem with four solutions. One of them is “one design” system which include an identical yachts. The other one is a “handicapping system” which includes different types of yachts allows them to race together. Third one is “open class”, which defined by a “box rule”, permits any design. And the last one is “construction class” that based on a formula. Measurements of yachts of this class have to fit to be accepted.

In one-design racing all boats have to comply to the same specific standard. All classes has a set of specifications that detailed with every single design elements and features of crews.

But in important regattas, the yachts are measured extraordinary for only that event, to guarantee that they adapt.

An open class is defined as a box rule that identifies a maximum overall size for boats in the class. , In this class of race, challengers are allowed to submit their own boat designs. They have to adapt the box rule but they have no handicap, which have to be applied on their boats. These races are mostly limited to high-budget yachts. Open 50 and 60 classes are most known offshore events, which is in box rule.

A construction class is based on set of restrictions; these boats are all exclusive and close in performance, size, cost and features. The most important construction class race is America's Cup and the most universally accepted construction formula is “The Metre Rule” in the world.

If all the yachts are not members of the same class or same features in a race, a handicap system is engaged to correct the race times of boats. The handicap system specifies a normal speed for each yacht. Each year, yachts are measured and these measurements are calculated to find out their rating coefficient according to its size, weight, tools and other features. And yacht clubs know all rating coefficients of each participant yacht. Each boat competes in the specified course in specified time. After all of them have finished, the handicap system and rating coefficients are used to correct each boat's finishing time.

Today, the well-known handicapping systems are PHRF, Portsmouth Yardstick, IRC and ORR. Before that, IOR and IMS were used by yacht clubs.

If we examine the history, almost the whole of the 19th century, yacht rating system were based on tonnage of the yachts. Especially in Britain the formulas, which defined the tonnage and rating, were measured with length and beam ignoring draft. For this reason, this tonnage system created very narrow hulls with a deep draft. During this time, in America, displacement is much more important than the Britain. According to them displacement determined the effective weight of yacht and they created broad and shallow hulls. But both, wide and shallow hull of America and narrow and deep hull of Britain had some problems and these two countries adopted their yachts to the formula of Dixon Kemp who was a British architect. According to him length and sail area related each other.

Early in 20th century, the British created new measurement system, which described as the “first linear rating”. In 1907, it accepted as “International Rules” by Royal Yachting Association (YRA) and European countries in Paris Conference. In this conference, participators described not only the measurement rules and ratings but also racing rules and construction regulations. This linear rating was very complex system. During this conference, the International Yacht Racing Union (IYRU) founded in Paris. The IYRU included yachting clubs from many European country.

But America didn't accept the first International Rule and used the Universal Rule formula created by Nathanael Herreshoff. He developed another linear formula, which included relation of displacement and rating. His formula explains the inverse ratio of these elements: "the higher the displacement, the lower the rating and the greater the handicap."

Out of the International and Universal Rule has come the Meter Class Rule about the same time. This class includes different "meter rules" which are 23, 19, 12, 10, 8, 7, 6 and 5 meter. !2 meter rating belongs to America's Cup and 23 meter "J Class yachts" are still using today. Also the 6 and 8meter class racing events still happening today and these yachts are being built.

At that time, because of the different rules, yachts were built to different rating measurements and standards according to the rating formula system under which they were due to compete. These two formulas were integrated in 1970 as International Offshore Rule (IOR). It was a fusion of the American CCA and the British RORC system seemed to have put and end to the problems of yachts of different types, size and weight racing together. After that, International Offshore Rules come into universal use but,the IOR length was used to calculate a time tolerance in a handicap race. In Europe this was computed on the period of the race, in seconds per hour. It identified as "Time on Time", however Americans chosen to base it on the distance of the race, as seconds per mile, It identified as "Time on Distance which is easier to compute at all point in the race.

The IOR measurement focused on hull shape, which defined with its length, beam, waterline and wideness measurements, boom and mast measurements, and yacht's stability. These measurements and penalties of yachts were used to calculate the handicap number, named an IOR rating. According to ratio of IOR system, “The higher the rating, the faster the boat”.

Also the IOR rule allowed wide and short boats with limited stability. A short waterline and broadly beam on deck, combined with a strong gravity. It means that crew weight ensured an important ratio of stability at small heel angles.

Towards the end of its life the IOR had become a stable rule, but by then it had a reputation of changing too often, and this sowed the seeds for its successors. IMS was introduced as a more scientific rule for racing yachts, driven by the USA, whereas Channel Handicap was introduced by the RORC as a simple club level rule that would hopefully feed people into IOR racing - though in fact it proved to be the final nail in the coffin for the IOR rule.

In 1990’s International Measurement System (IMS) rules replaced the International Offshore Rules (IOR). The Offshore Racing Congress (ORC) manages it. IMS uses a computer-aided program named a “velocity prediction program” (VPP) to forecast yacht performance. It is very important program, which integrated yacht’s hull form information for predicting yacht's speed. Especially yachts’ owners who want to design new yachts for maximizing its performance under the rules prefer this program. The velocity predictions based on basic physics that’s why IMS isn’t a performance based handicapping system.

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But only the most expensive yachts were able to gain a significant technology advantage. Smaller yacht owners started to feel disadvantaged under this rule. Starting from 2003 to 2007 a lot of handicap racing around the world changed and they started to use the newer IRC rule.

IRC is a newer system of measurement and handicapping, which classifies a wide-range of cruising and racing monohull keelboats for races. These system offering ratings containing single type toleration based on time and weight. The procedure of a handicapping rule means that the yacht hailed as the "winner" of the race may not be the one, which crossed the finish line first. The Royal Ocean Racing Club in the United Kingdom and Union National pour la Course au Large (UNCL) manage it. Any mono-hull yachts could be applied IRC, which considers some features like as carbon masts, asymmetric spinnaker, water balance and canting keel. These elements, which have been endorsed for several years, redound performance of yachts. The rule processes are private and calculation is keeping secret. Only UNCL in Paris and RORC Rating Office in UK know this calculation and issues IRC certificates. This privacy of the IRC rule inhibits designers designing their yachts to the IRC and effectively inhibits uselessness. The IRC rule is evaluated every year according to new developments, results of previous year and inputs from the users.

This system includes 3 types of certificates, which are Standard Certificate, Endorsed Certificate, (Endorsed) One Design Certificate. All these certificates include limitations of the hull, hull appendages, spars, rigging, all gear and sail measurements. Standard Certificate is based on owner declared information, designer data, but Endorsed Certificate is based on confirmed data from a certified IRC measurer for hull and rig data and a certified sail measurer for sail measurements. A certified IRC measurer is required for Endorsed Certificate. IRC One Design Certificates are open for yachts in classes recognized by the IRC. Only security issues, which are number of crew and safety equipment, is related to crew in IRC rule. All other information is related to structure and material of yachts.

From RORC, they support not only their domestic racing fleet but also in Portugal, Australia, Ireland, Singapore, Malta, Thailand, Honk Kong, South Africa, Italy, Spain and other countries in Mediterranean. Their total fleet was 5525 in total in 2011. [1]

[1] RORC Rating Office : www.rorcrating.com

2.3. Offshore Races, Yacht Handling and Team Organizations

The modern racing sailboat is light, fast and exciting to sail. The term new "racing yacht" is known as yacht with attractive shape design, light materials, technological sails, bowsprits and symmetrical / asymmetrical spinnakers anymore. Most racing yachts have a narrow and long fin keel with a big bulb at the bottom. This hull paired with a large technological mainsail. These new racing yachts (keelboats) have added a new encouragement to the sport of sailing and teams have new challenge of negotiating the racetrack in a fast, lightweight and technological yachts. So it presents new challenges for racing which includes starting, tacking. cybing and general sailing of the yacht below maximum speed in different environmental conditions. . In addition to the technical specifications of new racing yachts, these challenges need most efficient crew on board and most usable tools for them.
Because they need to move fast on deck and need to reach and use their tools and rigs easily. "Efficient Usability" is most important thing for design of racing yachts. During the design process users' feedbacks guide designers and they use different methods for evaluating users' experiences.

One of the most known methods is User Centered Design. User centered design is a feasible process which includes users' feedbacks, activity records, surveys during a development life cycle. So, firstly, racing activity will be defined with maneuvers in racing term. After that team members and their tasks will be explained and finally each maneuver will be detailed with each task: where is the location of each users during the maneuvers, what is their maneuvering positions one by one and which tools are they used by them at that time and how do they use these tools and equipments efficiently. Yacht design is complicated applicative sector because every project has to deal with the varied system of limitations, which forced by the user (from physical/dimensional limitations to psychosocial limitations) and with complete efficiency of the “system of yacht” (from engineering limitations to organizational and basically functional limitations of the several maneuvering positions and equipment). This information that will be defined step by step will base racing yacht design process.

2.3.1. Anatomy of Offshore Sailing Yachts

Most modern yachts are made from low maintenance glass-reinforced plastic (GRP), or fiberglass. The main on-deck area for the crew is the cockpit, from where they control the sails. Most cruisers have a cockpit table and comfortable bench seats for relaxation. Forward of the cockpit, the coachroof provides headroom for the main cabin below. Guard rails run down both sidedecks to the foredeck, passing through vertical stanchions fixed to the deck; they are connected to rigid metal rail structures at each end of the deck the pushpit (at the stern) and the pulpit (at the bow). The sails and masts of virtually all modern yachts have a Bermudan rig arrangement, with two sails and a single mast and boom.

Figure 178: Bermudan Sloop Rig, Photography by Seden Erdi Hazarhun, 2011

Auxiliary power is generally provided by an inboard diesel engine, which is economical over a long distance at a steady cruising speed. The engine is vital when docking the boat in a crowded marina. It also charges the batteries that power the yacht's electrical systems, enabling sailors to cruise in comfort with services such as hot water, lighting, heating, and refrigeration. Electricity also powers the yacht's navigation and communications instruments.

The typical yacht hull is V-shaped at the bow and round at the stern. To keep it upright, the hull has a heavily ballasted keel bolted to the underside. The keel's weight means that most yachts sail through the water with their top speed limited by the amount of water displaced by the hull. The hull sits down in the water and floats to its waterline. Modern yachts have wider hulls, with a high freeboard (height out of water) and a short fin keel. They have a large cabin space and achieve maximum performance when heeling at no more than around 20 degrees, making them comfortable to sail.

A modern yachts' bow is almost vertical, with greater volume; it has increased waterline length, resists pitching, and accomodates a forecabin.

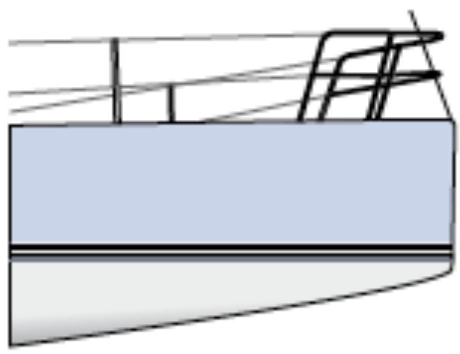

Figure 179 The Modern Yachts' Vertical Bow

Their sterns named as scooped stern, which is much, more practical than the traditional sterns. It provides a “step aboard” entrance.

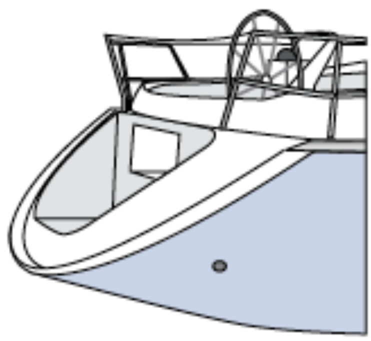

Figure 180 The Modern Yachts' Scope Stern

Modern yachts have a fin keel bolted underneath and a rudder hung on a skeg. Racing yachts have slim fin keels with a ballasted bulb at the bottom and a separate rudder.

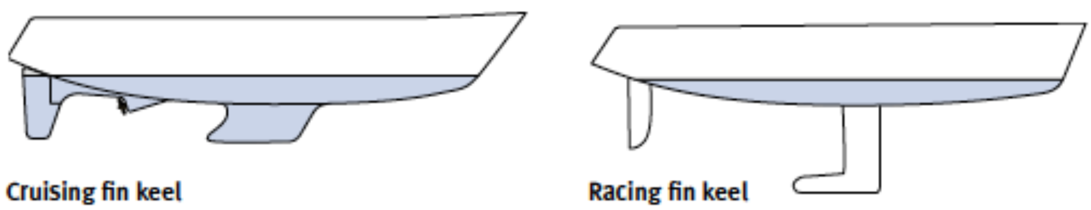

Figure 181 The Modern Yachts' Fin Keel

There are three type of boat in the literature of sailing yacht design. They are cruisers, racers and cruiser-racers. Cruiser-racers are designed for both racing and cruising performance. These are most preferred yacht type for users. Each design offers its own mix of speed, comfort, and easy handling. A light, sophisticated, expensive yacht designed primarily for racing requires a large, highly skilled crew but may also be practical for enjoyable family cruising. A heavier cruising yacht designed for both comfort and the best possible racing performance is very unlikely to challenge the performance of a pure racing yacht. On any yacht, the crew should first and foremost be able to handle the rig and its sails in all conditions. Rigs and main elements of sailing yachts can see in below. Hulls, keels, weights and all rigs on boat are strongly influenced by classification society standards, which had to be applied for being a part of offshore racing.

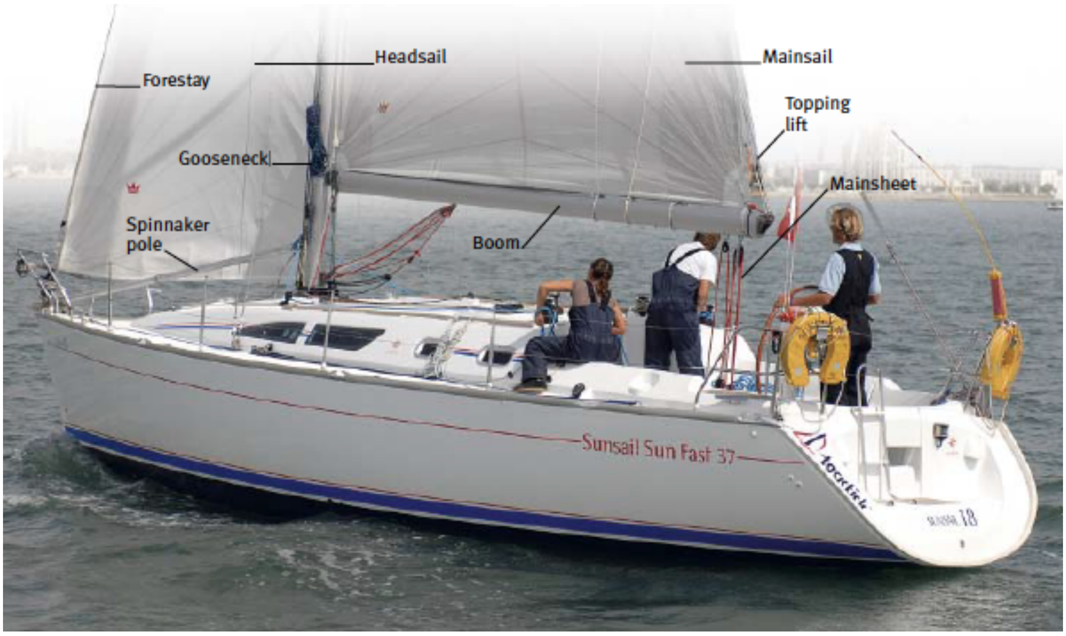

Figure 182 Anathomy of Sailing Yachts

Mast and rigging represent for sailing boats the structural system, which support the forces, developed by sails and control their optimum shape and trim; the boom mainly controls the attack angle of the main sail and it is subjected to lower loads. Masts and booms are defined as “spars”, stays and shrouds form what is known as “standing rigging”, that is the category of equipment which holds the sails, while the term “running rigging” groups other equipments (halyards, sheets) which have the function of continuously adapting the sail configuration to the changing wind conditions. The view forward from the cockpit shows clearly laid out control lines leading back from the mast, with clutches to lock them and winches to wind them in.

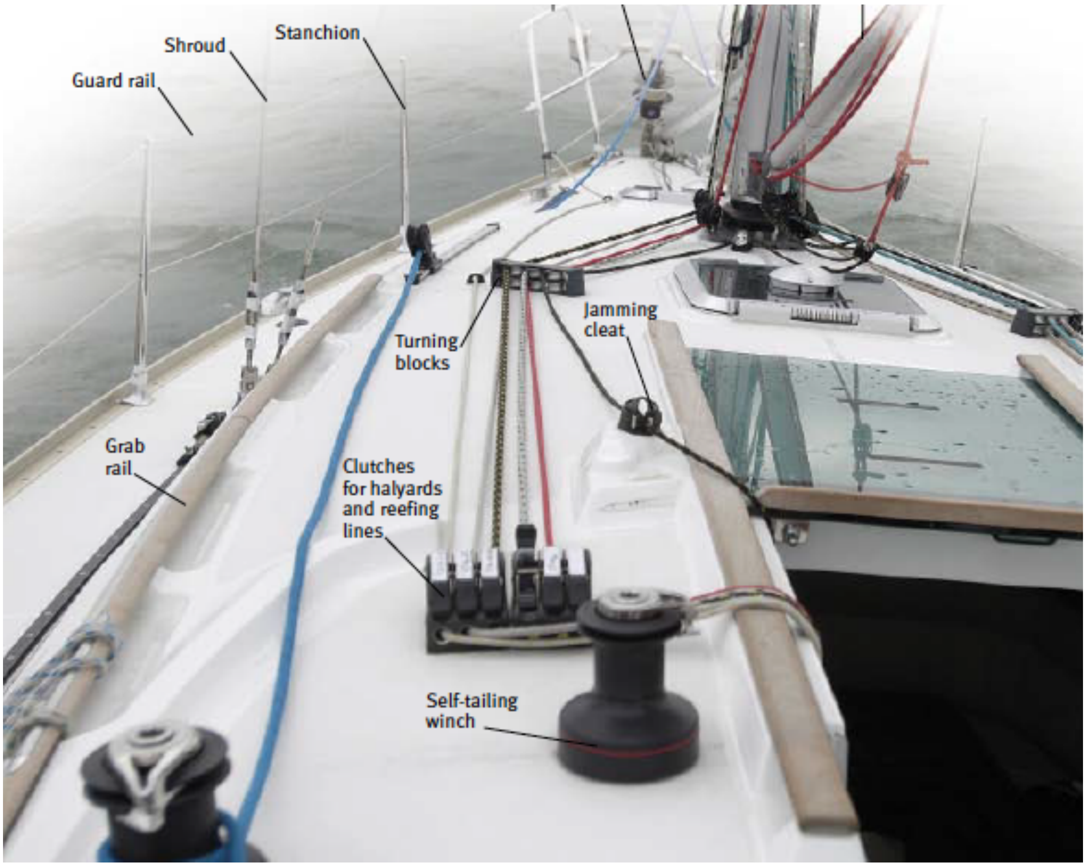

Figure 183 The view forward from the cockpit of sailing yachts

2.3.2. Basic Maneuvers in Offshore Racing

In offshore racing, the faster boat, which has individual features, as mentioned above, wins the race or at least it has an advantage. The point here is that good tacks, jibes and boat handling are very important. For example, the wind is blowing 20 knots and two racing yachts are in race. They are one-design boats, which have same features and sailing downwind at 16 knots. The first one has a bad jibe while competitor has a good. Because of this maneuver, the first one lost huge distance and speed. Crew, experiences and planning tactics is affecting whole step of the racing for each racing yachts. All boat handling maneuvers are operated by three important element; the first one is “users”, which have different tasks and different physical and knowledge-based specialties, the second is “tools and rigging” that are used for different tasks on board by different users and general technical features of yachts. All racing yachts have their own unique boat handling techniques but they are slightly different. So, the mentality of usage is same but location and number of tools and number of crew can be slightly different in each yacht.

Figure 184: Crew on Board, Fenerbahce I Team, Photography by Kaan Verdioglu

In addition to this information, tactics are slightly different in sailing yacht racing because clear air, minimizing maneuvers, wind velocity and hitting laylines at the start are more important. The typical race contains 4 main point. These are Start line, windward mark, leeward mark and finish line… Start line is between the committee boat on the right and buoy on the left, a “windward mark” is located upwind of the start line and a “leeward mark” is located downwind of the windward mark. So, the course path comprises running legs of sailing upwind, reaching the windward mark and rounding it, then sailing through downwind until the leeward mark and rounding it. This movement is repeating until cross the finish line.

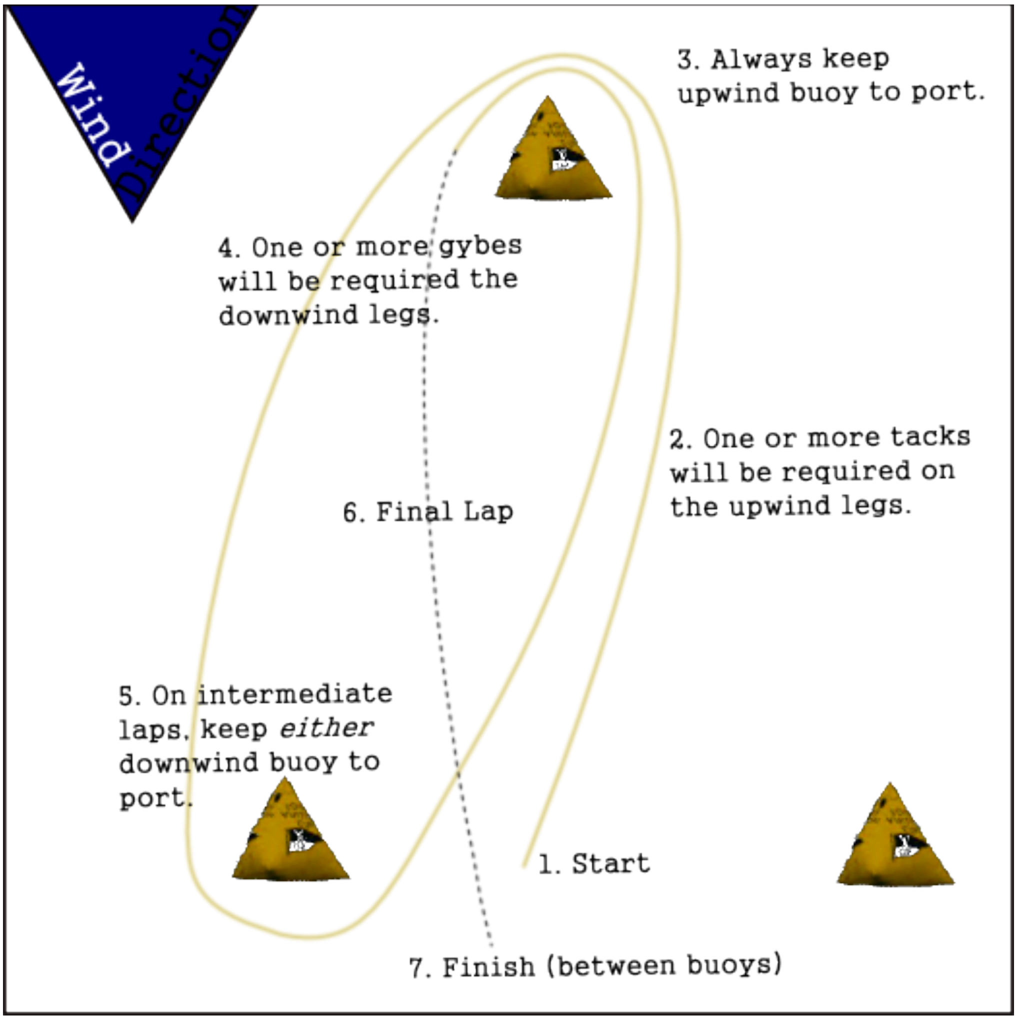

Figure 185: Windward / Leeward Course

Sailing boats cannot go directly to upwind. If its head into to the wind, sails will flip flap, the yacht will slow down and then move backwards. The nautical term for a boat in this condition is that it is “in irons”.

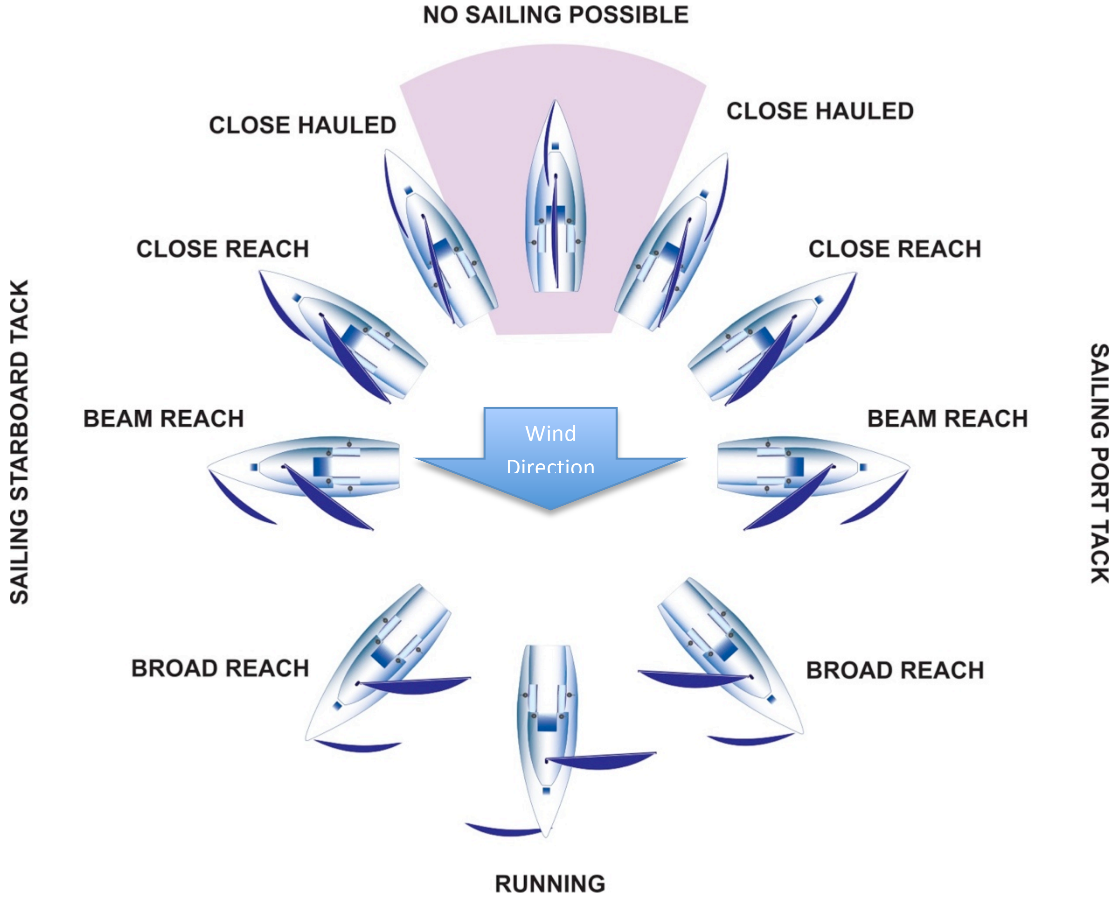

Figure 186 : Point of Sail

However, sailing yachts can move about only 45 degrees off the true wind. So, the yacht should do a series of tacks for reaching a windward mark and its movement looks like a zigzag. “True wind” is the wind speed and direction when the yacht is in a fixed position. If it is moving, the wind speed will appear to change. Apparent wind is what crew feels on the boat (true wind combined with forward progress). The yachts’ sails are designed to be highly efficient at driving the boat straight ahead, but on an upwind course there will also be a powerful sideways force on the sails that will push the boat sideways through the water. This is known as “leeway.”

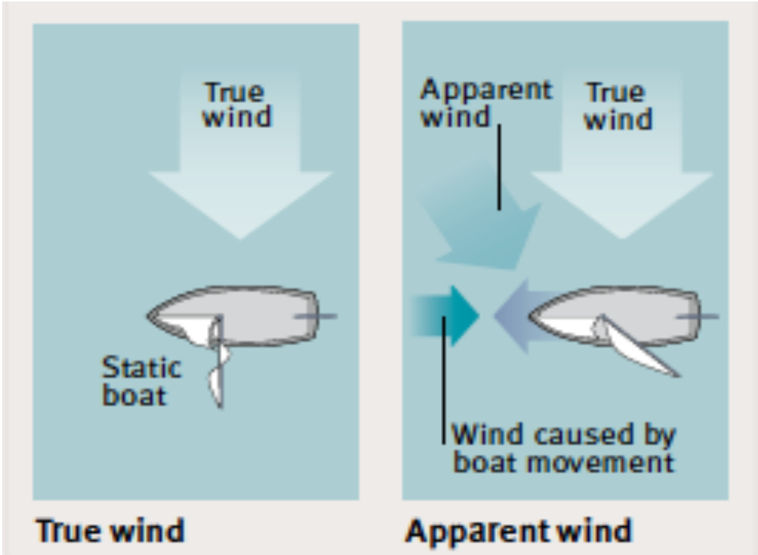

Figure 187: True Wind and Apparent Wind

A sailing boat has a foil under the hull, which resists leeway, allowing the sails to drive the boat forward instead of sideways. However, the resistance from the foil will make yacht heel with the sideways force of the wind, rather than slipping sideways. On a yacht, the keel is weighted with ballast to help prevent the yacht heeling right over, while the crew weight has limited effect. Even so, the crew stands out on a trapeze to achieve maximum leverage on the windward side.

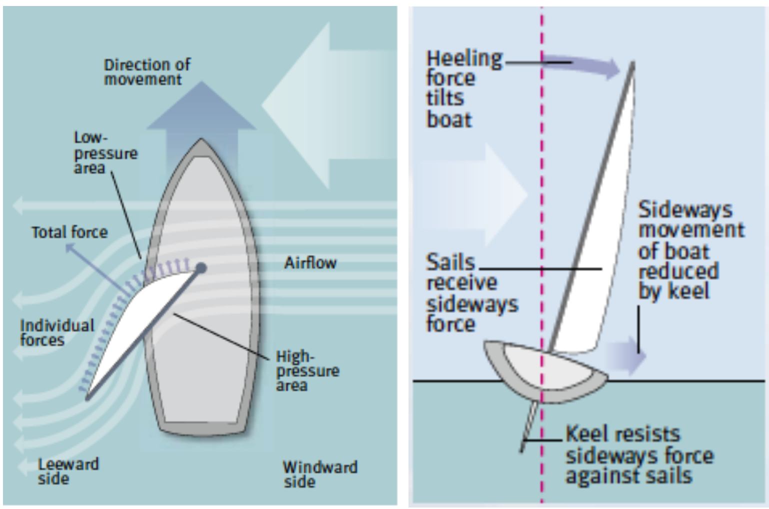

Figure 188: Wind Power

When the wind is blowing from behind the boat, sailing is described as "downwind." In this situation, there is less sideways force on the sails, and less heeling force on the boat, than when sailing upwind. With more concentrated forward drive, and less leeway, the boat should be able to sail faster. This may be helped by increased sail area from a spinnaker, which helps to blow the boat downwind at speed. In strong winds, sailing directly downwind may not be the best course. So yachts can sail directly downwind, but the users do not prefer this way. They prefer to follow a zigzag route towards downwind in a series of jibes.

The hull shape effects upwind performance, the hull must be easy to propel through the water. Even more important, it must have good resistance to going leeway, otherwise when the sails are trimmed to go to windward, the yacht will not sail forward but rather be blown sideways. Yachts go upwind with a headsail, which can be genoa or jib, and go downwind with a spinnaker. Each arrangement is faster for the angle according to the wind.

Before explaining users' task on board during the race, yacht's maneuvers should be described. As mentioned before, yachts can't sail directly to the upwind so; they need to do some maneuvers that are called "tacking" in nautical terms. While yachts sail a zigzag route towards upwind, they can follow different directions according to the wind. Close Hauled, or beating, is sailing as close as possible to the wind. Heading the yacht off or away from the wind until the wind is at right angles to the boat is "reaching". During these two courses, yachts have to do tacking for reaching the windward mark. Tacking, or going about, is simple maneuver, which means turning the boat about 90 degrees into the wind. The mainsail and jib must both be moved to the other side of the boat. Helmsman, tactician, mainsail trimmer, genoa or jib trimmer are important users of this maneuver.

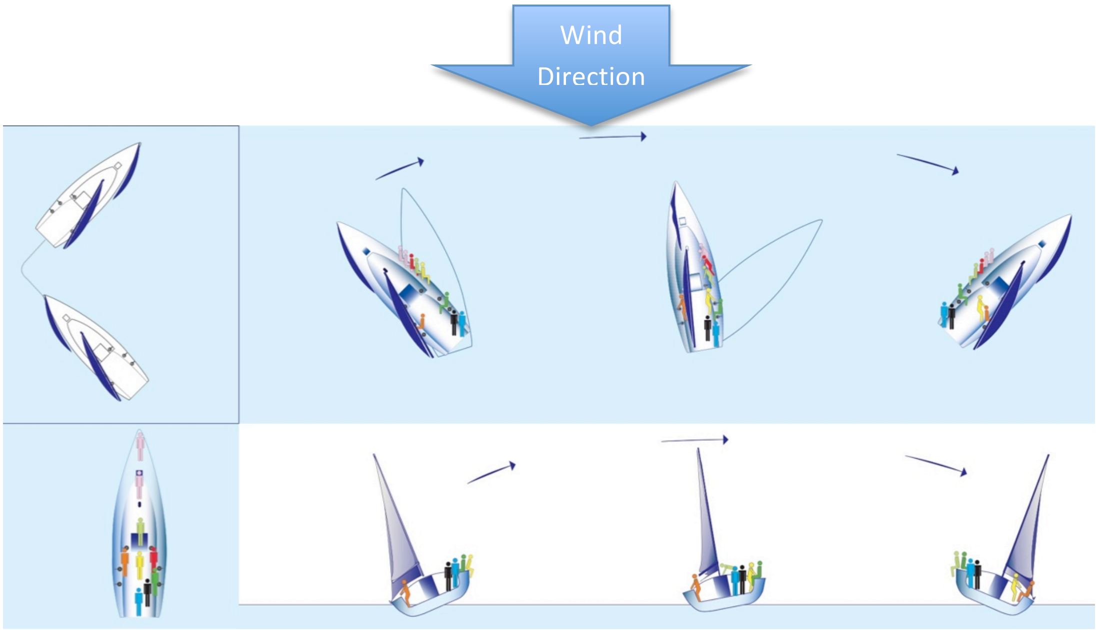

Figure 189: Tacking (Going About)

Tacking starts with the helmsman's word of command. The helmsman will let the crew know it is time to tack by yelling "Ready to Tack?" Each crew member gets into position for the tack and replies "Ready". The jib/genoa trimmer must remove the winch handle and place it in the winch pocket. Now the helmsman will push the tiller to start the turn and yell "Helms to Lee". When the boat is 1/2 way through its turn the sails will start to flap. The helmsman will yell "Break" signaling that the jib trimmer is to release the jib sheet. The pit person will be pulling in on the other jib sheet to bring the sail over to the other side of the boat. The jib trimmer will then cross the boat and start grinding in the jib to its correct position. In heavy air, the foredeck person will help pull the sail in by yanking on the clew. The foredeck person will also skirt the jib (pull it to the inside of the lifelines). Then the pit person prepares the unused winch for the next tack by placing 2 wraps on the winch and placing a winch handle in the winch. The mainsail trimmer will be adjusting the traveller car and mainsheet during the tack. The rest of the crew crosses from the old high side of the boat to the new high side of the boat.

The maneuver is complete when the pit person, jib trimmer and mainsail trimmer go and sit on the high side of the boat.

If the yachts sail a zigzag route towards downwind, again they need to turn the yacht about 90 degrees. Here the boat heading downwind and the course is changed to bring the wind across the stern. This movement is named as “gybing or jibing “. This is a much more difficult and risky maneuver than a tacking. During this maneuver, the mainsail and the spinnaker (symmetric or asymmetric) must both be moved to the other side of the boat. Helmsman, tactician, mainsail trimmer, spinnaker trimmer, mastman and bowman are important users of this maneuver.

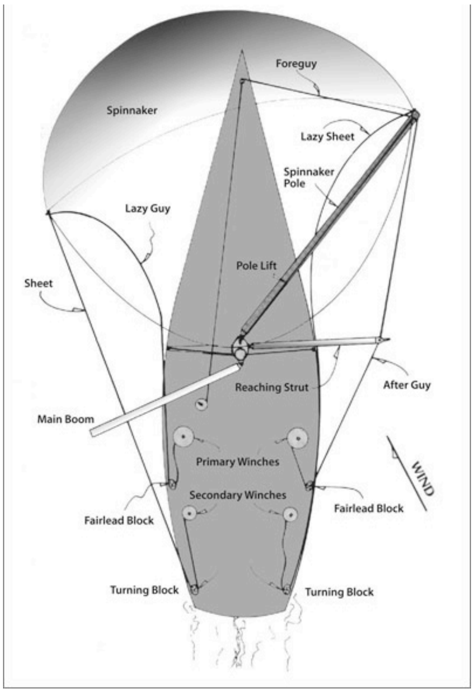

Figure 190: Spinnaker Set

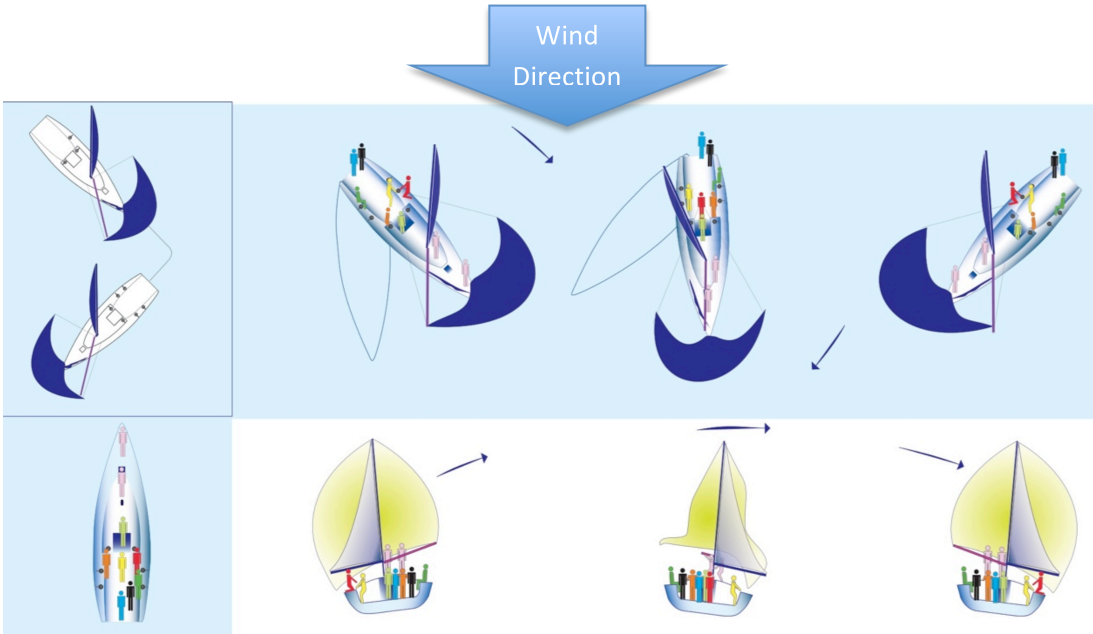

Figure 191: Gybing with Spinnaker

Also the gybing starts with the word of command of Helmsman. The mainsail trimmer pulls the mainsheet in until the boom is centered. Then as the boat is turned and the main goes limp, the mainsail trimmer pulls the boom across to the other side of the boat. Then the trimmer must be ready to release the sheet to trim the sail if needed. In a gybe, the helmsman will yell, "Ready to Gybe?" In preparation of the gybe the spinnaker pole must be trimmed back. That means the downhaul will be eased and the guy pulled as the spinnaker sheet is eased. Two people must be working together do trim the spinnaker back; the spinnaker trimmer and the guy trimmer. When the helmsman turns the boat more downwind as the two trimmers adjust their sheets. Then the helmsman will tell the mastman and bowman to go to the mast. The mastman will approach the mast from the high side of the boat (opposite side of the pole). When the mastman and bowman are ready and on the helmsmens' command, they respond with "Ready". When the helmsman starts his turn he yells, "Gybe Ho". The mastmen will unhook the spinnaker pole from the mast. When the boat is 1/2 way through the gibe, the helmsman will yell, "Break". Then bowman hooks the pole to the spinnaker sheet and then unhooks the spinnaker pole from the other spinnaker clew and the mastman hooks it to the mast. During the his/her acrobatics, the sheet and guy trimmers are working together to keep the spinnaker flying in front of the boat. Their job is not to let the spinnaker collapse. Unfortunately this is much easier to say than do. At the time the mastman hooks the pole back onto the mast he yells "Made!" That is the signal to the helmsmen that he can complete his turn and gybe the mainsail.

Good boat handling is a requirement to effective racing. The crew should be able to sail well and necessary to good boat handling is regular crew. During each maneuver, each position and task should have clearly defined for each crew. Each of them should know their responsibilities and they should do their tasks in same way each time for each maneuver. If the crew number increases, the responsibilities of them should be divided. The crew must be organized and Helmsman is needed to organize boat handling and need to concentrate on boat speed with sail trimmers and a tactician has to manage the course efficiently. As a team, they have to trim the sails, watch the instruments and wind, read the compass, watch the air condition, track the fleet, and call and listen tactics for driving the yacht efficiently in racing. The crew needs usable tools and effectual space for accomplishing these requirements. So, broad areas of responsibility, users' tasks and their tools and rigs on a boat should be defined.

2.3.3. Crew Tasks and Organization

Sailing yacht racing requires a extensive type of skills: like as sailing and boat handling skills; an understanding of wind and weather; knowledge of rules and tactics, specialized sail trimming technics, organizational skills to manage crew, analytical skills. All these skills combine with the technical features of yachts and useful and manageable tools. Crews' physical abilities, manageable tools, and confidence affect the speed of yacht during the race as much as yacht's technical specifications. The positions of the crew and their tasks are most important thing for this activity. The tasks for each position are about the same in keelboats over 30 feet. Having the knowledge of what to do at buoy rounding, tacks, gybes and getting a good position on a boat, enhance their chances of acceleration. There are nine type of user on board, which is over 30 feet:

- Helmsman / Skipper,
- Tactician,
- Main Sail Trimmer,
- Headsail (Genoa) Trimmer
- Spinnaker Trimmer
- Mastman,
- Bowman
- Pitman

Firstly helmsman/skippers must be experienced to deal with any environmental condition. The crew should also posses the ability to b e equally skilled by supporting the skipper in controlling the yacht efficiently. These users should be stationed according to their individual tools and sheets. They would be handle them clearly and should also be able to use their power to the best possible advantage. And their positions in the cockpit (on the windward or leeward rail) should be well known by them. In regular conditions, the center of their weightiness should be about the center of buoyancy of the hull (of the yacht).

In this part, over 30 ft yachts which sail with 8 to 10 crewmembers in mind will be examined and the basic crew roles; positions and tools that is used by each of them will be defined. This explanation will be based our definition of racing yacht design characteristic. User and product relation

2.3.3.1. Helmsman / Skipper

Task:

- Handle the boat in all conditions
- Completely know all racing rules
- Coordinate the crew
- Predict wind direction and to keep information of weather in mind

Figure 192:Helmsmen/Skipper and Genoa Trimmer (Team Toka-MAT12)

Preparation:

- He/she should check the crews' preparation
- He/she should confirm the course, weather and wind direction with tactician
- He/she should check safety staff for all possible emergencies
- He/she should define the crews' roles for providing crew coordination

Tools & Rigs:

- Steering wheel, navigation tools

2.3.3.2. Tactician

Task:

- Follow wind speed and direction
- Determine route and attempt to choose a favored side
- Provide helmsman/skipper with information about other boats
- Analyze yacht performance relative to other boats
- Provide leadership to helmsman/skipper

Figure 193: Tactician , Helmsman and Genoa Trimmer (Team Toka-MAT12)

Preparation:

- He/she should follow wind speed and direction
- He/she should determine line ranges.
- He/she should determine route.
- He/she should keep start time.

- He/she should track other yachts and inform helmsman about other yachts
- He/she should determine taking and gybing times.
- He/she should call time and/or distance to the line or marks for helmsman
- He/she should analyze yacht performance relative to other boats
- He/she should advise on appropriate sails and settings for the conditions

Tools & Rigs:

- Navigation device and compass
- Pencil and note pad (waterproof preferred), Rule book
- Weather radio

2.3.3.3. Main Sail Trimmer

Task:

- Trims mainsail for the greatest speed.
- Talks continuously with the genoa/jib and spinnaker trimmer and helmsman to keep both sails in the same trim mode and keep the yacht going on the correct heading and speed.

Figure 194: Mainsail Trimmer (Team UKA UKA-Melges 32)

Preparation:

- He / she should check the mainsail and securely connected on all three corners with the halyard, clew, and tack shackles wire tied.
- He / she should check all the battens secured and at the proper pressure if adjustable.
- He / she should check main sheet system and all control lines making sure everything is in working order.
- He / she should mark the settings of the outhaul, cunningham, vang, backstay, traveler, and sheet tension before racing.

Tools & Rigs:

- Main sail, mainsail traveler
- Winch, Main Sail sheet system; the outhaul, cunningham, vang, backstay,

2.3.3.4. Genoa or Jib Trimmer

Task:

- Adjusts genoa or jib for the best tactics and boat speed.
- Talks directly with helmsman/skipper about speed and height, the force in the sail, and the situation other boats and location of nearby marks.
- Talks with mainsail trimmer about boat speed and sail.

Figure 195: Genoa Trimmer and Pitman (Team ???)

Preparation:

- He/she should check the form/type of the jibs or genoa, that sail is in the correct bag, and that the correct sails are onboard.
- He/she should know the wind varieties of each headsail and the boat's target speeds for different conditions.
- He/she should check the winches and handles, backstay adjusters, sheets and spares.
- He/she should assure that the jib/genoa sheets are lead correctly.

Tools & Rigs:

- Genoa or jib set
- Winches, handles, sheets, backstay adjusters, and spares

2.3.3.5. Spinnaker Trimmer

Task:

- Adjusts spinnaker for the best possible tactics and boat speed.

- Talks directly with helmsman about speed, the force in the sail, and the situation other boats and location of nearby marks.
- Talks with mainsail trimmer about sail and speed.

Figure 196: Spinnaker Trimmer (Team Orion- MAT12)

Preparation:

- He/she should check the conditions of spinnakers, that sail is in the correct bag, and that the right sails are onboard.
- He/she should know the wind varieties of spinnaker and the boat's target speeds for different conditions.
- He/she should check the winches, handles, spinnaker sheets, spinnaker pool guy, shackles, and spares.
- He/she should leave one wrap of the spinnaker sheet on the base of each side winch.

Tools & Rigs:

- Symmetric and asymmetric spinnaker
- Winches, handles, spinnaker sheets and guys and spares

2.3.3.6. Mastman

Task:

- Pulls all halyards at the mast to raise the mainsail, genoa and spinnaker
- Assists bowman with headsail changes, spinnaker sets, gybes, and douses,
- Helps maneuver spinnaker pole.

Figure 197: Mastman (Team Toka- Mat 12)

Preparation:

- He/she helps bowman to set up the front of the yacht by connecting headsails and rigging spinnaker gear.
- He/she should know all halyards at the mast for sail sets.
- He/she put marks on halyards where they exit the mast once they are completely hoisted.
- Run zippers back to the end of the jib bag and reconnect it.

Tools & Rigs:

- Halyards at the mast, genoa or jib sets, spinnaker sets, spinnaker pole and spares

2.3.3.7. Bowman

Task:

- Changes headsails.
- Connects, sets, gybes, and douses spinnaker.
- Calls starting line, waves, and other boats.
- Climbs rig for tuning and repairs.

Preparation:

- He/she should sure that the spinnakers and genoa/jib are race packed.
- He/she should check the condition of all gear including headstay feeder and groove
- He/she should be sure the spinnaker pole is rigged correctly.
- He/she should be sure the spinnaker halyard attaches the spinnaker.
- He/she should be sure the spinnaker gear is run correctly and that the

spinnaker pole is on the right side with the gear in it.

- He/she should attach the spinnaker gear to the spinnaker in the bow hatch.
- He/she should tape anything that could rip the spinnaker.

Figure 198 : Bowman (Team Fatlemon- Beneteau First 40.7)

Tools & Rigs:

- Headsail (genoa or jib) set and spinnaker set
- Spinnaker pole, spinnaker sheets and spares

2.3.3.8. Pitman

Task:

- Adjusts some sail settings, halyards, and spinnaker pole settings.
- Keep time to the start. Be sure to tell loudly, clearly, and constant.
- Adjust settings such as the outhaul, vang and genoa/jib halyard.
- Assist trimmers by helping to trim.
- Arranges yacht's inside and stows sails.
- Works directly with trimmers, bowman, mastman and to affect maneuvers, sail trim and sail changes.

Figure 199: Pitman (Team Toka-MAT12)

Preparation:

- He/she stows heaviest items as low as possible below perfectly above the keel.
- He/she stows sails inside of the yacht in order of their projected use.

- He/she stores important items such as unused sheets close to the companionway for reuse.
- He/she checks that all spinnakers and genoas/jibs are race packed.
- He/she organizes all control lines and halyards to make sure they are suitable to run.

Tools & Rigs:

- Electronic devices (for timing…)
- Winches (for assisting trimmers)
- Sheets and halyards (for adjusting settings)

Teams don't always have all crew on the boat, or the same people for doing all these tasks. So, they can't provide too much specialization or they need more experienced crew who has knows more than one task's necessities. They need to combine or switch positions as necessary in six sailing positions. For example, when the team sails with five, they will have to combine some of the genoa trimmer and mastman tasks, and others help at critical moments to each others. Four crew makes sail hard, because each person will have to do a number of tasks on time. In this situation, tools and rigs must be easy to use and they are located as possible as accessible very quickly.

In research stages, all the basic maneuvers in typical racing will define with step-by-step explanations for each team member. Their working location, working path on deck for each people during the race and uses of tools will examine in user centered design methodology.

2.3.4. Managing Usability, Functionality and Pleasure in Sailing Yacht Design

The relationship between users, yachts and the sailing medium is not simple use relationship. This is acceptable also for tools and other equipment. Usability and pleasure are connected to each other. Especially pleasure directly depends on usability and usefulness. It means, pleasure relates the positive perceptions and feelings created by the usage of a yachts or sailing environment. Perceptions and feelings are individuals of users and strongly connected with the physical, sensorial behavior and environmental situation of them. These behaviors and situations are one of the most excited research areas, which applied to design known as User Centered Design.

The aim of User Centered Design (UCD) is to create products, which are useful, usable, and desirable according to users' requirements. It has been research, modeling, and evaluating the functional usefulness and usability of products and systems and places at the middle of the identification process of design, by means of the users' needs, wants and some usability and aesthetic (which can be defined as sensational requirements) for the product.

UCD is able to offer a valuable support in relation to the yacht design projects of environment, positions and equipment, in addition to this physical part, all users' tasks and activities can be examined with it. Its literature has placed some requirement levels referable to the users' requirements. The requirements of the sailing yachts refer to a several characteristics. These are concerning the usability, functionality and safety of tools and functionality and usefulness of sailing environment, which are identified with users' physical and mental "pleasure". If users correlate right relation with the product and the environment, pleasantness naturally comes up and correct relation is provided by proper design.

Usability methods have developed to address the individual requirement to understand how regular users relate to products. Today, evaluation of the physical and sensorial qualities of designs is also achievable. UCD manages to measure it with specific methods and operational instruments. As the “competitive” meaning of sailing, it is easy to understand how critical and important it is for producers, to get to read, understand and manage in a real planning way the feelings experienced by the users who relate with yachts, organizations, and the environment. UCD professionals pursue to evaluate user interaction with products and technology. User and usability studies include collected users' feedback with respect to their emotional response to the product. This feedback helps to measure ease of use or performance.

Several tools can be used to research user requirements, tasks, environments, etc. These tools include ‘traditional’ user centered design techniques (psychology, anthropometry, etc.) and pleasure methods are derived from design research and personality studies. New UCD methods are developed to answer specific questions. To develop an integrated understanding of what makes a product ‘useful, usable, and desirable’ will require a combination of methods and analytical tools.

As mentioned before, precondition of pleasantness is usability of design. The UCD usability approach that is based on the idea of designing products that can be used by users with maximum efficiency and minimum physical problems requires the most efficient theoretical support to the development of sailing yacht design. It is an approach that allows the achievement and it offers a cyclic progress.

- Identifying aims of the product
- Identifying the usage and tools
- Identifying the requirements of the users, organization and environment,
- Planning solutions

According to this approach, the course of identification and reaching of the users' needs are on the center of the research. The users' needs and the requirements of the products could be expressed according to different priority levels during the process from the lowest to the highest. And they are considered when designers are planning the design criteria.

Theoretical and methodological studies on the theme of usability of products have increasingly developed in recent years. If we looking into the yacht design sector, we can see that "pleasantness" is one of the main subjects of producers. They serve consumption of luxury and work with their consumer one to one. So, they have to know every detail of their consumers' needs, expectations, behaviors and cultural backgrounds. Because of this, the concept of pleasantness of product attracts producers' attention.

In this instance, as a part of a UCD methodology, pleasantness that include physio, socio, psycho, and ideo, which are four pleasures, could be examined by researchers. (Jordan 2000) Some theoretical thoughts follow the experimental approach to the subject of valuation of pleasure. Several methods started to research. One of them is "Consumer-oriented" method, which is proposed by Kansei Engineering. In this method, the design process includes the three phases, which are information, generation and evaluation. Kansei Engineering's aim is to create a computer aided model for the primary phases of design process for creating design tools according to their evolutions. This system based on especially the regular thinking process of the designers. Their evaluation made of the sensations created on persons by the various descriptions of surfaces, shapes, colors and materials by using a database (Bouchard, Limm, Aoussad,2010)

Second one is the “Sensorial Quality Assessment Method (Sequam)” which is suitable in evaluating the pleasure and emotional characteristics of the products. In other words, this method identifies individual physical features of products, which affect users' perceptions and/or product design decisions of designers. The perceptions about products which are experienced by the their users when they come into direct contact with the them are evaluated by this method. (Moody, Burtner,2009)

And the more recent, Citarasa Engineering Model, a new user-centered design approach to design that the most effective vehicle. This model integrates the cognitive and affective requirements of customers. (Khalid 2005), In this model, system maps information and requirements of users for creating parameters and generates optimal design solutions. Citarasa Engineering Model is using generally in mass production system.

Such theoretical considerations and assessment methods are evidently applicable also to the products for yachting, to evaluate the usability, functionality and pleasantness of the environment. It is, of course, the opening of research that is still at the start in this applicative field, which promises, though, to give interesting results to increase the awareness of the designer and the objectivity of his/her choices attributed to aspects that, until now, were the exclusive prerogative of his/her individual sensitiveness and perceptive abilities.

CHAPTER 3

DESIGN PARAMETERS OF OFFSHORE SAILING YACHTS ACCORDING TO USER CENTERED DESIGN.

The multidimensional complexity of yacht design, in specific of sailing yachts, interested a system of relations that involve several fields of satisfactoriness, like as, structural engineering, industrial design, material engineering, interior design, fluid dynamics, marketing. In addition to them, this is the complexity of a product that have special usage characteristics between a user and yacht because of the environmental conditions and sail trim conditions in continual movement in the sea.

The UCD approach, together with the different system of methods, control and valuation techniques of the project offers the designer a useful support to the design management of yacht design.

3.1. Characteristics of Offshore Sailing Yacht Design

Yacht design is the applicative branch of industrial design that deals with the design planning of sailing yachts, which are for offshore races or cruising. It is a designing sector characterized by a specific complexity, for it must coordinate varied and interacting multidisciplinary fields, which are the scientific fields of engineering, industrial design, interior design, ergonomics, marketing, and ecology, with their individual particular disciplinary articulations. For example, considering sailing yachts only from an engineering point of view, it is a matter of complex propelled machines which move between air and water, stressed by static and dynamic loads. So, their study includes several fields of learning between which there is naval architecture (study of resistance to the movement of the hull), aerodynamics (efficiency of the appendages and sails), structural engineering, and material technology. Other side, from a design point of view, it is a matter of relation between user and yacht which involves their needs, ergonomic and aesthetic requirements according to design parameters and design systems.

As far as the origin of the project is concerned, however, it can be said that the greater complexity derives from the fact that the pleasure craft embodies both the internal symbolic and functional values of the house, of the “refuge” (stability, strength, safety, privacy), and the external ones of the “vehicle” (lightness, dynamicity, functionality, maneuverability, usability). In this, even the dimensions of the object have an important role in the definition of the relationships between the concepts of house and vehicle: in general, it can be assumed that so much bigger the boat is, especially on the inside, so much the relationship with physical constrains and with figurative “dimensions” of housing becomes tight (also as a consequence of the greater effective “stability” of the bigger sailing yachts), and therefore, its relationship with the sea becomes weaker. Thus, if the comparison with civil architectural areas and its more typical furnishing systems is generally immediate and spontaneous in big ships, in small crafts, in particular sailing ones, one often witnesses compromises between the spatiality of the living area and that of the binnacle. Additionally, in contrast with other means of “habitable” locomotion, crafts are forced to resolve the opposition between movement and stop with a greater planning effort: “A boat is represented as an object which moves even when it is still. When a camper van is still, it is static like a house; a craft is always in movement even when it is still” (Spadolini 1987).

A boat, therefore, is represented as an unstable object that moves inside an element that is also unstable. Therefore, the external “shell” takes upon itself the difficult task of carrying out the role of a boundary, limit, edge, real and symbolic, between an internal, finite, static, and domestic world, and the sense of infinity conveyed by the external marine context, which is variable, unstable, wild, and indomitable. In a sailing yacht, these relations become complicated because the “rolling” point of sailing and the continual movement are almost a rule.

Additionally, in planning a sailing craft it is necessary to consider the need to integrate the technological and technical innovation aspects, in continual evolution, with a specific figurative and cultural codification, at times with a millennia long tradition, particularly present in this field of the project.

The first image that probably comes to everybody’s mind when thinking of a sailing yachts is that of a “deck surface,” of a rather complex morphology, cluttered with specialized equipment placed in an apparently casual way and without a visible aesthetic sense, on which members of the crew carry out specific tasks, at times very rapidly, without apparent order. In reality, by studying the tasks and equipment of a sailing craft in a more analytical way, it transpires how it is, above all, a place of highly organized and disciplined activity, based on rigorous formal, personal, and functional relations between artifacts and individuals, with expressly hierarchical roles, which operate in limited areas for the same common aim, which is the overall performance of the craft.

An similar consideration could be made for the “underdeck” areas: whether it is a sailing craft, the nautical internal areas are variously recognizable because of certain distinctive elements that are present in them, which are an expression of functional results or simple formal heritage tied in with nautical tradition.

Thus, for the designer it is a matter of dealing with an articulated system of historically represented morphological and spatial relations, in which the multiplicity of human activities, the spatial areas and the equipment present on the craft. On the other hand, it is related to deal with the evolution of roles and tasks on board, which tend to follow morphological, functional, and technological modifications in positions and equipment. In the evolutionary panorama, is constantly oriented toward research and experimentation the nautical designer carries out a primary and coordinating role between the various areas of competence involved for a typological and functional redefinition, both of the spatial areas and of positions and single equipment. It consider, on the one hand, the evocative cultural result of tradition and the technological progress obtained in the field of materials, building, and production techniques, and electronic miniaturization.

3.2. UCD applied to Offshore Sailing Yacht Design

Yacht design is a especially complex applicative sector of industrial design, both of them operate on variable representative scales, from the construction scale to that of single equipment, and because every project must deal contemporarily with the diversified system of limitations imposed by the user (from physical-dimensional ones to psychosocial ones) and with the overall efficiency of the “system-boat” (from engineering ones to organizational or simply functional ones of the various maneuvering positions and equipment).

Thus, the methods and techniques developed by user centered design and applied to design represent a valid operative and instrumental support for yacht design, in order to direct the planning action with awareness toward morphological and spatial research that is both elegant in its language and fluid in its articulation and functionally efficient and pleasant to use. In particular, the UCD approach, which is based on the idea of planning artifacts that can be utilized by users with maximum efficiency and minimum physical and mental discomfort, provides the most meaningful theoretical and methodological contribution to the development of some aspects of yacht design. It is an approach that allows the acquisition and assessment of users' requirements by means of structured and verifiable methods to turn them into planning instruments. It proposes a cyclical course, articulated in a series of activities:

- Identifying the basic functions and aims of the product (principal, secondary, and accessory)
- Specifying the use context and its components (characteristic of users, task, equipment, and physical and social environment in which the interaction with the product is carried out)
- Identifying the demands of the users and organization, thereby defining the ergonomic requirements of the product
- Producing planning solutions and prototypes, to assess them, with the users' contribution, in relation to the requirements identified

Within this approach, the process of identification and achievement of the users' demands takes on a central role: it can come about both on an objective basis (by referring to measurable parameters and establishing for each of them, by appealing to regulations, the most suitable acceptability thresholds), and on a personal basis, when one is interested in identifying even latent emotions, preferences, expectations, and desires. The users' demands and the consequent requirements of the products may, in turn, be expressed according to different priority levels, from the lowest to the highest

Because of the complexity of yacht design, it tends to be faced naturally in a "particle" way: a clear division of tasks and roles among different, extremely specialized areas of competence tends to approach the project in parts, often with a distinct division between the aspects of a "productive" nature (economic, building, and systemic) and the so-called "human" factors (regarding the individual or social use of the product). The role of the yacht designer is precisely to plan the shape of the nautical product by coordinating, integrating, and articulating such factors. Therefore, they find a valid aid in the UCD methods and instruments to evaluate and plan, most especially, the user–yacht interaction with greater awareness: they manage to do this at all levels referable to the users' demands and regarding the different scales of the project, from the single pieces of equipment present on board to the more complex spatial areas.

3.3. Different Applicative Area of User Centered Design to Sailing Yacht Design

The UCD places at the center of its identification process, by means of the users' demands, some usable requirements for the product. The UCD literature has recently placed four different requirement levels referable to the users' demands in a close hierarchical relationship (Jordan 2000). The requirements of the nautical product refer to various aspects. It is possible to identify an analogous articulation for the nautical product too. Thus, the requirements concerning the safety of equipment and the environment are identified those regarding their funtionality, ease and practicalness of use, including the requirements that concern their pleasantness, the physical and mental “pleasure” that is experienced in interacting with the product and the environment. For each of them, UCD is already able to offer a precious contribution in relation to the nautical project of environment, positions and equipment, as well as, in a figurative sense, to establishing all those tasks and activities, even apparently secondary, which are carried out on the craft.

In particular, on the safety on board, user centered design provides the most suitable instruments to analyze the characteristics of individuals and the limits of their physical abilities, even in extreme environmental and physical conditions in the context of functionality. This research can relate directly to the typological evolution of the equipment and the various parts of the craft to allow a critical, objective, well-pondered reading of it. On the plane of usability of the equipment and physical comfort, functionality practice allows the identification of more innovative solutions also by means of observation of organization and structure of tasks on board. On the pleasantness plane, UCD has defined the most useful instruments and methods to assess the individual interactions of users with components, tools and equipment, and the environment.

Furthermore, in all cases, the multidisciplinary approach of UCD to the design and the availability of methods, intervention procedures, and operative instruments that it offers, allows the study of the requirements of the user’s well-being to be faced whether in relation to the single product/equipment or to the task/position or to the environment/context in which he/she finds himself/ herself.

3.3.1. Safety on Board

The “safety” requirement of an artifact may be considered both generic and defined and regulated by a complex and articulated system of national and international standards, even in a specific planning sector such as yacht design.

In general terms, safety may be defined as the set of conditions regarding the safety of users as well as the defense and prevention of damage depending on accidental factors. In the nautical field, some sources of danger are obviously correlated directly to the technical productive aspects of the craft. Therefore, there are numerous safety standards oriented toward the control and testing of the aspects of structure, building, buoyancy, etc.

One may add that, in the nautical field, almost all safety standards are attributed “only” to regulating such aspects. For example, even in the international normative picture, just a few technical safety standards are applied to the crew. Among them is the ISO 15085: 2003 standard, entitled “Small craft: man-overboard prevention and recovery,” whose salient points refer particularly to the differences in the level of the deck: the requirements of foot stops, gunwales, manropes and stays, non-slip elements, and boarding means usable without assistance. Furthermore, this standard high- lights another problematic aspect concerning the safety requirements of pleasure boats. However, in this case, too, the various aspects are not considered with the completeness and organicity that the subject would require.

Thus, it happens that the variability of the physical and perceptive characteristics of the users as a fundamental aspect to define the accidental sources of danger are not considered. Nor, least of all, are the numerous “disturbance” effects that interactions with the context can produce on the individual considered, which, in actual fact, reduce his/her physical abilities. On the contrary, UCD planning teaches that observation and analysis of the “system of interactions” between users, contexts, activities, and equipment represent the fundamental principle of every "safe" and "comfortable" project. This is a concept that can also be considered to be at the root of the difference between the "safety" "functionality" and "ergonomics" of a product: in fact, by means of UCD planning it is possible to obtain "also" better safety conditions, while the simple application of adequate safety measures may be attributed strictly to single pieces of equipment or activities, do not in themselves guarantee overall conditions of well-being for the individuals who have to carry out particular tasks with particular equipment in specific environmental conditions.

Unfortunately, on many yachts, as happens in many other "workplaces," the realization of maneuvering positions is often the result of a simple "assembly" process of the single elements that make it up: perhaps they correspond individually to specific safety standards, but they are not the subject of a real, combined, and coordinated planning activity, with the inevitable risk of accidents.

On the contrary, to reduce the risks, to optimize the efficiency of the "boat" system and, at the same time, to pursue the well-being of the individuals involved in the activities on board. It is advisable to make reference above all to the so-called UCD principle of "totality of interventions," which calls for turning one's planning attention to general, wide-ranging subjects, leaving the single aspects of the problem to a second stage of in depth study.

Starting from such a consideration, the multidisciplinary wealth of UCD is already able to offer the yacht designer many operative instruments and suggestions useful for planning tools and other equipment, positions, and safe areas on sailing boats in a correct way.

The correct use of UCD data and the dimensioning of the accessible and visibility areas, are useful for an initial definition of the dimensional requirements of areas and positions, and for the placing of components and equipment. Furthermore, analysis of the organization of activities on board allows the reduction of risks of accidents caused by human error in coordinated and collective activities, which exist, for example, on board during maneuvers to change the points of sailing.

The knowledge defined clearly by UCD, therefore, already seems especially useful at this main definition level of product requirements regarding safety to widen the range of the variables tied in with the planning subject, allowing contemporarily the objective checking also of many aspects concerning the safety of users.

3.3.2. Practices with Tools and Environment : Functionality

The sailing yacht itself sums up the typical values of a dwelling and a vehicle. I can say that, above all for the smaller craft, the design is in search of continual compromises precisely between the spatiality of the living or working area and those of the "binnacle." This means that in a planning sense the perceptive relations must be taken into consideration with which the users relate to in the "reduced" areas of the craft, which are obviously different in comparison with the more traditional ones.

Furthermore, the sailing yacht's space is, by definition, a space that moves continually and noticeably in all directions. It is constantly in motion, even when the boat is "still" at its pontoon.

The extent of the movements that the yacht is subject to depends usually on its dimensions, speed, angle of contact with the waves and, naturally, weather conditions. Such motion affects the conditions of life and work on board in a meaningful way. In particular, the rolling and pitching can take on a meaningful role in the definition of the conditions of well-being of the users, causing the classic malaise commonly called “sea sickness,” to real loss of balance. Therefore, the need for users to learn to live with the incessant movement of the craft without being excessively disorientated by it is another factor that greatly affects many aspects of planning.

These initial considerations involve some initial, substantial, typological, distributive, and dimensional variations of the nautical environment compared to the structure of dwellings on board. Therefore, the difference reaches well beyond the simple morphological and stylistic characterization of the design or tools’ design or choice of materials for the finishing, which could refer directly to nautical tradition.

The need for work areas that allow the most common activities on board to be carried out, working with the narrowness of the spaces. With the even violent movements of the yacht and with a transversal listing of the whole hull as regards the horizon, which can last for relatively long periods, has caused every component of the craft, both outside and inside, from the single equipment to the positions and micro environment, to envisage planning solutions full of strictly functional values that often derive from a nautical tradition consolidated by centuries of history. Therefore, case records of planning in the nautical field are a rich source of ideas and considerations attributed to typological and functional solutions, often extremely original, general, and detailed. Some are of a general nature, attributed to all parts of the yacht, such as those that tend toward a generalized reduction of corners, in search of a morphological continuity between surfaces, never interrupted and connected as much as possible by adopting planning solutions now consolidated.

Other specific solutions, subsequently added, are attributed to single environmental units (cabins, bathrooms, cockpits, etc.). Systems are involved, widely discussed in the literature of the sector, in which a compromise is found between the requirements of the user, attributed to the activities they carry out, and the adaptable and movable characteristics of the minimum spaces assigned to them.

In these cases too, user centered design research offers a planning approach and all the necessary instruments to identify and verify particularly innovative solutions even starting from a critical dismantling or historical-typological analysis of the requirements for the use of parts and components of the “yacht” product, from the most consolidated planning solutions to the experimental ones.

3.3.3. Practices with Tools: Usability

In recent years, user centered design has developed many methods and operative instruments that are useful to the design and assessment of the usability aspects of the products. Procedures are involved, about which detailed literature is now available, which are able to quantify and, above all, provide objective data on the qualitative aspects attributed to the apparent subjectivity of judgment of the ease of use of a product. In particular, the so-called “user trials,” carried out with the direct involvement of the users, provide reliable indications about the requirements, expectations, and possible problems that they reveal regarding the use of the product that is the object of the study (Rubin 1994). Methods are involved that are obviously also applicable to the equipment present on pleasure boats, although few cases of this type are reported on in the literature.

The planning complexity of certain aspects of yacht design concerning the user–yacht–sea interaction, on the contrary, requires "ergonomic" research regarding the assessment of usability to deal with two specific planning conditions of the sector, which in a certain sense would entail a clear definition of new methods oriented, so to speak, toward a greater "evaluative multidimensionality."

These conditions, concern some highly specialized equipment present on board, such as winches, grinders, rudders, bridges, etc., for which the users' body takes on a fundamental role. User, in turn, can be extremely variable, as it is tied in with the nature of the tasks, the environmental conditions (listing boat, climatic conditions, etc.). The areas available and naturally, the various equipment that must be used, even contemporarily. It is well known that an incorrect physical situation can cause a feeling of pain and discomfort. On the contrary, correct physical situation can notably improve the efficiency and effectiveness of the action and the user's satisfaction. Many users on a boat are classified as "special", are hard to classify and continually modified to maintain balance during the execution of the task. This means that the effectiveness of the action and the overall efficiency of the system cannot leave out of consideration an assessment associated with the equipment, their operating position, and the variability of body that the user may assume while using the equipment to carry out a certain task.

This last consideration offers an idea for further careful thoughts regarding the assessment of usability of nautical equipment. Nor should the study of their correct use, in fact, leave out of consideration an analysis of the overall organization of activities on board and above all, the hierarchical structure of the tasks that each user is called on to carry out, during a single maneuver of the yacht, when every single activity must be coordinated with those of all the other members of the crew. In this sense, planning every single piece of equipment in view of its use means taking into account both the demands imposed by the overall organization of the activities on board and the possibility of the equipment adapting itself to a subjective attitude of the single user, which is also a variable regarding the task and environmental conditions of use.

Therefore, it is a matter of verifying the possibility of using more than one assessment method of the usability together to plan the equipment-cockpit system of maneuver, maybe in association with other analytical instruments, as for example those concerning the hierarchical task analysis (Shepherd 2001), which allows breaking down, in an objective and analytical way, the activities and tasks of each member of the crew, including even single, elementary actions, to identify planning limitations in an analytical manner.

3.4. Different Applicative Methods in UCD for Research on Practices: Collecting Practice Data

There are ranges of methods of user-centered design to help gathering design data. Some of those methods whose brief descriptions will be explain one by one in this part were used in this study. These methods:

- Ethnographic observation
- Video ethnography
- Photo ethnography
- Contextual interview

- Surveys

3.4.1. Ethnographic Observation of Research Group

Ethnographic observation is a method borrowed from social science research. Designers utilize this method to understand unarticulated needs and issues that users of particular products, environments and systems have in order to create innovative design solutions.

3.4.2. Photo and Video Ethnography

Photo and Video ethnography is a way to capture human behavior in the context of the person's natural environment as a means of gaining insights about user behavior and needs. Photo capturing and videotaping allows designers to view and re-view user behavior. The analysis of the tapes and photos are used to present insights and implications for design solutions. Not only is videotaping and photo capturing essential at the beginning of the design process as needs are identified, but it is also key throughout the process as designers gain an understanding of a particular user context and as prototypes are developed.

3.4.3. Contextual Interview with Racing Teams

In this technique the interviewer observes the users in the context of doing the actual work task that was being analyzed. The interviewer assumes a role similar to an apprentice. The goal is to understand the work in the natural setting as it normally occurs. Contextual interviews typically last approximately two hours and the interviewer is guided by a specific predetermined focus. Data are gathered and notes are taken during the interview. Data are gathered specifically to allow the interviewer to construct diagrams that describe and define the work tasks that are being analyzed.

3.4.4. Surveying Users' Practices

Surveying users' practices is a very useful evaluation method for measuring their needs, requirements, inquietude, pleasure or other feelings about products or environment. In this method, different types of questions which are prepared carefully for what designer want to know about product or environment are asked to them one by one and answers are being more trusty, thereby evaluation of surveys are more helpful for designers.

3.4.5. Hierarchical Task Analysis

Hierarchical task analysis is a specific framework for analyzing tasks. This framework involves identifying the goal of a task within a specified context and examining if the goal can be met. Hierarchical task analysis provides a flow chart for completing task analysis.

User and task analysis is a collection of methods that have the purpose of understanding human performance. These methods systematically explore user goals and means of reaching these goals. The personal characteristics of the user and the environmental context of task performance are addressed. The process of user and task analysis involves either systematic observation or interviewing users or both observation and interviewing. Data from these observations and interviews is organized and analyzed.

CHAPTER 4

EVALUATION OF USER TASKS AND TOOLS ON BOARD IN OFFSHORE SAILING YACHTS

4.1. Brief Explanation of Methodology: Analysis of Collecting User Practice Data

Sailing is a collaborative organized work system that the joint approach of user centered design and work organization is a formidable means of increasing system productivity and at the same time, improving the quality of effectiveness. If designers use them together, they contribute to reducing errors and injuries and to enhancing the satisfaction and pleasure and care of those engaged in the group activity.

This research comprises these methods, which are allowing a hierarchical evaluation of the tasks and analysis of functionality, usability and pleasure about usage of different tools that are used for each task. There are few methods evaluating both these aspects. The integrated use of different methods of task and work analyses may reveal the best way to analyze the different movement of user acting in collaborative organized work systems, especially in the more complex ones, in order to guide design choices on new, aesthetic, comfortable, and functional station solutions.

Sailing activity is defined by an interrelated set of elements (activities, riggings, and people), working in special environmental conditions, pursuing the main object of “sail” with efficiency, effectiveness, and satisfaction. On board, each hand has several defined roles, duties, and tasks: these are carried out by interacting with specific riggings in specific “areas” of the sailing yacht.

The study started collecting data and information mostly from the nautical literature, concerning both the operating principles of the propelling system of a sailing yacht (such as the reaches, the riggings, and the most common practices), and the different roles of the crew on a sailing yacht similar to the studied one.

Since the study was concerned with group activity in small spaces, this fact was important in beginning to understand the kind of direct and hierarchical relations between each user and between users and the different parts and riggings of the sailing boat interacting with them.

4.1.1. Research on Races in Turkey

The first phase of the research was useful to collect initial information on types of boats, which are racing in IRC system in Turkey and the race results of last two years was examined. Each race examined one by one for true information about all yachts. During this phase, Turkey Offshore Racing Club helped to this research about yachts and races. In addition, they gave information about IRC rating system, and measurement details of yachts. Detail information made easy to understand characteristics of offshore racing yachts. Rating systems are limiting design elements because of the equivalent of all yachts that have individually a rating coefficient. Rating coefficient, which has a formula, is calculated considering the measurements of hull, keel, mast, weight, water line and other measurable elements. Only authority of IRC who are entrust by TORC[6] knows this formula. And TORC keeps all IRC certificates of racing fleet of Turkey secretly.

UNCL IRC

CERTIFICAT TEST

Bateau:	***Stabilité***
Nom: **TEST2 FIRST 30**	SSS Base Value: 23
No. de voile:	STIX: N/A
No. de Cert 17770	AVS: N/A
TCC: 1.001 2010	ISO/IRC Design Category: N/A
	ISAF Plan Review Cert: N/A

Information

Type	TEST FIRST 30 1.90	Date série: 2009	Facteur de coque: 8.4
Genre:	Bermudien Sloop	Age bateau: 2009	Facteur de gréement: 1.01
Délivré:	TEST NON VALIDE POUR COURIR	Equipiers: 7	Facteur d'élancement: 1.08
Notes:			
Notes:	poids du bulbe: 700 kg		

Coque		***Elancements***		***Gréement & Grand voile***		***Voile d'avant***		***Artimon***		***Spinnaker***	
LH:	9.51	BO:	0.41	P:	12.30	LLmax:	12.50	PY:	0.00	SPA:	81.98
LWP:	8.46	x:	0.30	E:	4.40	LL:	12.50	EY:	0.00	STL:	4.20
Bau maximum:	3.20	h:	0.10	J:	4.19	LP:	4.40	LLY:	0.00		
Poids:	3907	SO:	0.64	FL:	13.38	HHW:	2.20	LPY:	0.00	*SLE*:*	*13.1*
Disp IRC	4497	y:	0.12	MUW:	1.34	HTW:	1.15			*SLU*:*	*13.1*
DLR:	207			MTW:	1.95	HHB:	0.10			*SF*:*	*7.1*
Tirant d'eau maxi:	1.9			MHW:	2.92	HSA:	27.66			*SHW*:*	*7.65*

Informations complémentaires

Voile et bulbe en fonte: Quille unique	TCC sans spi: 0.981
Pas d'ailettes	Plusieurs voiles d'avant permises
Moteur intérieur : Poids 150kg	Nombre maximum de spinnaker à bord: 3
Hélice 2 pâles repliables/orientables	Tangon/Jockey pole avec ou sans bout dehors
Ballast intérieur 0 kg	2 Barre(s) de flèche(s) 0 Guignols
Poids avec les coussins	0 Paire(s) de bastaques ha 0 Paire(s) de bastaques basses
Filières conformes à l'OSR	Mât principal en aluminiu Gréement câble
Energie manuelle utilisiée pour régler le gréement courant	HSA=0.125*LL*(2*LP + 3*HHW + 2*HTW)
Pas de ballast transférable	SPA=((SLU+SLE)/2)*((SF+(4*SHW))/5)*0.83

Certificat délivré par le IRC Rating Authority et valide du 11 Oct 2010 09:50:14
Au 31 Dec 2010 sauf remplacement ou invalidation par les règles de l'IRC
J'accepte les mesures qui figurent sur le present certificat et je m'engage a signaler au Centre de Calcul toute erreur ou toute modification ulterieure.

Signature: *(Proprietaire)*

CERTIFICAT TEST

*CHANTIER BENETEAU,
C/O Eric Ingouf

France

(C) RORC/UNCL 2010

Centre Nautique Paris-Boulogne Face au 36 Quai Alphonse Le Gallo 92100 Boulogne sur Seine
irc@uncl.com tél: +33 (0) 1 46 04 17 80 fax: +33 (0) 1 46 04 17 73

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Figure 200: Sample of IRC Rating Certificate

According to racing results, the yachts which are preferred for racing was determined. These brands and models of racing yachts were categorized,

[6] TORC; Turkey Offshore Racing Club

considering their size, cockpit typology and different equipment system and their emplacement. After determining the typologies, each user's work location and their tools and equipment were defined on board (for each team on their yacht typology). In evaluation phases, these information will be given in detail.

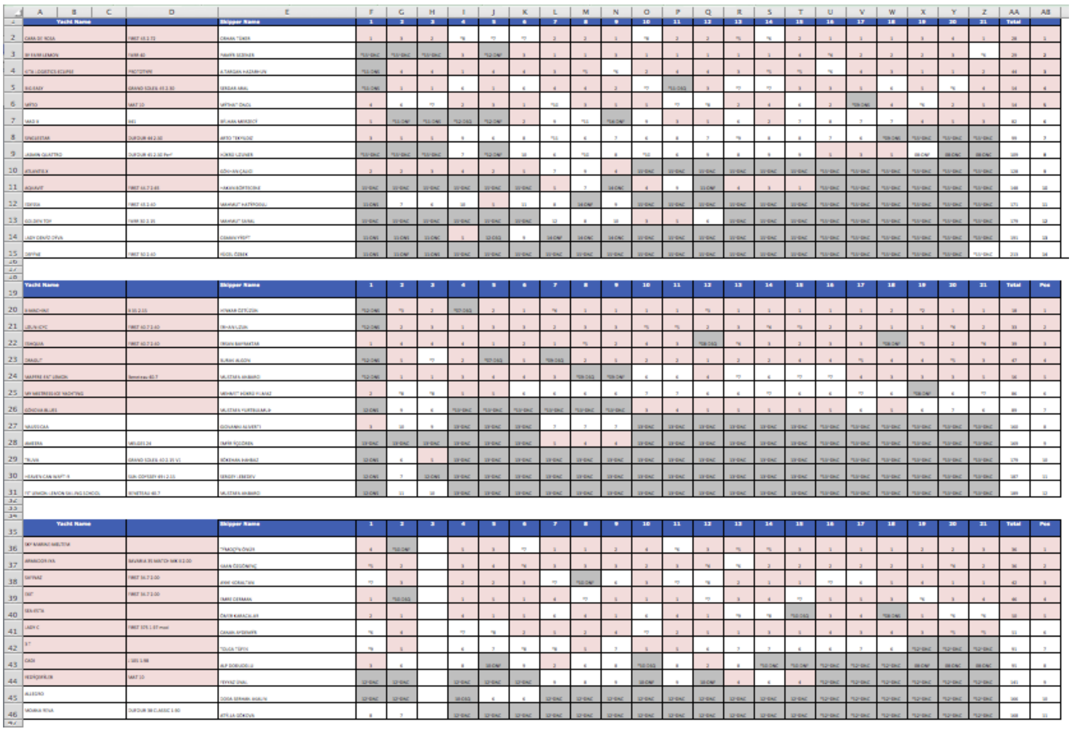

Figure 201 Sample of Race Result Tables (Each Columns represent one race and pink color represents top 5 for each race)

4.1.2. Surveying User Practices on Board in Racing Yachts

After getting information about racing yachts in Turkey, next step was connecting with team members who are target group of this research for getting personal information and problems and expectation about their yachts. Main goal was doing a survey with them. This method was selected because is more accurate and has a bigger degree of participation from the respondents (with e-mail, mail and one to one). This survey was divided in two parts. In the first part I asked the participants some generic question related with their tasks, yachts and location of work area on board. In the second, I asked more specific questions for each maneuver in racing related with problems, expectations and needs about their tasks, design of tools, design of environments and practices regarding different types of racing route with a priori maneuvers.

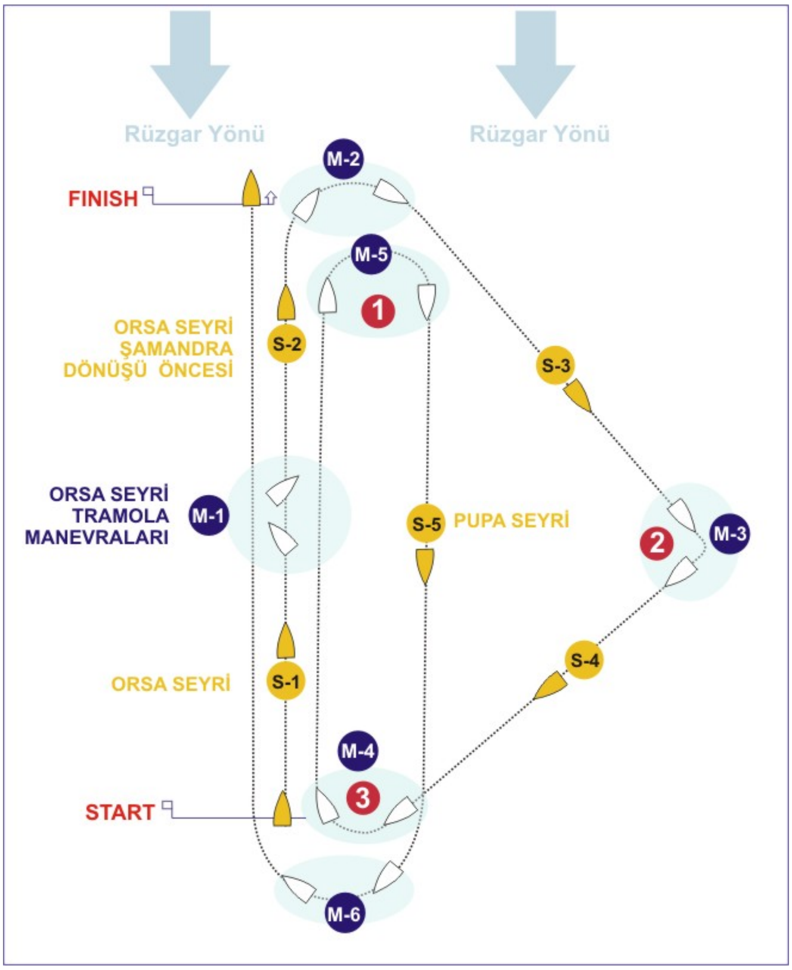

Figure 202: The Route of Racing in Survey

All team members marked on survey their before and after location on board for each maneuver and defined their tasks and tools and put in to words their problems about functionality, usability or ergonomically. This type of survey has provided to draw a work path for each team member for complete racing time. And their intersection between each other during the race could see through this way. Owing to schematic survey, all problems and expectations decomposed one by one for each maneuver, for each user and tool and for each type of racing yacht. Questions related to problems of functionality of tools and environment, problems of usability of tools and expectations about better design solutions about their problems. These elements are the bases of this research. In addition to surveying, ethnographic observation, video and photo ethnography technics and contextual Interviews supported to research.

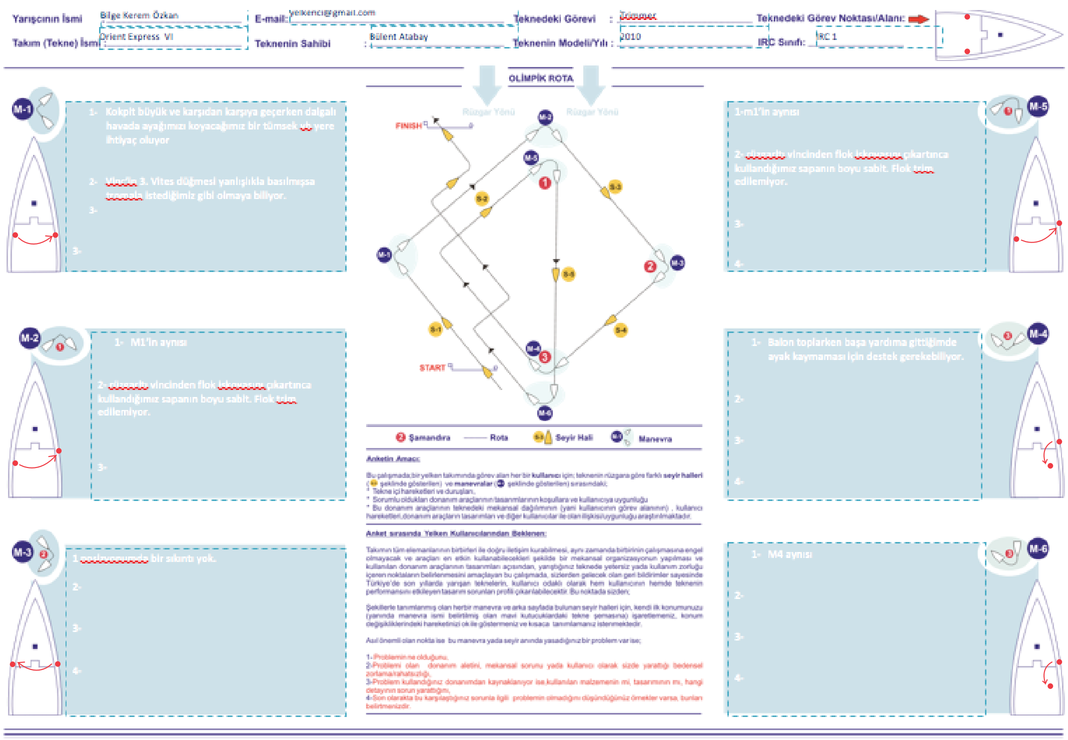

Figure 203: Sample of Survey

4.1.3. Observing User Practices on Board in Racing/Sailing Yachts

Ethnographic observation and photo and video ethnography methods are utilized by designers to understand unspoken issues about design of products in order to create innovative design solutions. During the process of this study, in addition to surveying with users , I have been in different types of boats in races and recorded movements of crew on board and taken photograph. Photo capturing and videotaping provided me to recognize new unnoticed problems.

Figure 204: Observing User Practices on Board , Farr 40, Flying Box Lemon-Arkas Team. Photography by Seren Borvali

Figure 205: Observing User Practices on Board, A 35, Dragut Team. Photography by Seren Borvali

Figure 206: Observing User Practices on Board , First 40,7, Yapi Arti Mobidick Team.

Figure 207: Observing User Practices on Board , A 35, Eker Yayik Ayran Team.

Figure 208: Observing User Practices on Board , X 35, X-Machine Team.

In addition to all these observation data, during the race I did an interview with users in the context of doing the task and data are gathered and notes and photos are taken during the interview. These are particularly to allow me to draw schemes which describe the work tasks that are being analyzed for each maneuver.

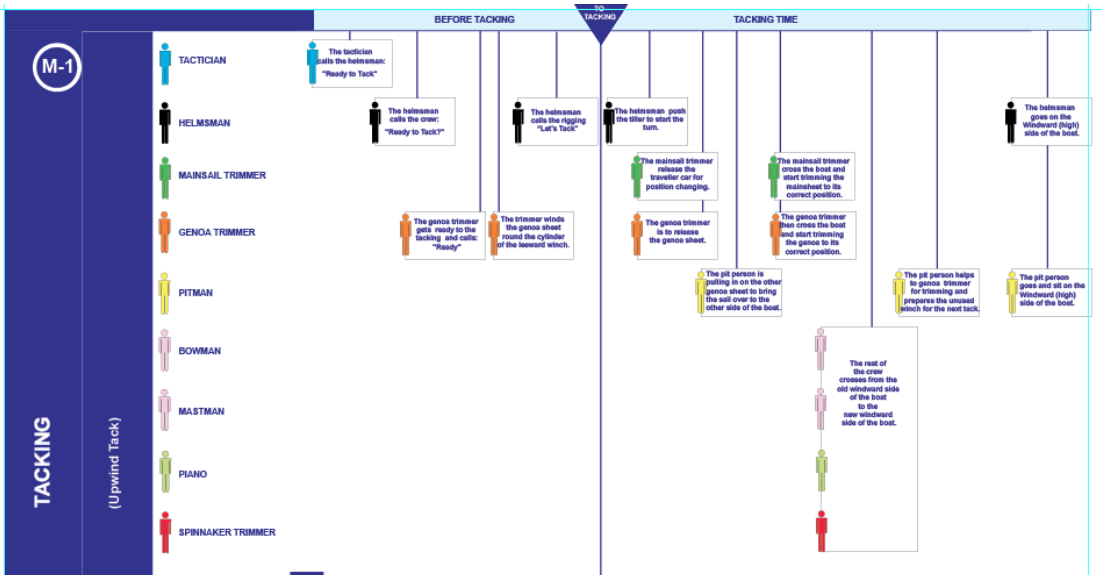

Figure 209: Scheme of Work Tasks for Each User in Maneuver

4.1.4. Tasks Analysis of Users on Board in Racing Yachts

Using method such as the hierarchical task analysis (HTA) was set in order to analyze the users tasks, which is in rapid succession, in comparison with the tasks connected to the most important riggings of a sailing yacht. Especially, from the nautical literature, information was collected on the crew usual tasks and schemes during the principal maneuvers. (tacking and gybing).

After that it was possible to piece together the maneuvers temporal sequences, according to the approach of HTA. Six different “fixed plan sequences” were derived for basic race route as mentioned before and each next task is due to the completion of the previous. Moreover, for each step of the user’s task sequences a length of time was supposed, and problems for each task marked on this fixed plan sequences on true time in regard to the different kinds of cockpits and the users’ typical location .

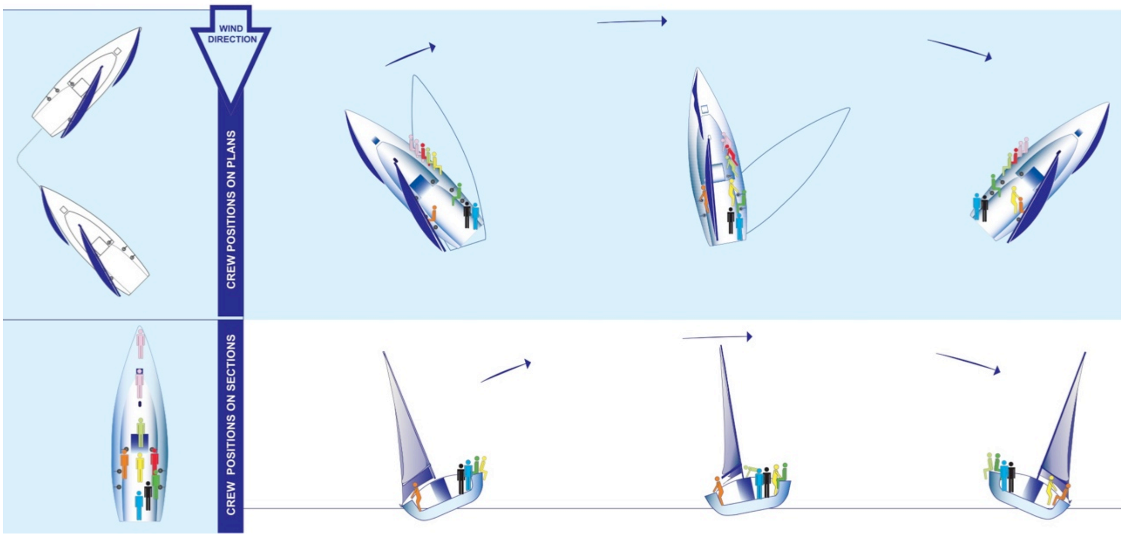

Figure 210: Crew Positions In Maneuver Time

Figure 211: Sample of Hierarchical Task Analysis of Tacking Maneuver for Different Kinds of Cockpit and Users Tasks with their Problem Marks

4.2. Experimental Evaluation of Users' Data

A direct observation was planned and developed in first step. The purpose was to verify the correctness of the theoretical data and hypotheses (task sequences and problems about tools and environment), and to point out any practical skills and unusual situation that were not mentioned in the specific literature.

The target group of the survey is racing yachts and their users in Turkey because accessibility and communication is most important subjects for this research. The yachts and its team were chosen who have been racing for 2 years. Races that were in Istanbul, Izmir, Bodrum, Marmaris and Gocek [7] were examined and all race results decomposed according to their IRC classes and boats measurements. IRC classes (for each race) are not stable; it is separated according to number yachts that join to race. Because if there is not enough yacht for each classes, some classes can be combined within one class. But all for these yachts ratings[8] in races are stable. After the analysis of all race results, all boats were categorized and scheme of the racing fleet of Turkey came up. It is seen that boat owners choose both racers and cruiser-racers. But teams who are more professional choose complete racer yachts. Racing fleet of Turkey contains a racer yachts like as Farr40, Farr55, TP52, Melges 32, A40RC, Farr30, Melges24 and racer-cruisers like as Beneteau First 45, First 40.7, First 34.7, Mat 12, Mat 1010, Mat 10 , X35, X41, A35, Grand Soleil 45 and Corby 29.

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[7] Races are organized by Racing Clubs that are Turkish Offshore Racing Club and other yacht clubs(Istanbul), Eagean Offshore Racing Club (Izmir), Bodrum Offshore Racing Club (Bodrum), Marmaris International Racing Club (Marmaris) and Gocek Yacht Club (Gocek)

[8] Rating is a coefficient that multiply with its race time and other factors after the race comes up from yachts height and other measurements.

TEAM	MODEL
ARCORA - 4 KMS RC	A 40 RC
ENCORE	A 35
EKER YAYIK AYRAN	
DRAGUT	
WALKABOUT	BENETEAU FIRST 24
INFINITI	BENETEAU FIRST 40.7
MAPFRE-FAT LEMON	
DRAKULA	
FIT LEMON	
UZUN ICYC	
ESHQUIA	
GÖKOVA BLUES	
YAPI ARTI MOBY DICK	
CARA DE ROSA	BENETEAU FIRST 45
CAPRICORN	
FAIRWIND	BENETEAU FIRST 45
DEFİNE	BENETEAU FIRST 50
SAKE	BENETEAU FIRST 34.7
PASSION ONE	
SAFINAZ	
EXIT	
AQVAVIT	BENETEAU FIRST 44.7
AKMETAL	CORBY 29
HEDEF YELKEN / AYK	
SHARKY - FRANKE	DEHLER 34
SEHER	
SINGLESTAR	DUFOUR 44
TAXI JR DIVARESSE	FARR 30
TEAM SPIRIT	
MITO	
PROVEZZA 5	FARR 40
FLYINGBOX LEMON-ARKAS (Provezza 6)	
7 BELA	
ORIENT EXPRESS VI	FARR 55
FB-MAD MAX-ERGO-EKIPPO	FIGARO II
GOBLİN	
LADY B	GRAND SOLEIL 45
SEABEE	
BIG EASY	
SHAKER	J 122
CADI	J 105
YEDÝÇERÝLER	MAT 10
MATRAK	MAT 1010
MATADOR	
TURKCELL ALİZE	
BARBAROSSA II - FIRATPEN (MAFRE BY FARR LEMON)	MAT 12
ORION	
AMEERA XS	MELGES24
IDEFIX	MELGES 32
UKA UKA	
UNO (GOBLIN 3)	ONE TONNER
PROVEZZA 7	TP52
X-DREAM	X 35
AGGRESSIVO KAHVE DÜNYASI	
X-MACHINE	
MAD X	X41

Figure 212: Racing Fleet of Turkey[9]

[9] They are not total yachts in Turkey but they attend all races consistently and be placed in top 5 .

According to this table all types of yachts specified and categorized considering the cockpit shape and tools. Type 1 is 40-55 ft racer yacht without a seating unit and interior furniture. Type 2 is 40-55 ft racer-cruisers, which are using for both racing and cruising. Type 3 is 24-35 ft racer yacht and Type 4 is 24-35 ft racer-cruiser like as type2.

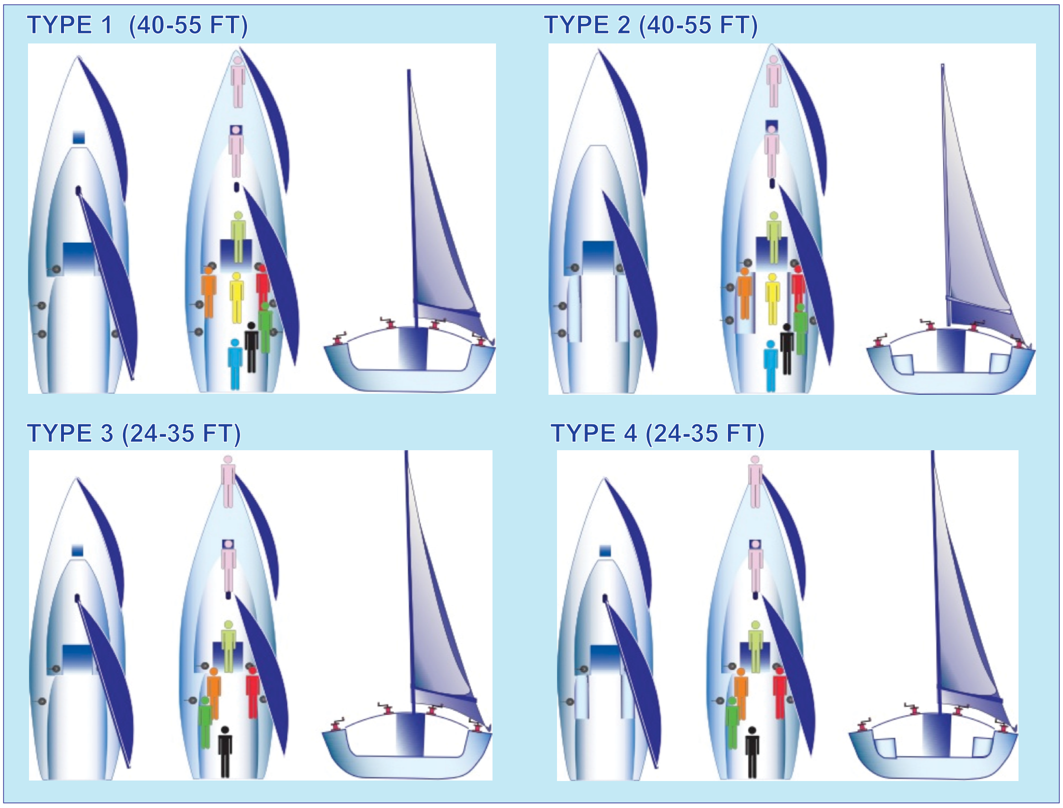


Figure 213: Cockpit Typologies

After the specification of racing fleet of Turkey, next step of research started with their users. In particular, all users were observed during the races especially in six maneuver time analyzed (tacking and gybing (with spinnaker set)): movements of performances were observed and bodies and locations were observed and in addition to these ethnographic observations, user surveys were used for getting to know their opinions, needs, problems and expectations. Total of 62 users participate to this survey.

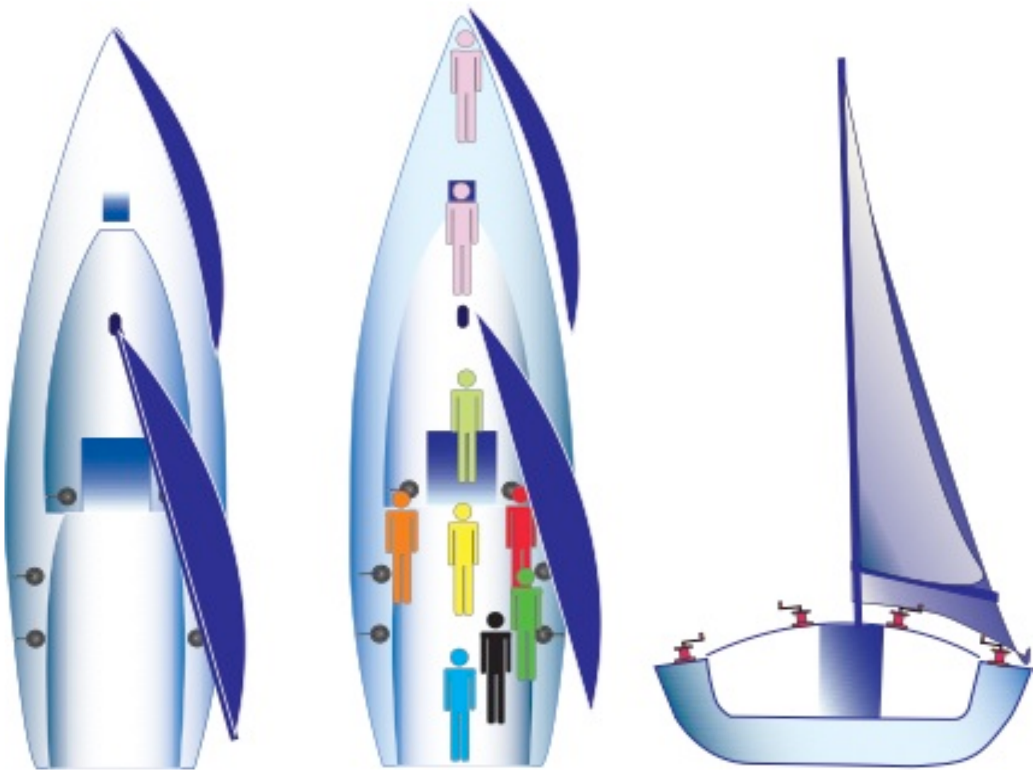


Figure 214 : Type 1 Cockpit Typology (40-55 ft)

Figure 215: Type 1 Cockpit Typology , FARR 40 , Hooligan Team , Photography by Seden

Erdi Hazarhun, 2011

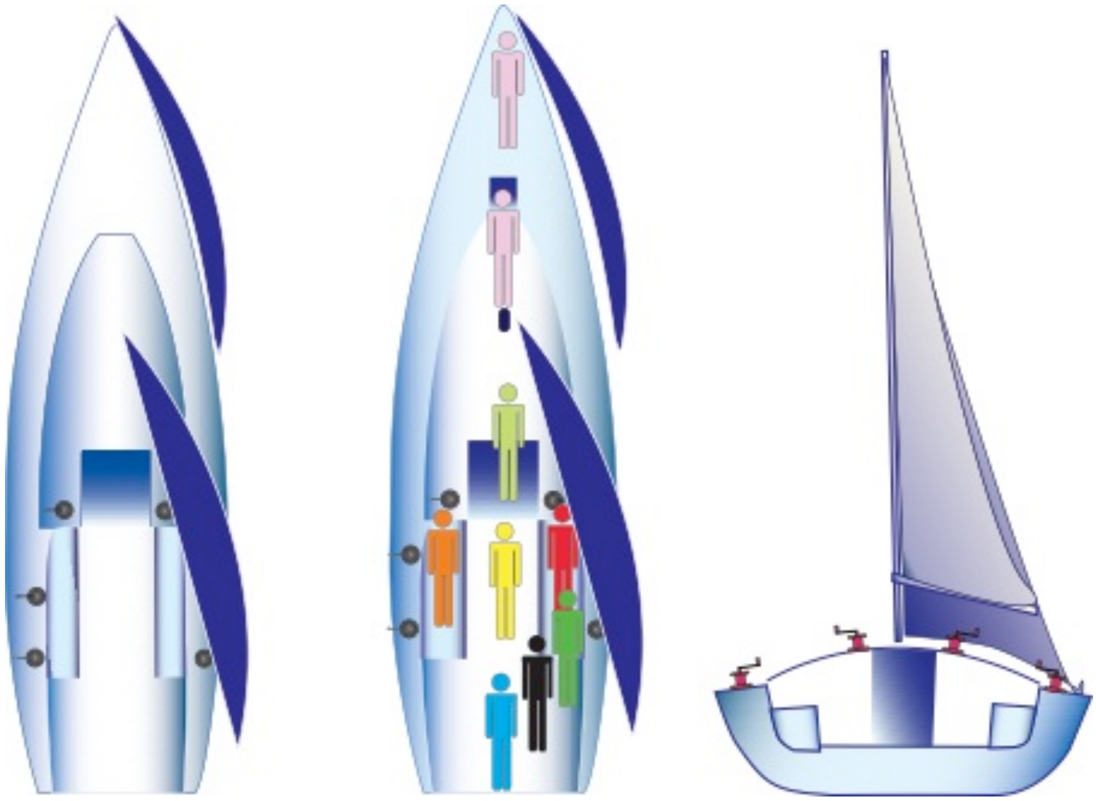


Figure 216 : : Type 2 Cockpit Typology (40-55 ft)

Figure 217: - Type 2 Cockpit Typology, MAT 12 , Mat 12 Team , Photography by Patricia Willocq

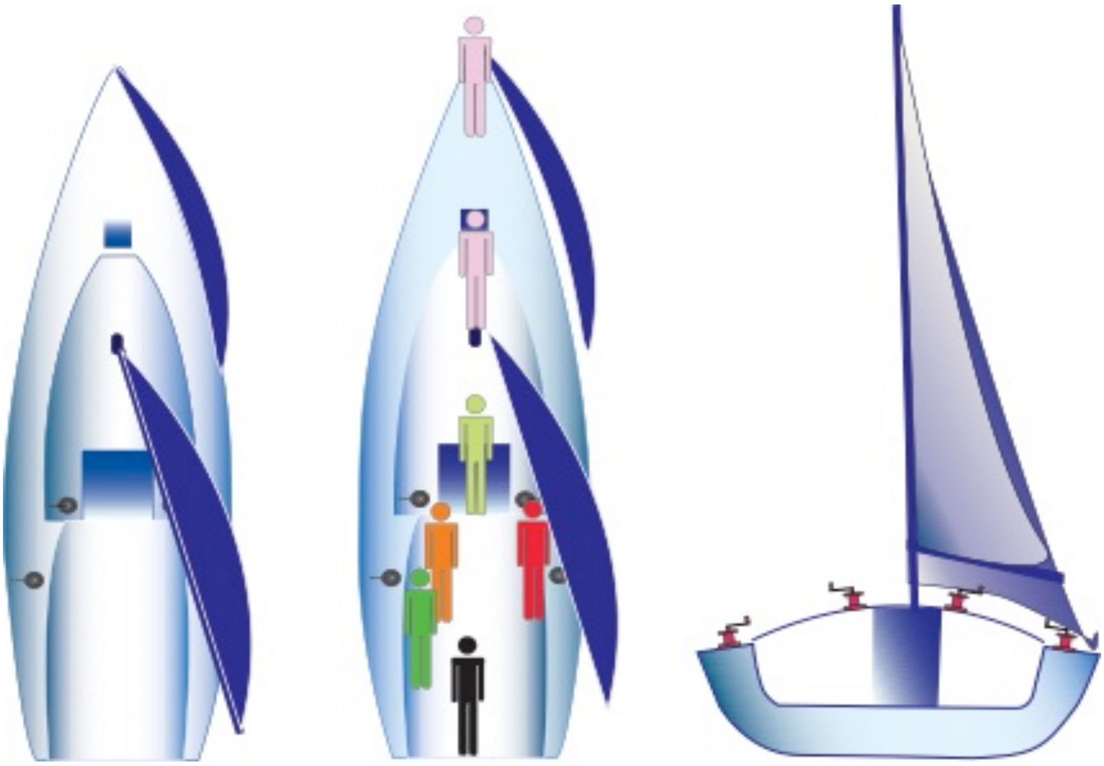


Figure 218: Type 3 Cockpit Typology (24-35 ft

Figure 219: Type 3 Cockpit Typology, Melges 24 , Ameraa Team , Photography by Kaan Verdioglu

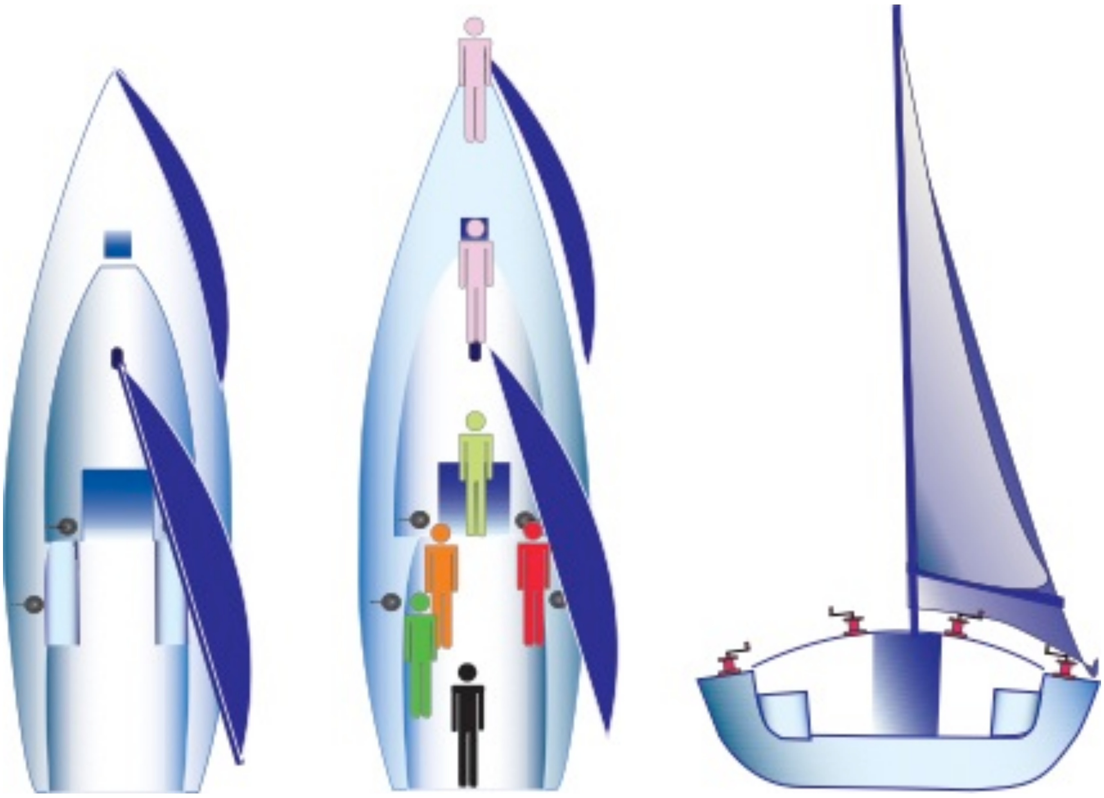


Figure 220: Type 4 Cockpit Typology (24-35 ft)

Figure 221 Type 4 Cockpit Typology, X35 , Aggressivo Kahve Dunyasi Team , Photography by Kaan Verdioglu

On the whole, approximately 9 users for each yacht were observed for Type1 and

Type 2 whose size in between 11-12 meter and approximately 7 users for Type 3 and Type 4 whose size in between 8-10 meter. Assessment was limited with these four groups and prepared in two categories, which are tools and environment (space). Usability and functionality are evaluated under these two categories for each user in all maneuvers.

4.2.1. Maneuver 1 (M1) : Upwind Tacking

If the yacht will sail to reach a upwind objective, it will be necessary to zigzag up towards it, changing direction each time by tacking (Coming About). When the tactician makes a decision to tack, he informs the helmsman and he will call out to his crew "Ready to tack". After this signals, the crew to ready the sheets.(sheets are the lines that control the mainsail and headsail). Readying the sheets means making sure that they are not tangled; that they will be free of any obstruction and that they are positioned to best facilitate carrying out the tacking maneuver. When the crew has readied the sheets the crew will yell, "Ready". The helmsman says, "Let’s Tack" to notify the crew that the turn up through the wind is being initiated. And the boat makes the turn, the bow of the sailboat begins to point more directly into the wind and the genoa and then the mainsail will begin to luff. At this stage and in light winds, the upwind genoa sheet can be released and the downwind genoa sheet can be tightened as the boat comes around onto the new tack.

For tacking maneuver, all observation incomes and marine literature gave us a lot of information. Considering the all information, work scheme has been done for tacking maneuver and users are marked on it. During the maneuver time, different users change their location and tools and at that time some problems can occur.

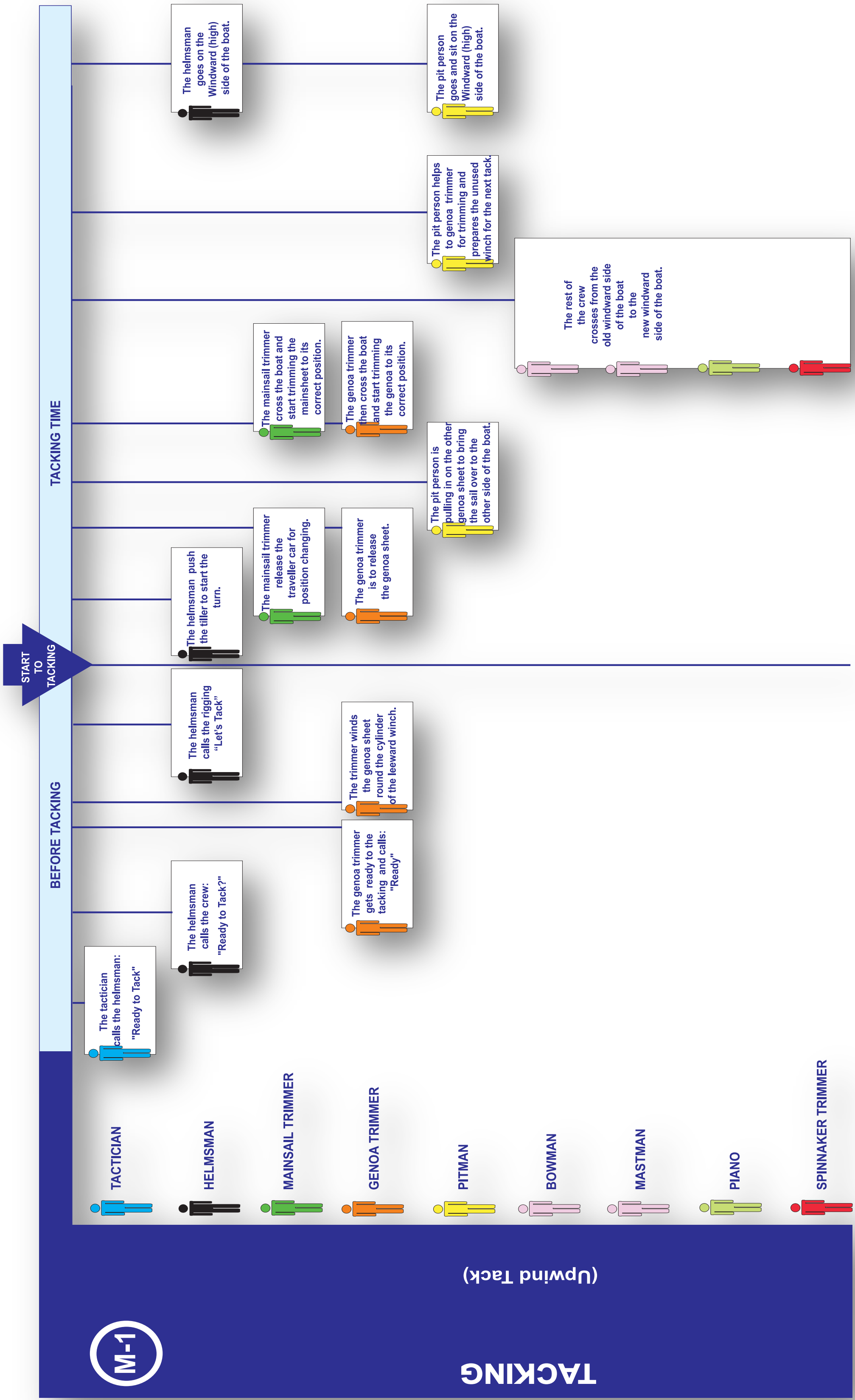


Figure 222 : Work Analysis of All Team in Tacking Maneuver

4.2.1.1. Helmsman

Firstly, work analysis started with helmsman’s task. A helmsman is an individual who is responsible for the steering on board. He/She can use tree different types of rudder. single steering wheel, double steering wheel and tiller.

Figure 223: Types of Rudders

Helmsman, who is working in Type 1 Cockpit, declares the tiller’s height as a problem on tacking time. Because, in tacking time, they have to jump on tiller and this movement can cause to accidents. This is a usability problem about tiller. According to market research results, some producers are using new design of tillers that have new lower shape and it is more ergonomic. Other rudders do not create any problem according to their users in Type 1.

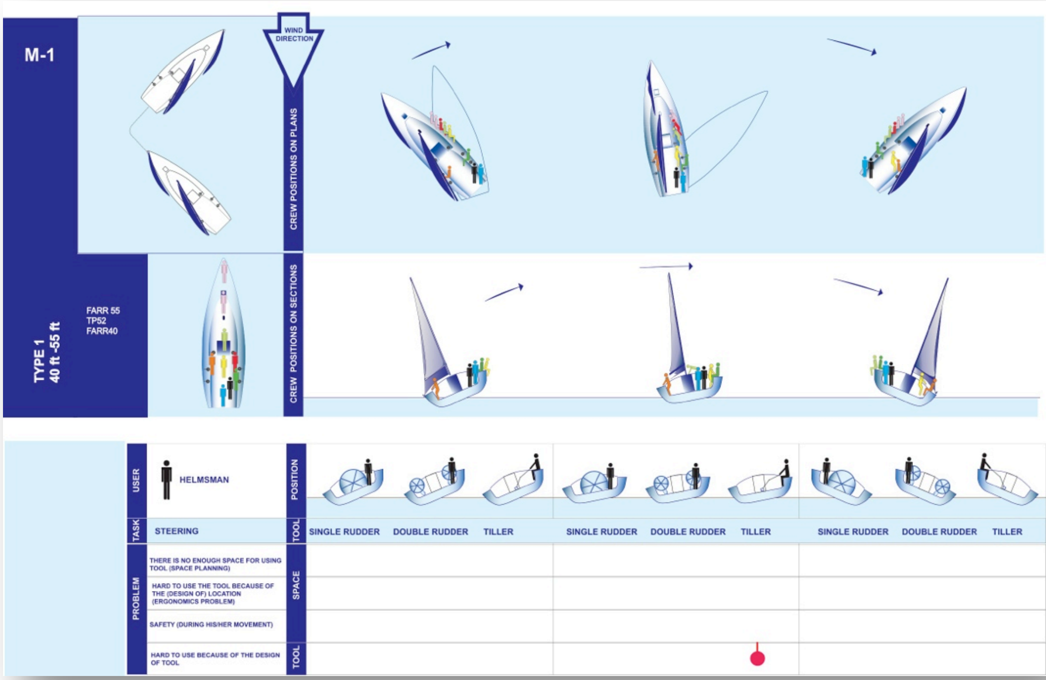


Figure 224: Work Analysis of Helmsman in Type1 Cockpit

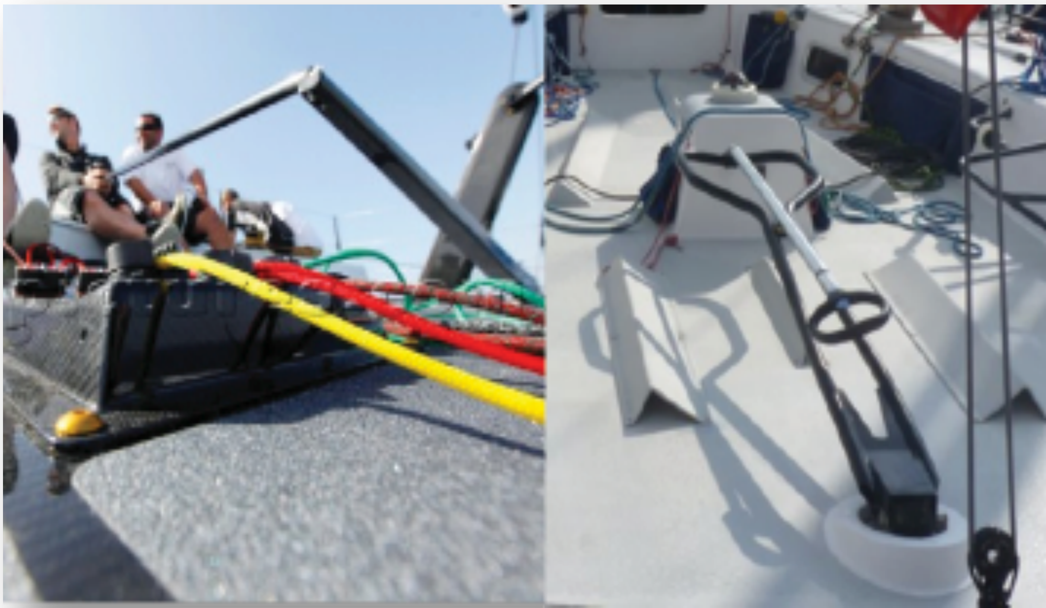


Figure 225: Design of Tiller (TP 52 and Farr 40 Racing Yachts) Photography by Seden Erdi Hazarhun

Helmsman of Type 2, mentioned both tiller's height and single steering wheel's location as a problem. In addition to problems of Type1, user defined single steering wheel's location very close to the sitting units and mainsail trimmers location. This closeness creates some collision and discomfort for helmsman. This is not specific problem for this maneuver; it's a general problem of Type 2 and Type 4 cockpit typology.

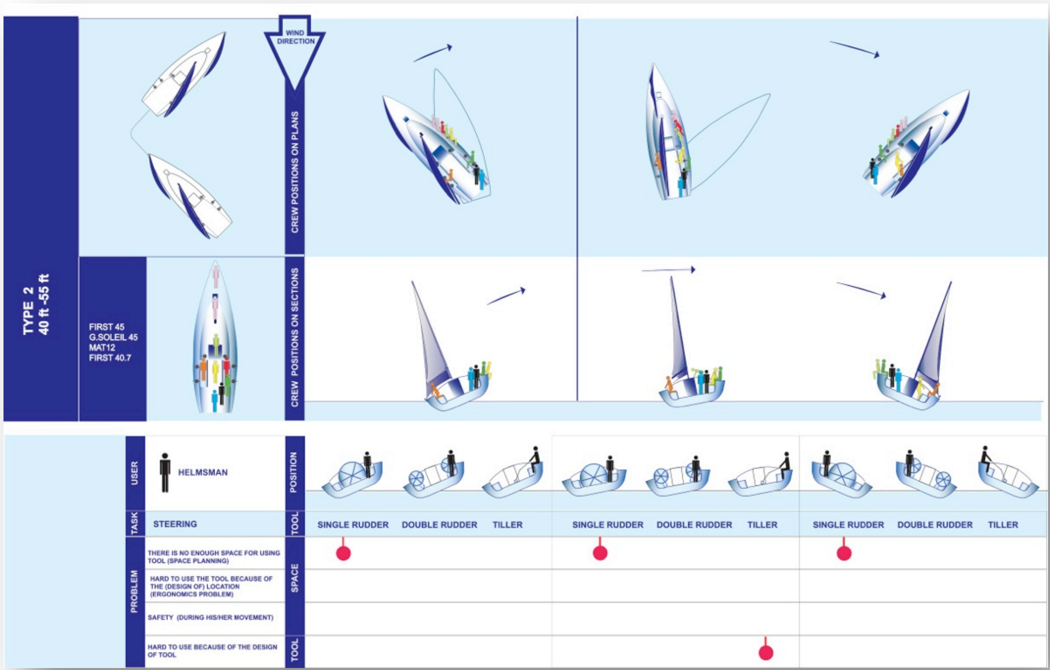


Figure 226: Work Analysis of Helmsman in Type2 Cockpit

Figure 227: Location of Single Steering Wheel in Type 2 Cockpit Typology

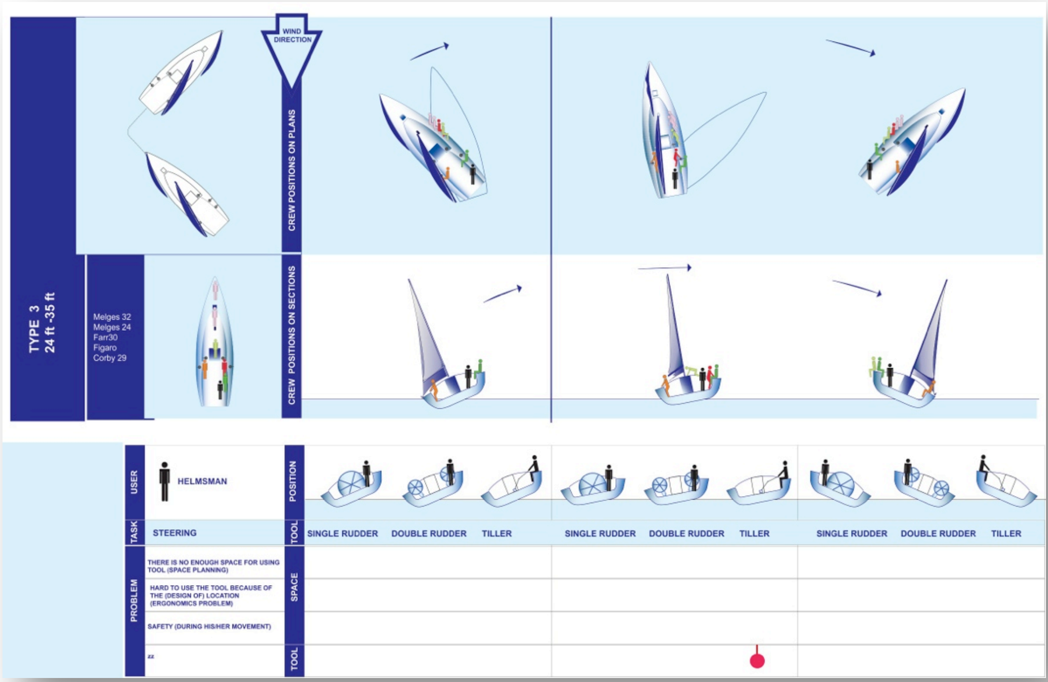


Figure 228: Work Analysis of Helmsman in Type 3 Cockpit

Figure 229: Location of Tiller in Type 3 Cockpit Typology

Helmsman of Type 3, mentioned tiller’s height as a problem too. On tacking time, “jumping on high tiller” defined hardest movement of helmsman because of the upright angle of boat.

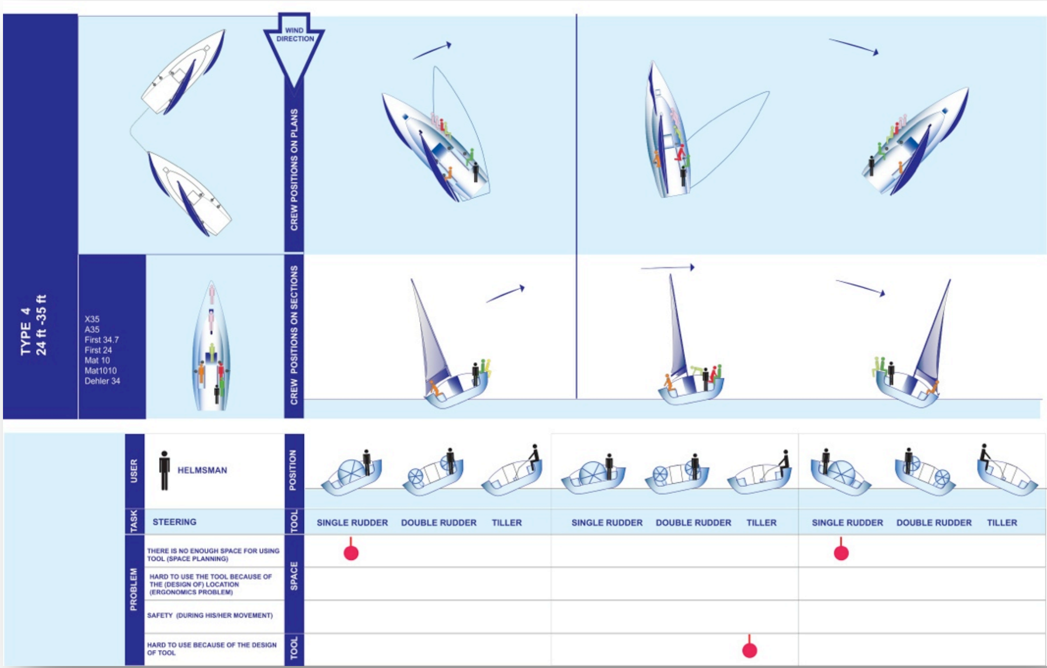


Figure 230: Work Analysis of Helmsman in Type 4 Cockpit

Figure 231:Location of Helms in Type 3 Cockpit Typology

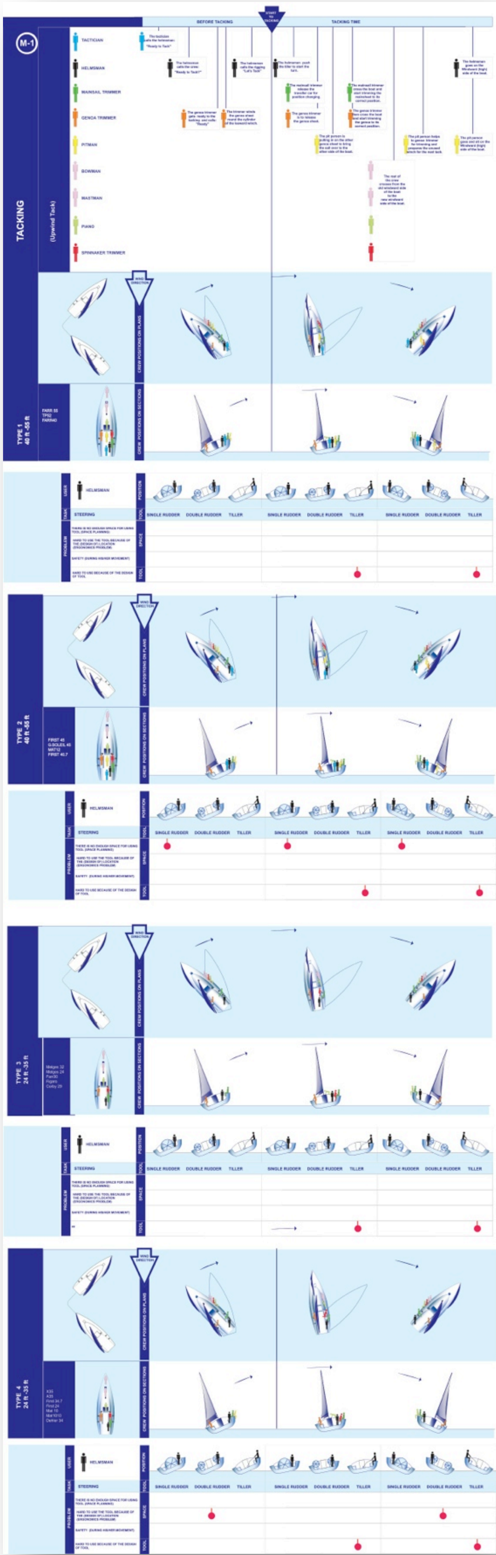


Figure 232 Work Analysis of Helmsman for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.1.2. Mainsail Trimmer

The mainsail trimmer is responsible for monitoring the boat's upwind performance, trimming to keep the boat sailing fast, pointing high, and in balance and controls mainsail. He/she controls the traveler position of the boom and keeps the boom centered (traveler to windward) until overpowered. According to the wind conditions, the traveler is used to make quick adjustments and mainsail trimmer uses winches to fine adjustments in detailed. He/she uses mainsheet on winches and extracts the appropriate power from the main in balance with the genoa (headsail)

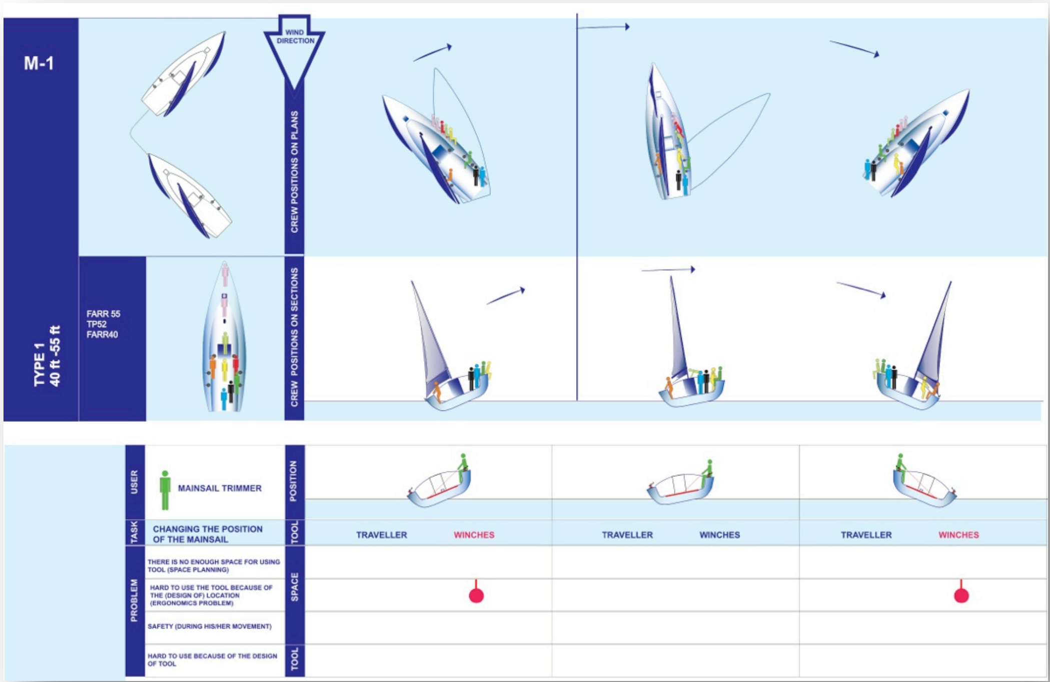


Figure 233: Work Analysis of Mainsail Trimmer in Type 1 Cockpit

Type 1 Cockpit typology includes Farr40, TP52, Farr 55 yachts which are very special racing boats. Designer Bruce Farr who is doyen of the yacht design sector designs all of them. According to users of these yachts, there are not too many problems, nevertheless the problem point for mainsail trimmer is winches and they need to use foot stops for using in upwind course as seen below because of the power of mainsail. (*Figure 234)* Sometimes they need one more person to pull mainsheet and the other person uses winches because of the power of wind in hard weather.

Figure 235: Mainsail Trimmer in Type 1 Cockpit

Type 2 Cockpit typology includes racer-cruiser yachts like as Mat 12, X41, Beneteau First 45, Beneteau First 40.7…etc. These types of yachts have seating unit in cockpit area and create space problems for users. Some designs allow to mainsail trimmer wider space for using tools. Seating units are truncated where his/her work area starts and this approach creates convenience for their work and traveller and other tolls place in this wider space more comfortable. (Figure:) Otherwise they have to sit side of boat and put their foot on sitting unit. This form of living hinders to use foot stop and they can't use their tool efficiently because of the uncomfortable working area.

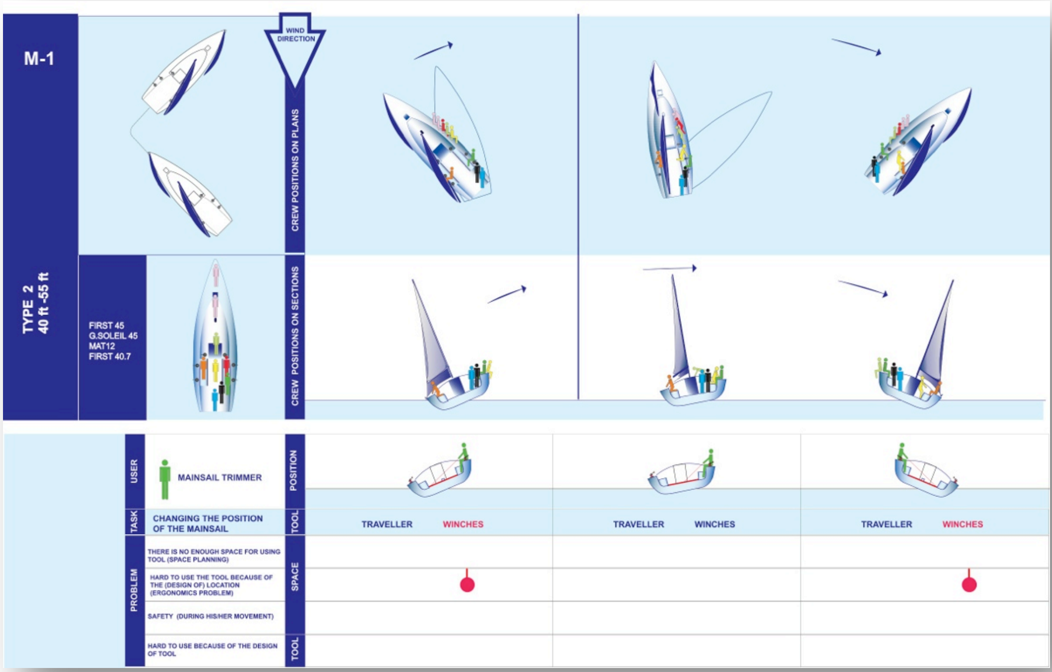


Figure 236: Work Analysis of Mainsail Trimmer in Type 2 Cockpit

Figure 237: Mainsail Trimmers of Mat 12 and Beneteau First 40.7 Yachts.

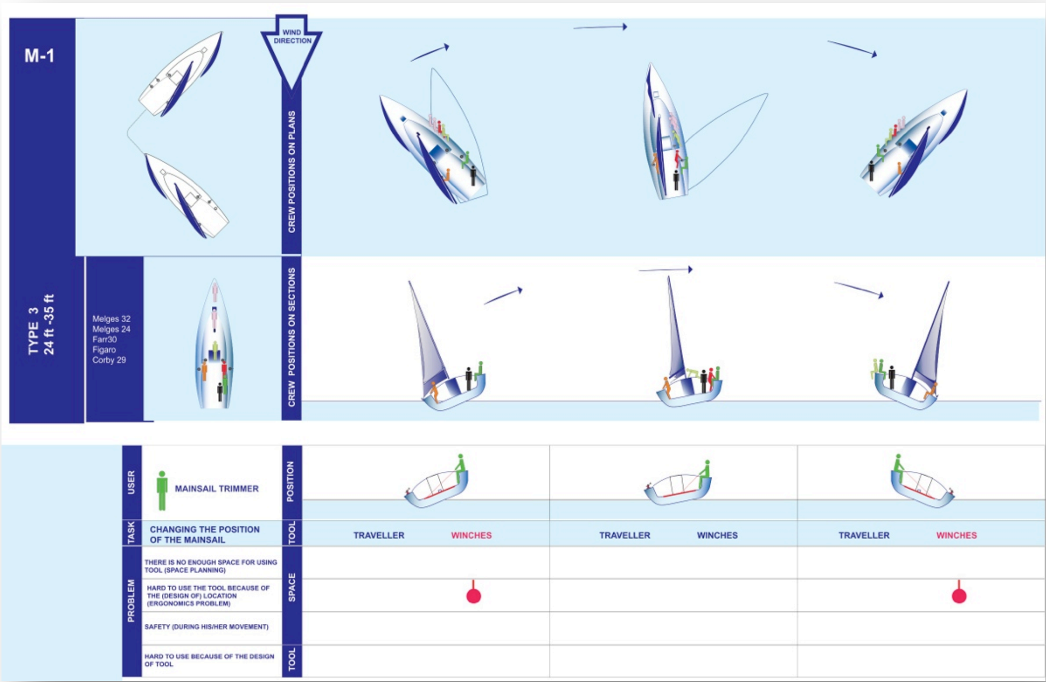


Figure 238: Work Analysis of Mainsail Trimmer in Type 3 Cockpit

Type 3 Cockpit typology includes racer yachts like as Melges32, Farr 30, Melges24, Beneteau Figaro…etc. This type of yachts designed as completely racer, so they have not seating units but these are small yachts. There are not enough winches and owner of yachts add winches more individually. For these type of yachts' mainsail trimmers has similar problem with Type 1's. They have

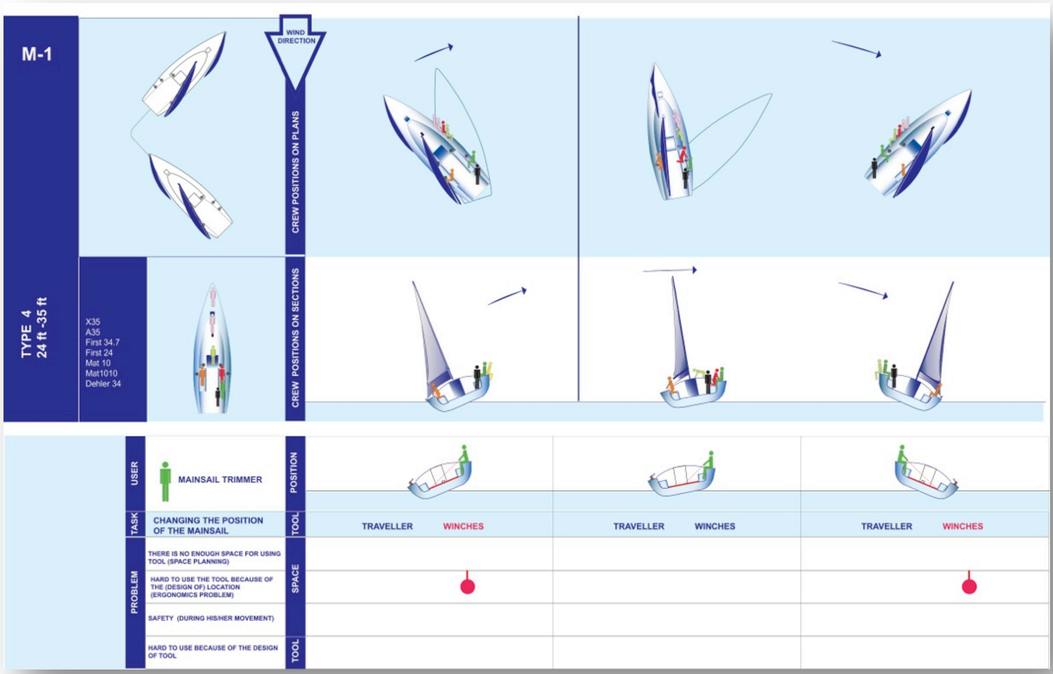


Figure 239: Work Analysis of Mainsail Trimmer in Type 4 Cockpit

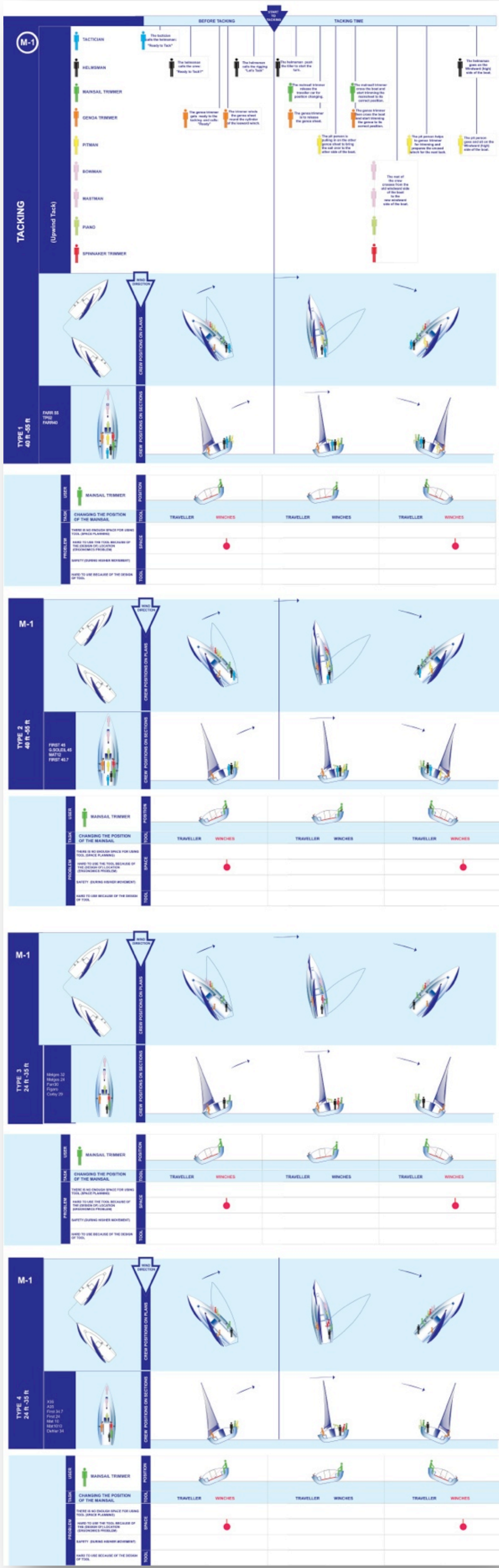


Figure 240 Work Analysis of Mainsail Trimmer for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.1.3. Genoa (Headsail) Trimmer

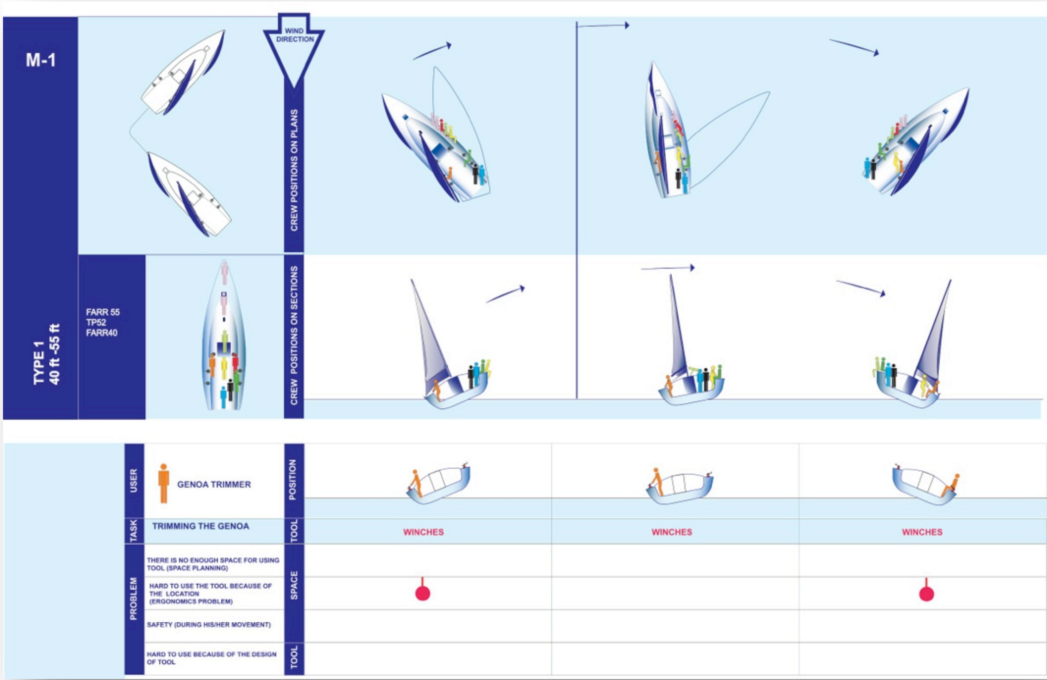


Figure 241: Work Analysis of Genoa (Headsail) Trimmer in Type 1 Cockpit

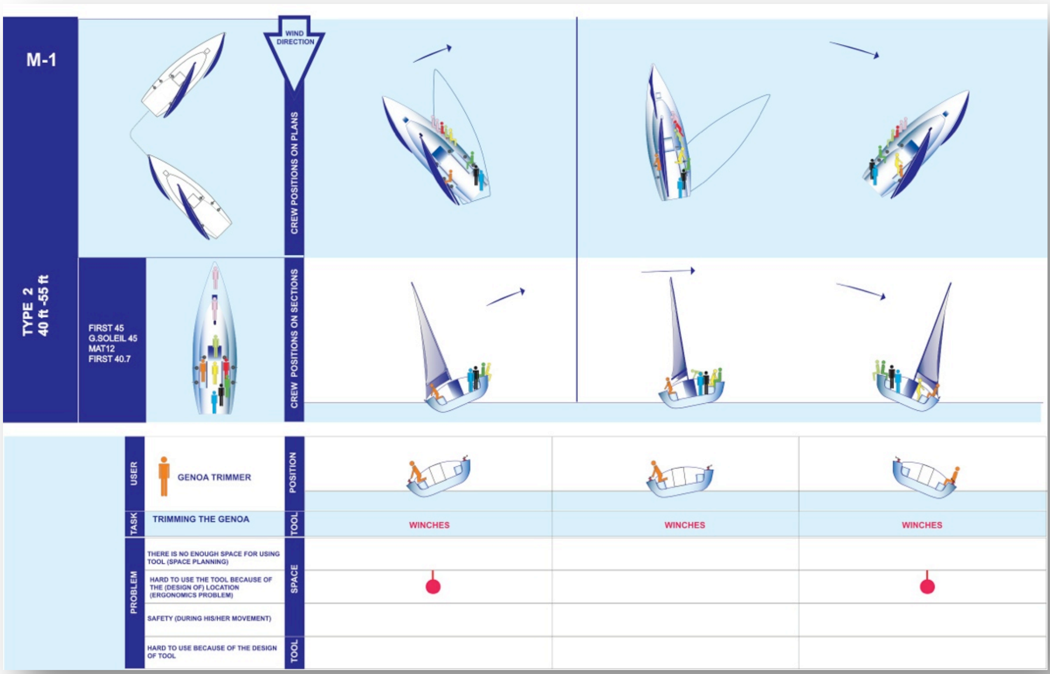


Figure 242: Work Analysis of Genoa (Headsail) Trimmer in Type 2 Cockpit

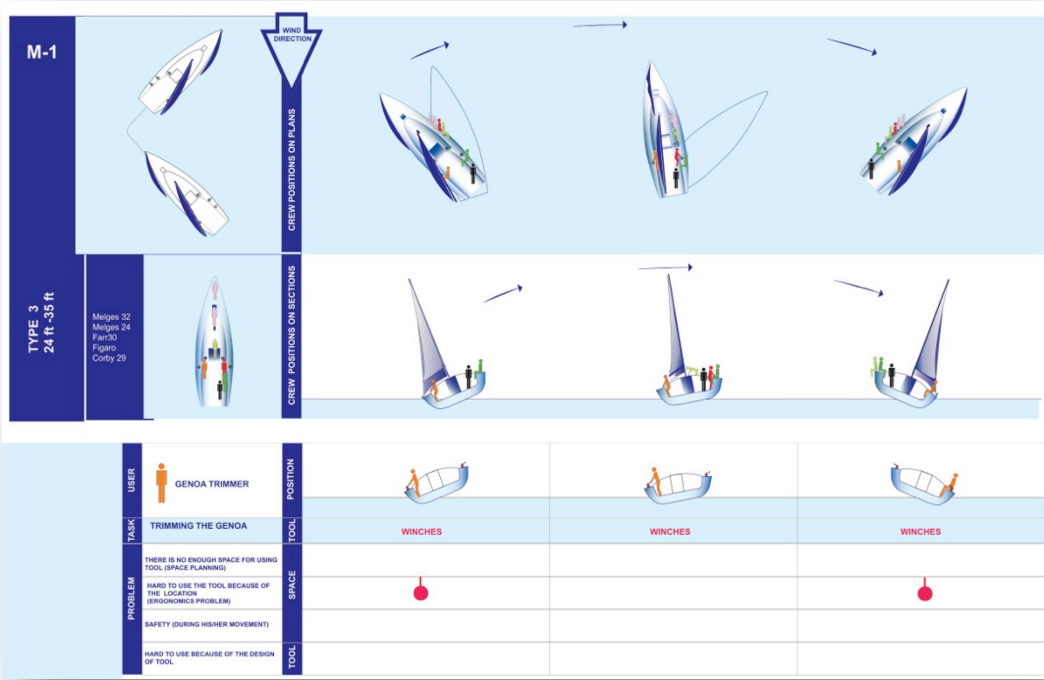


Figure 243: Work Analysis of Genoa (Headsail) Trimmer in Type 3 Cockpit

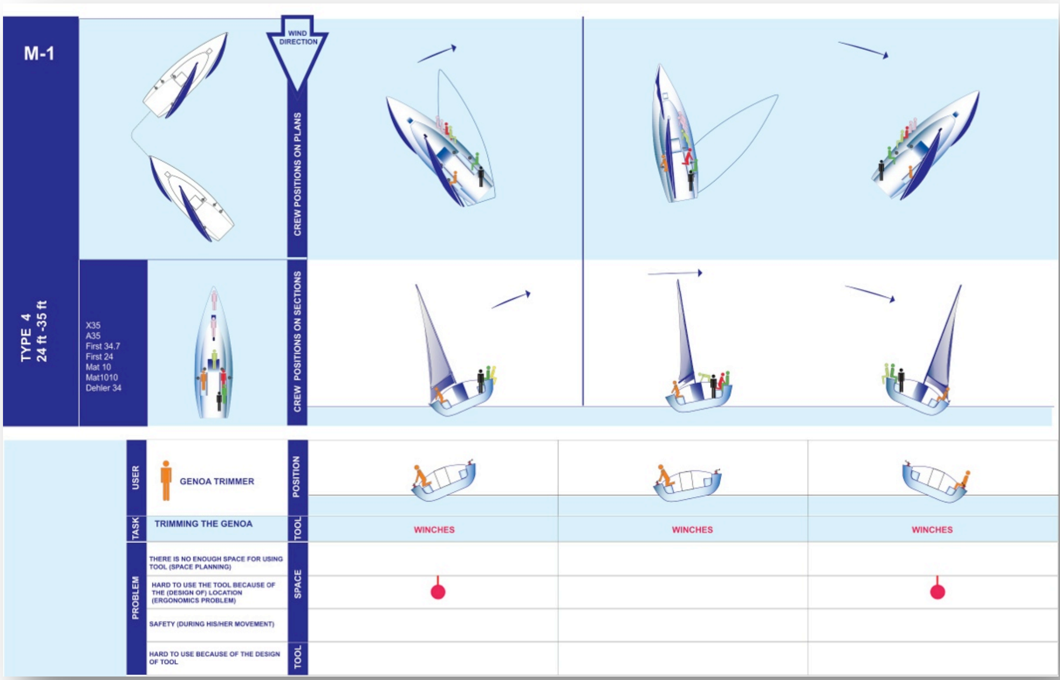


Figure 244: Work Analysis of Genoa (Headsail) Trimmer in Type 4 Cockpit

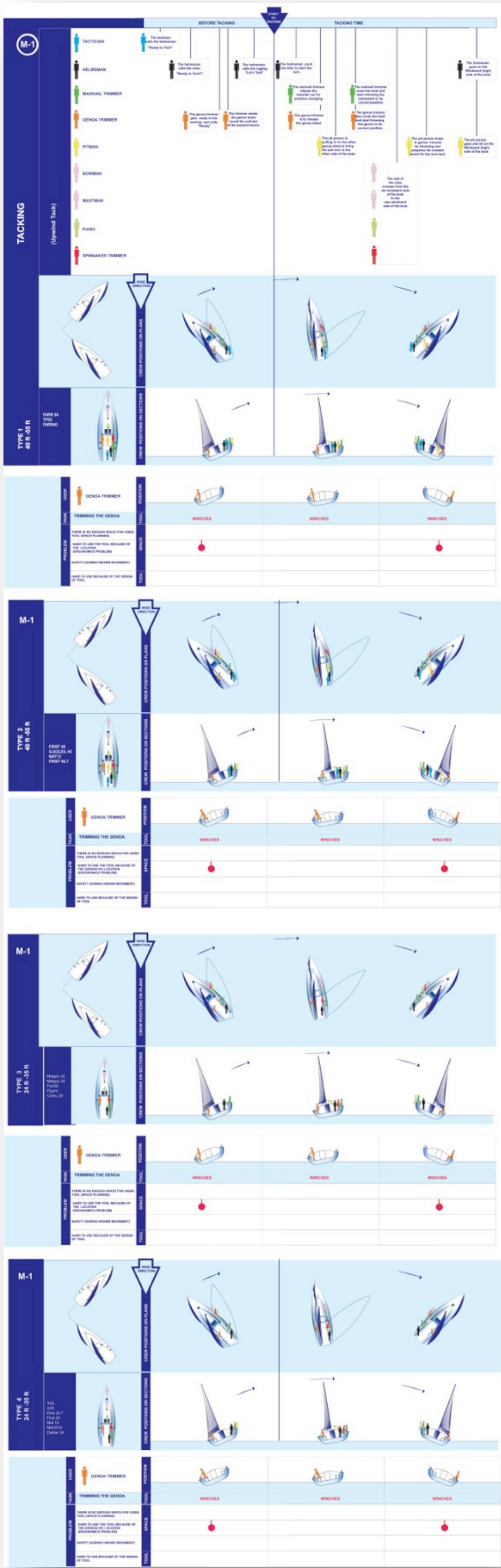


Figure 245: Work Analysis of Mainsail Trimmer for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.1.4. Pitman

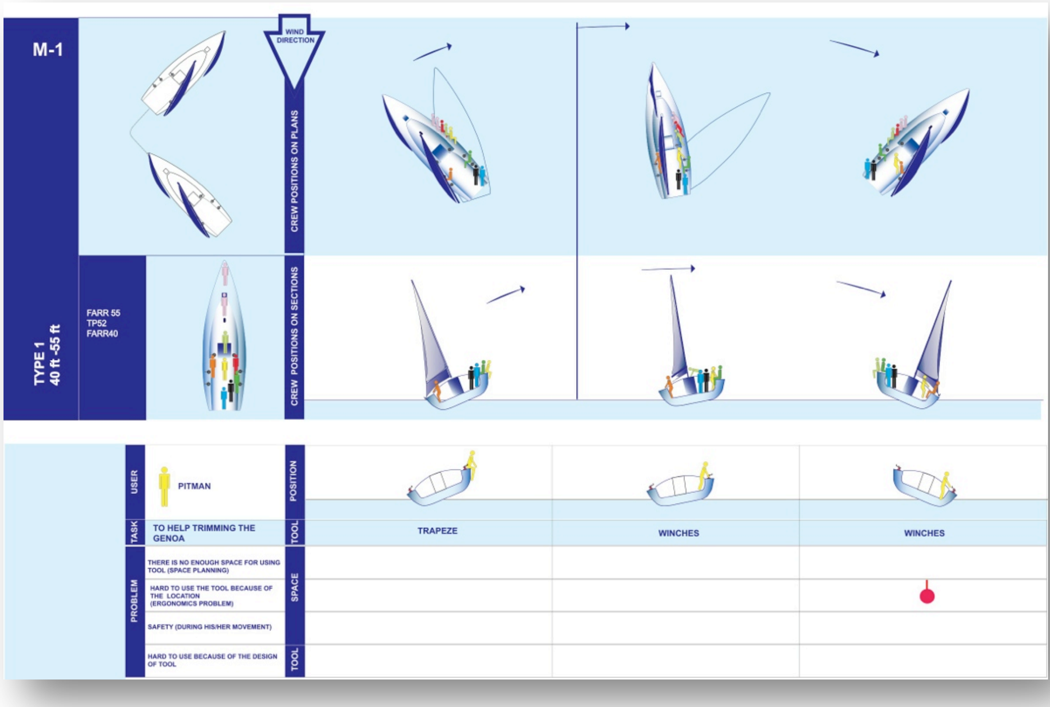


Figure 246: Work Analysis of Pitman in Type 1 Cockpit

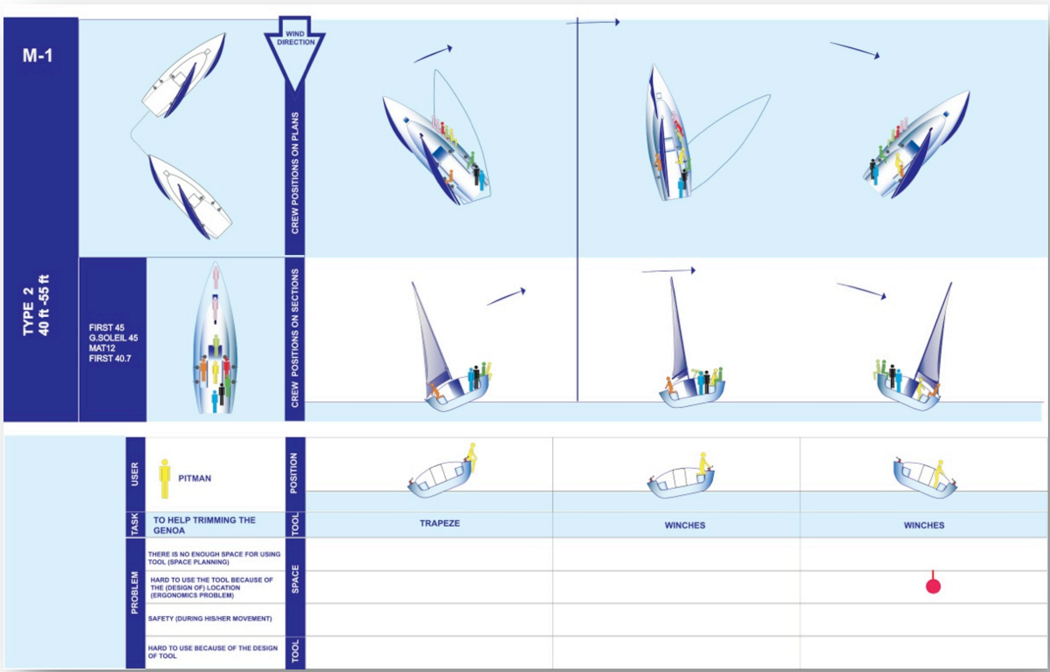


Figure 247: Work Analysis of Pitman in Type 2 Cockpit

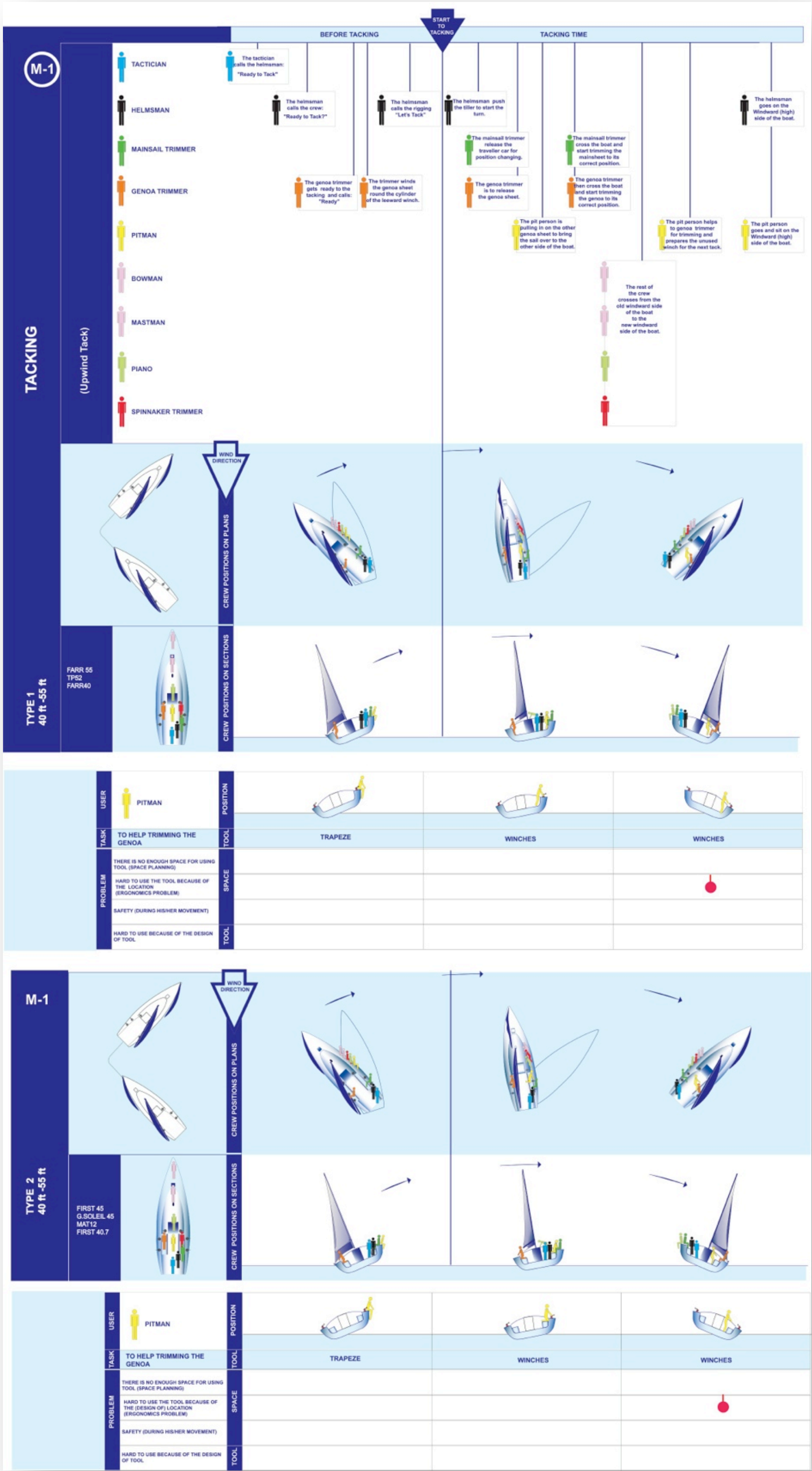


Figure 248: Work Analysis of Pitman for Type1/Type2 Cockpit Typology

4.2.1.4. Bowman

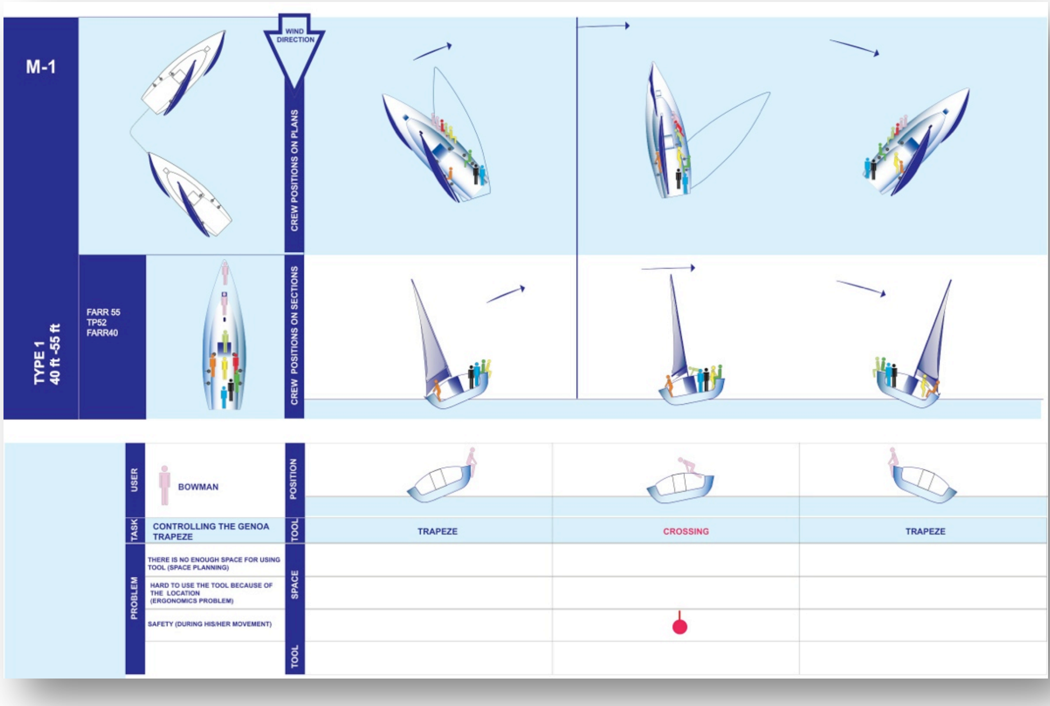


Figure 249: Work Analysis of Bowman in Type 1 Cockpit

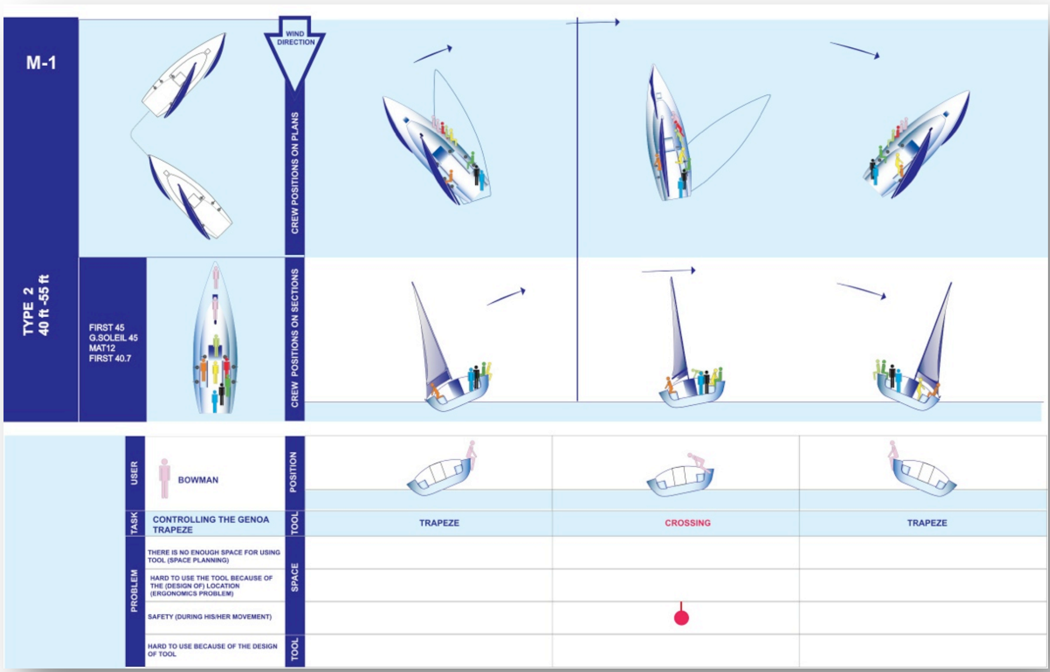


Figure 250: Work Analysis of Bowman in Type 2 Cockpit

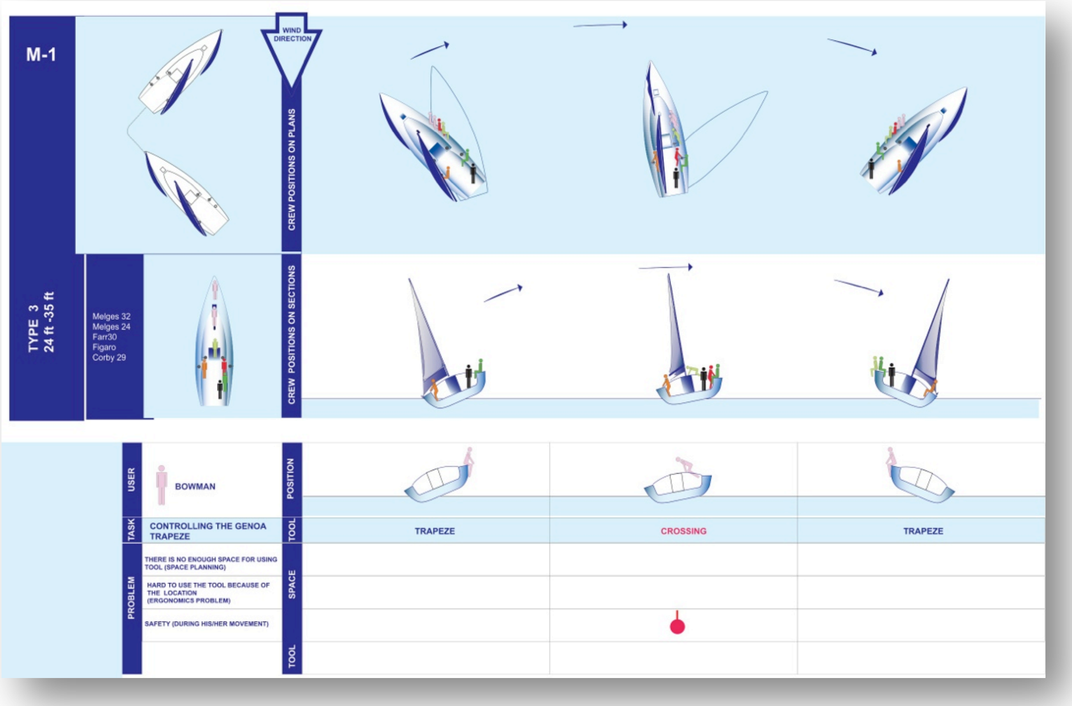


Figure 251: Work Analysis of Bowman in Type 3 Cockpit

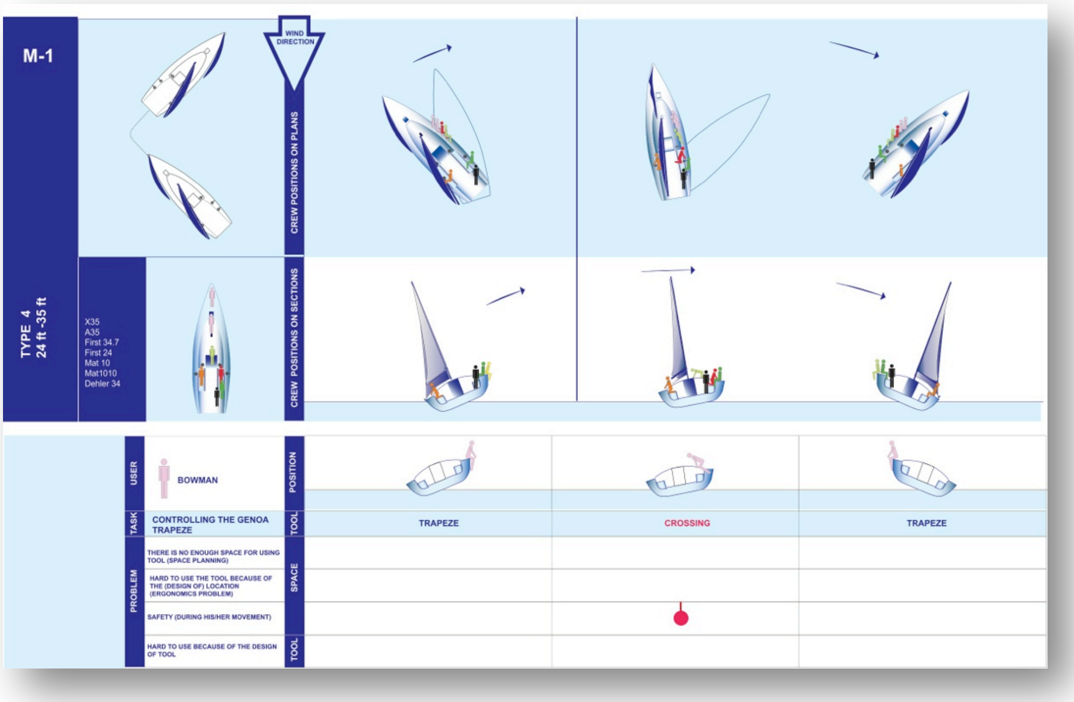


Figure 252: Work Analysis of Bowman in Type 4 Cockpit

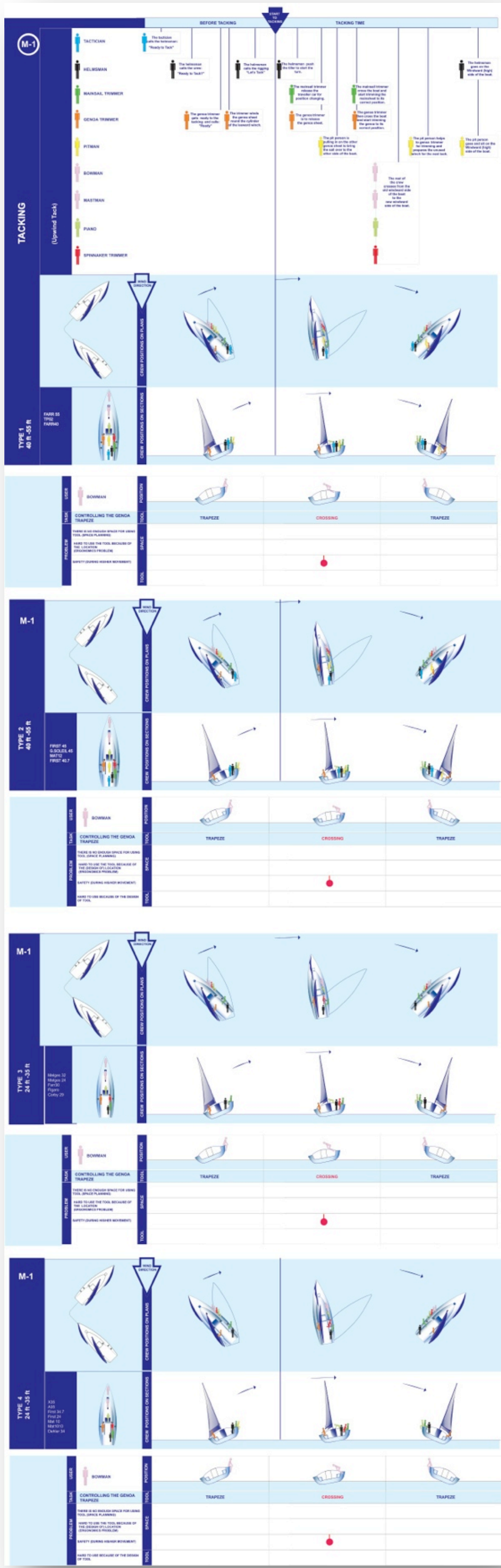


Figure 253: Work Analysis of Bowman for Type1/Type2 Cockpit Typology

4.2.1.5. Mastman

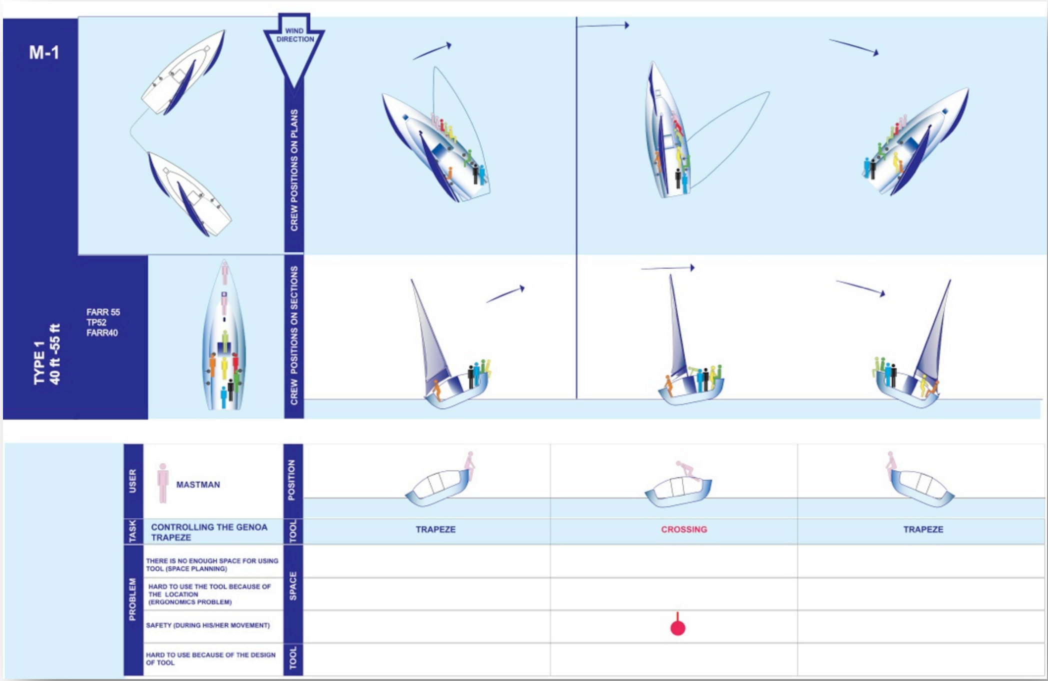


Figure 254: Work Analysis of Mastman in Type 1 Cockpit

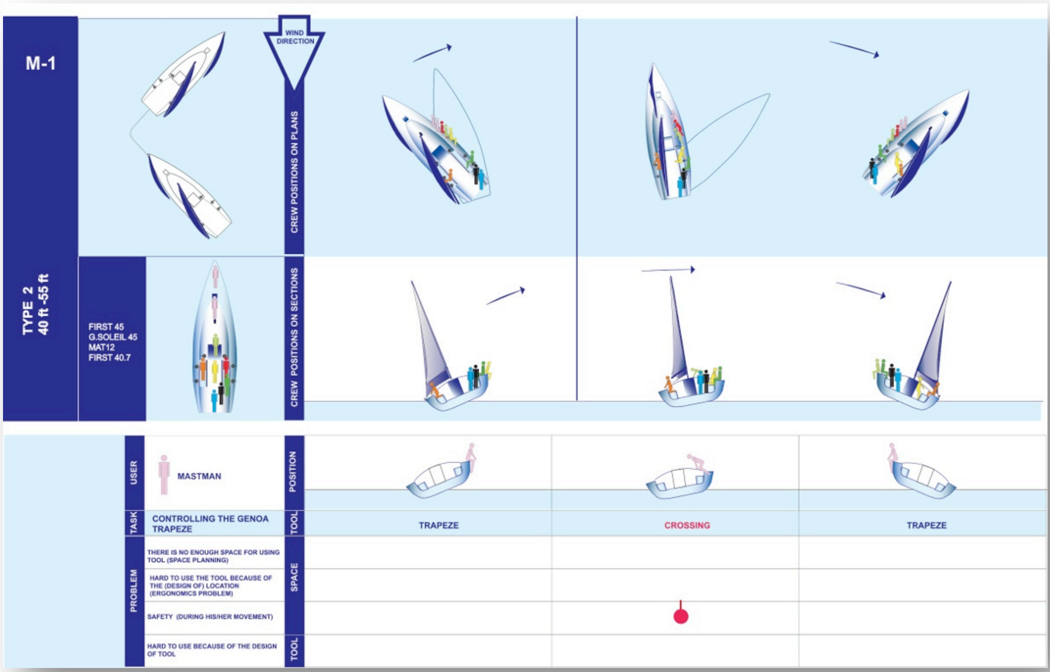


Figure 255: Work Analysis of Mastman in Type 2 Cockpit

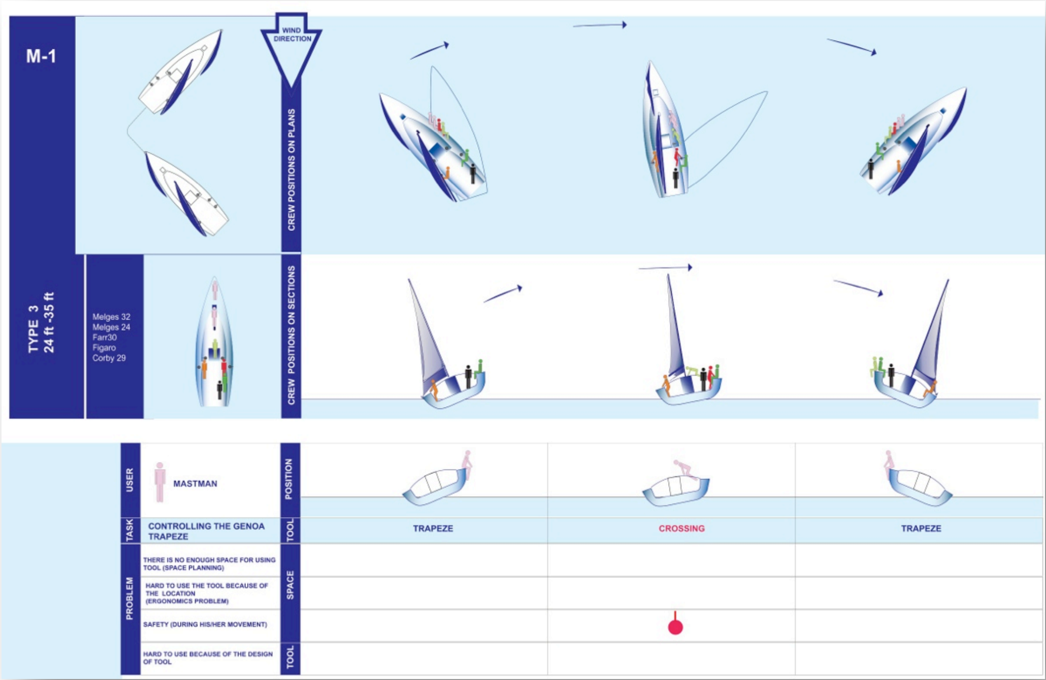


Figure 256: Work Analysis of Mastman in Type 3 Cockpit

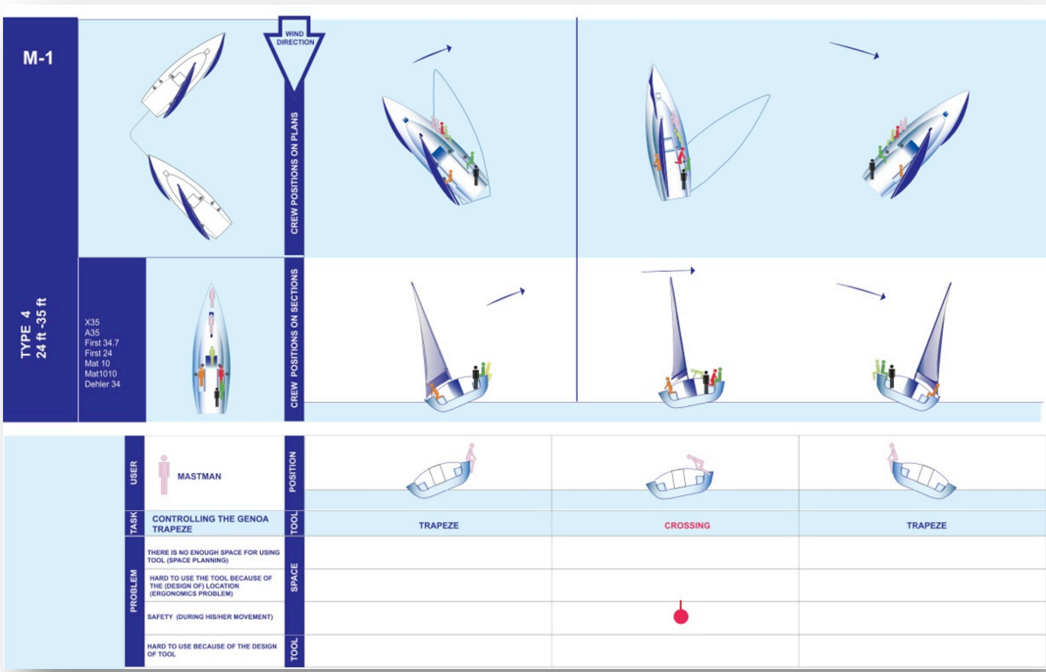


Figure 257: Work Analysis of Mastman in Type 4 Cockpit

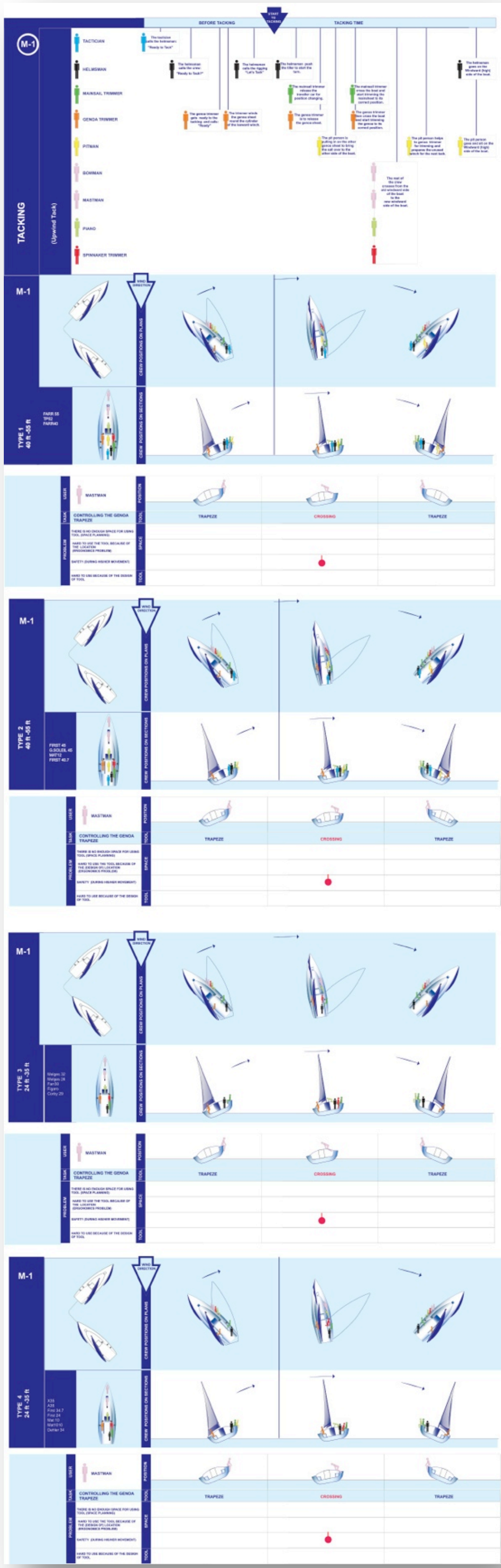


Figure 258: Work Analysis of Mastman for Type1/Type2/ Type3/Type4 Cockpit Typology

4.2.1.6. Piano

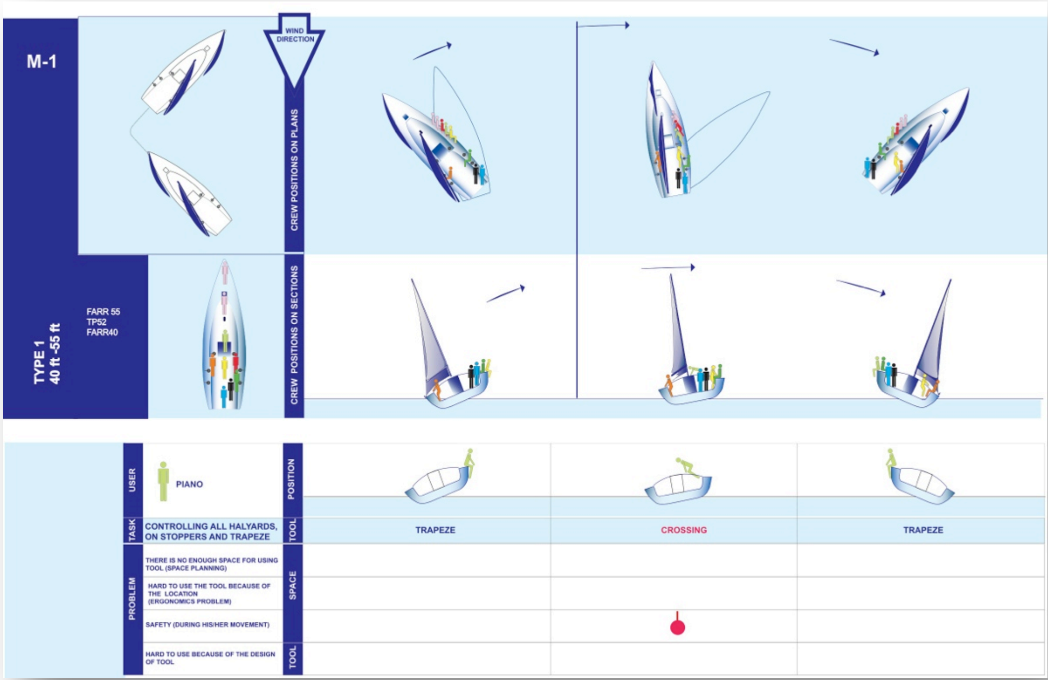


Figure 259: Work Analysis of Piano in Type 1 Cockpit

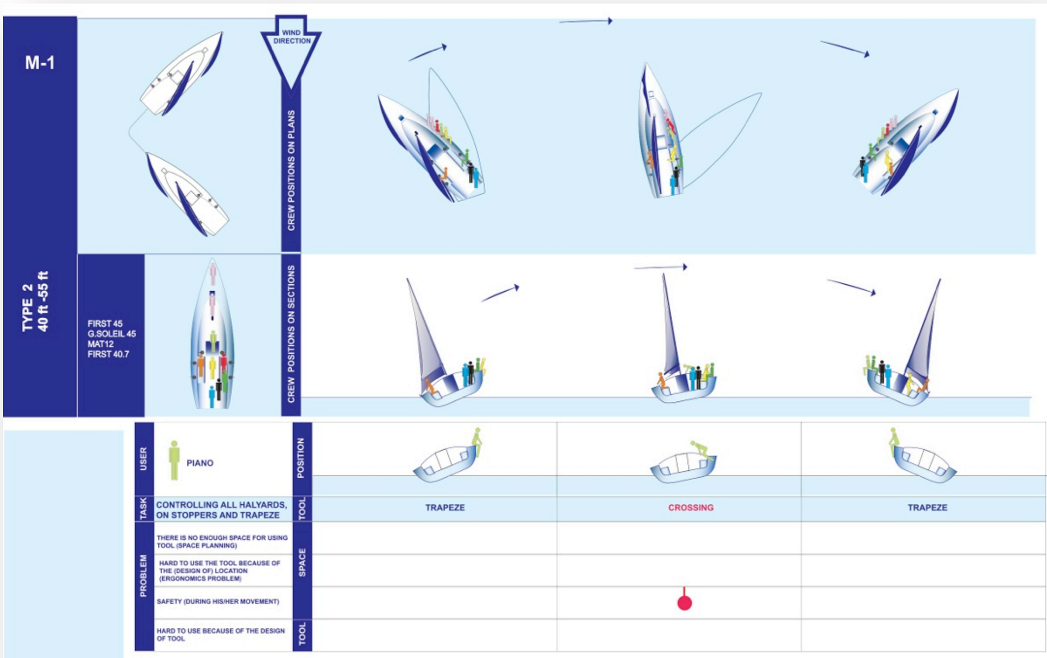


Figure 260: Work Analysis of Piano in Type 2 Cockpit

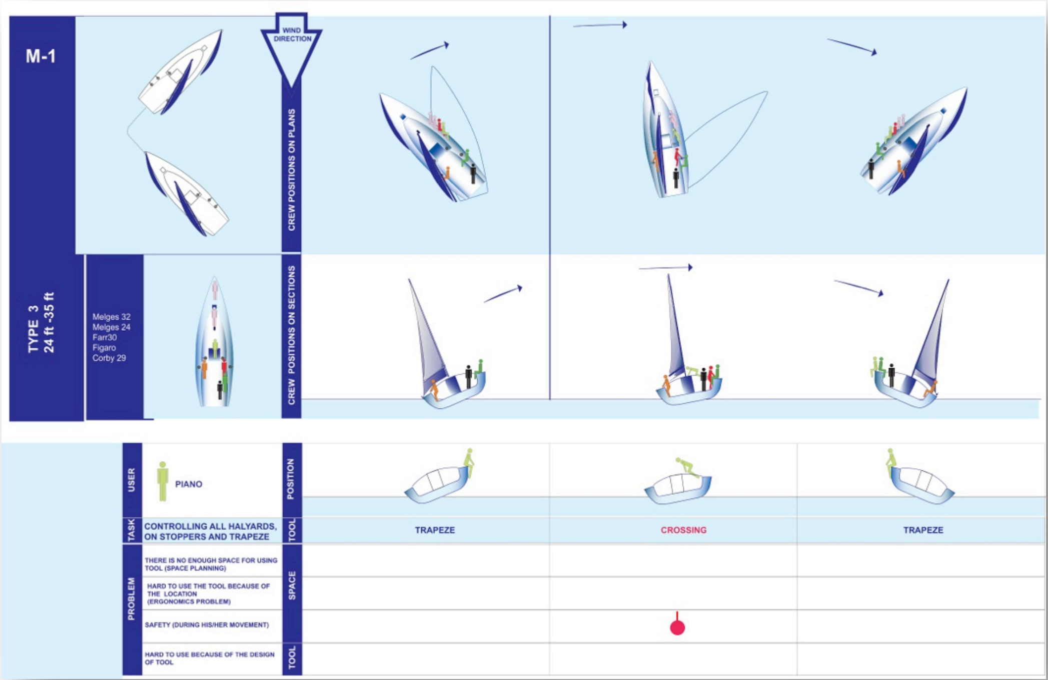


Figure 261: Work Analysis of Piano in Type 3 Cockpit

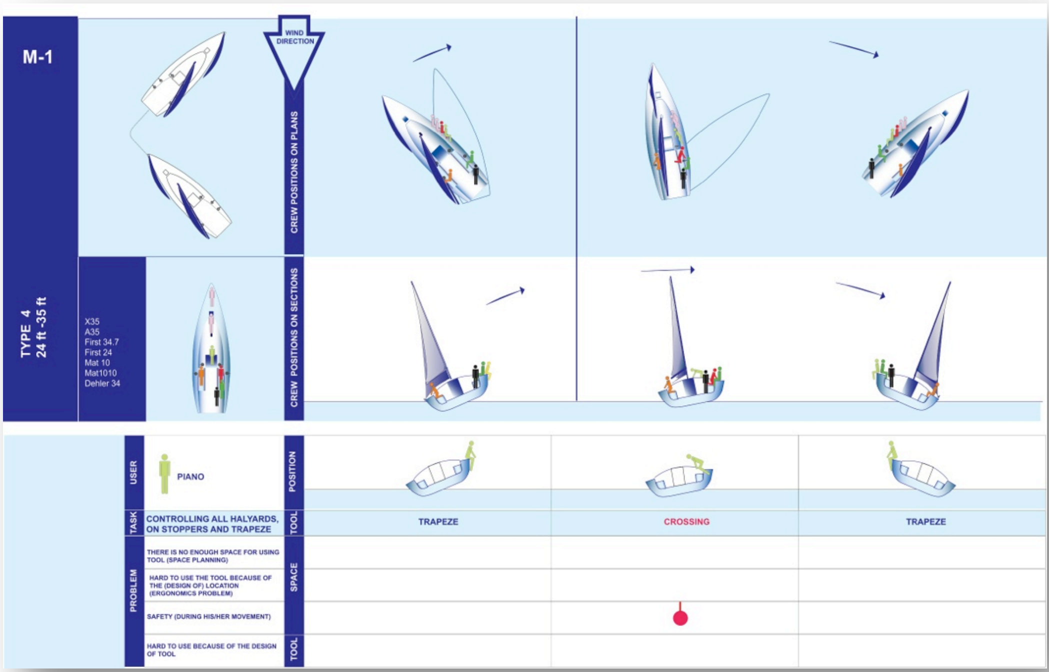


Figure 262: Work Analysis of Piano in Type 4 Cockpit

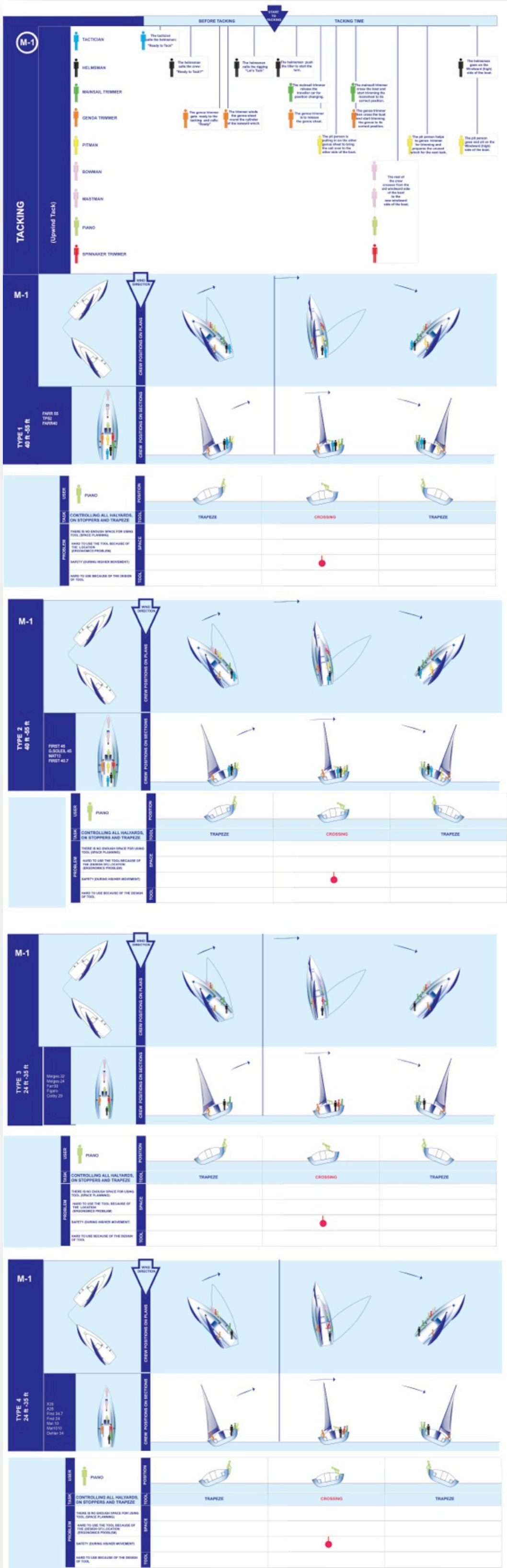


Figure 263: Work Analysis of Piano for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.1.7. Spinnaker Trimmer

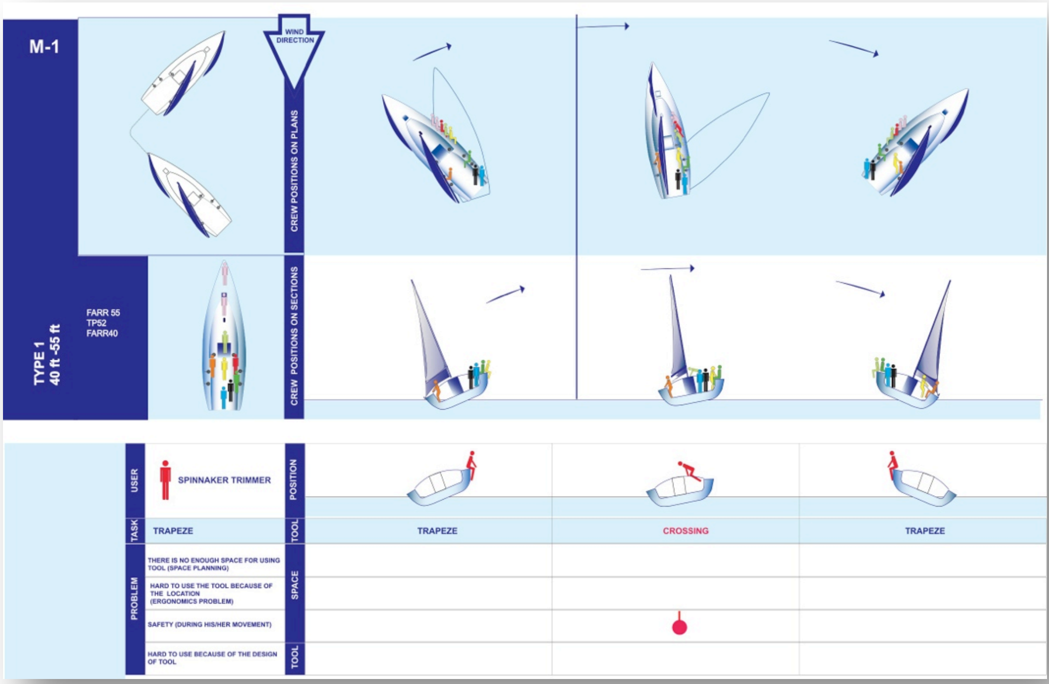


Figure 264: Work Analysis of Spinnaker Trimmer in Type 1 Cockpit

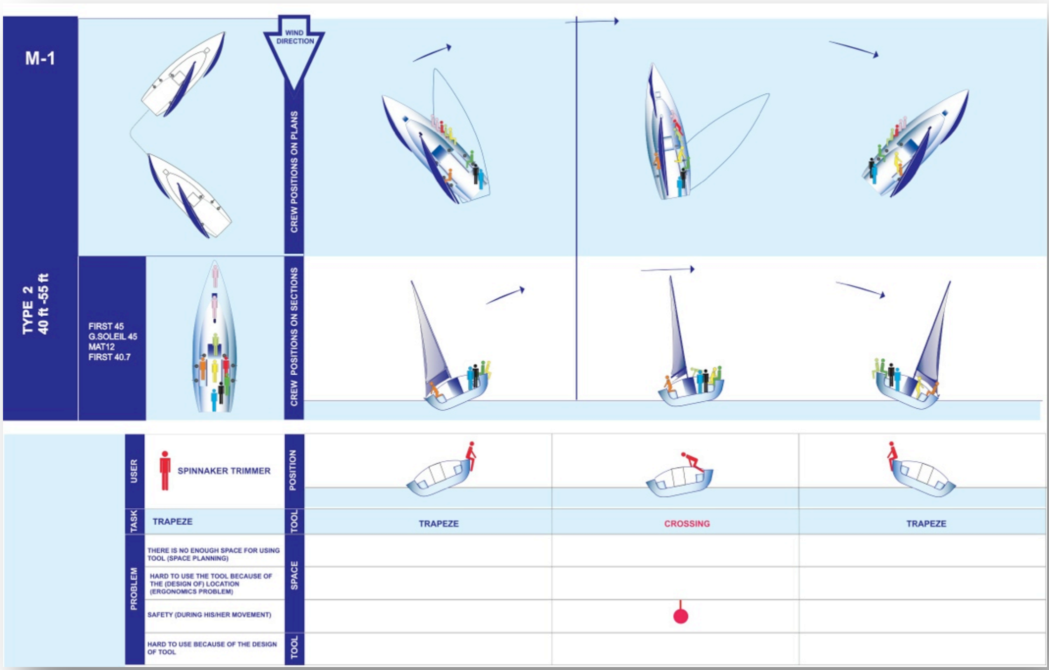


Figure 265: Work Analysis of Spinnaker Trimmer in Type 2 Cockpit

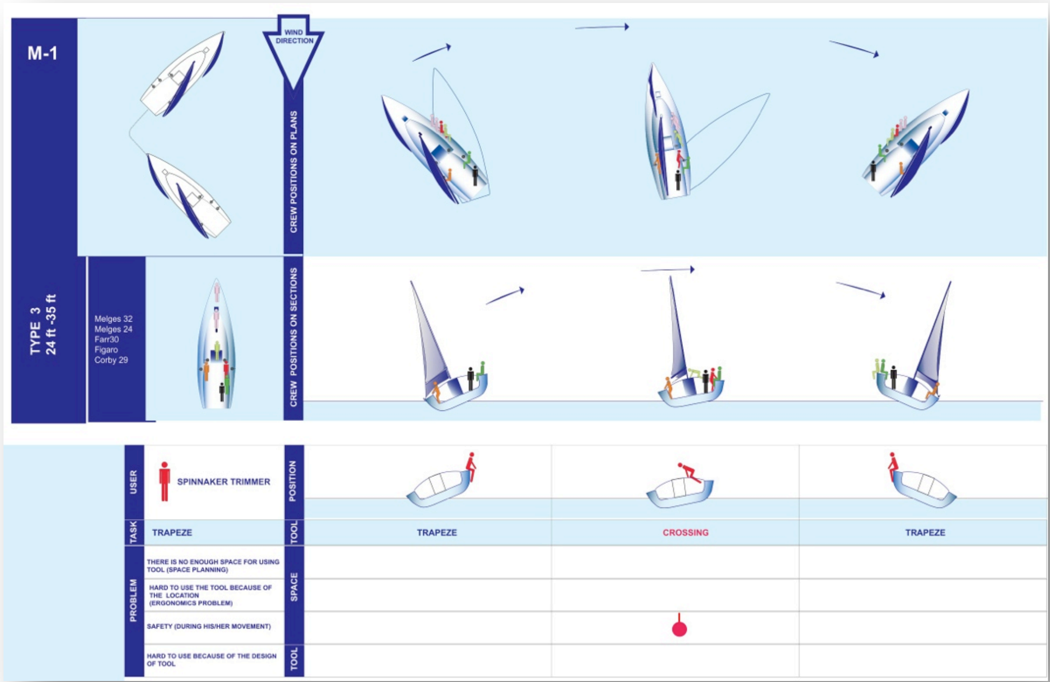


Figure 266: Work Analysis of Spinnaker Trimmer in Type 3 Cockpit

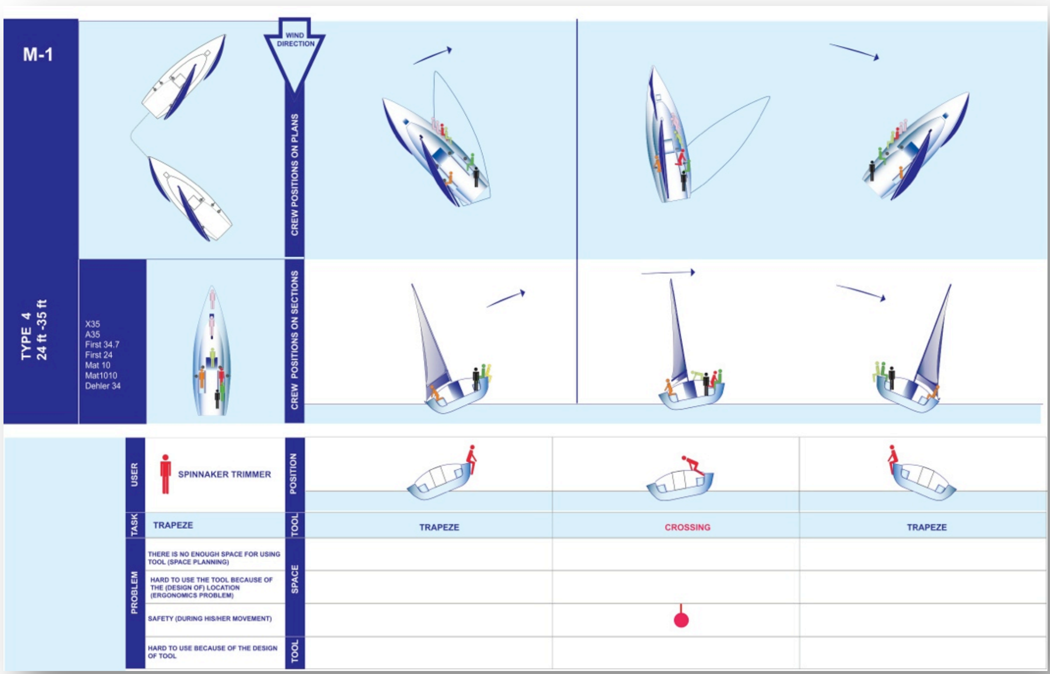


Figure 267: Work Analysis of Spinnaker Trimmer in Type 4 Cockpit

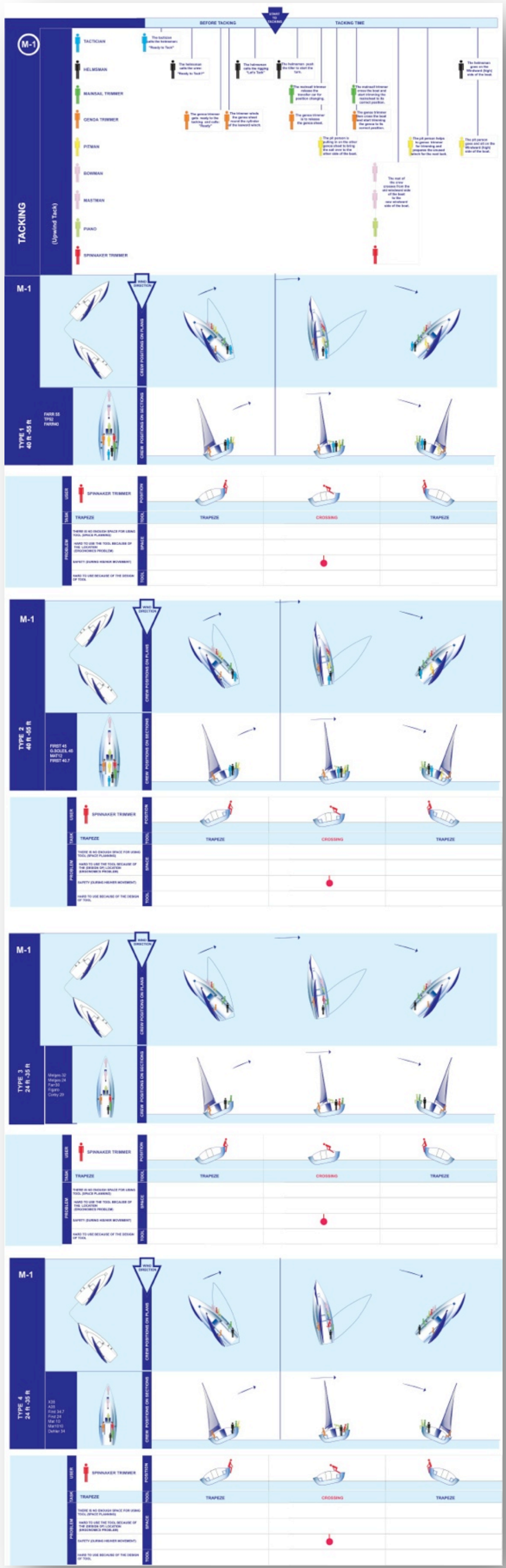


Figure 268: Work Analysis of Spinnaker Trimmer for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.1.7. Tactician

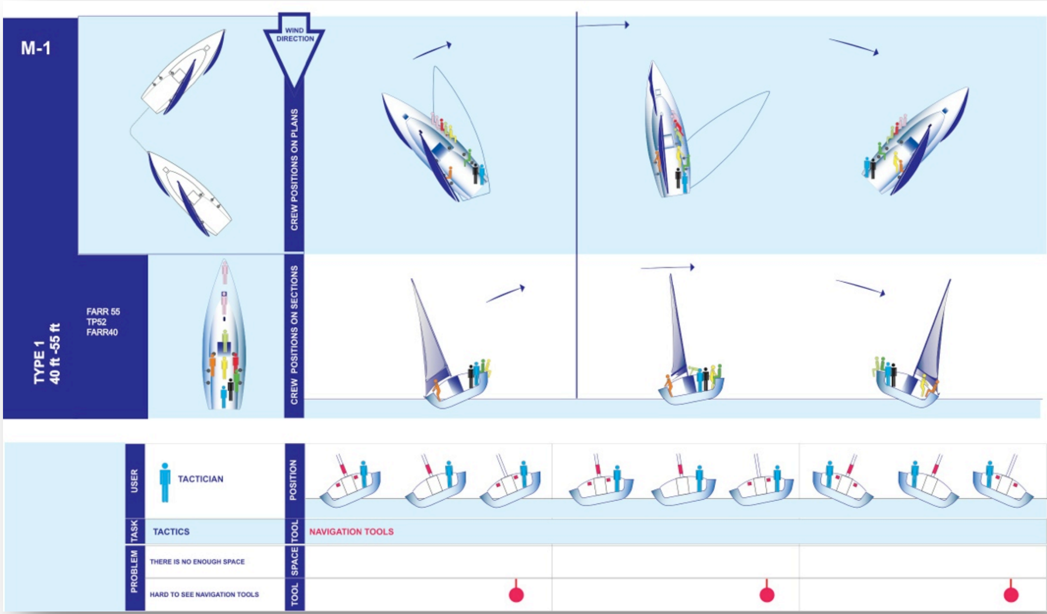


Figure 269: Work Analysis of Tactician in Type 1 Cockpit

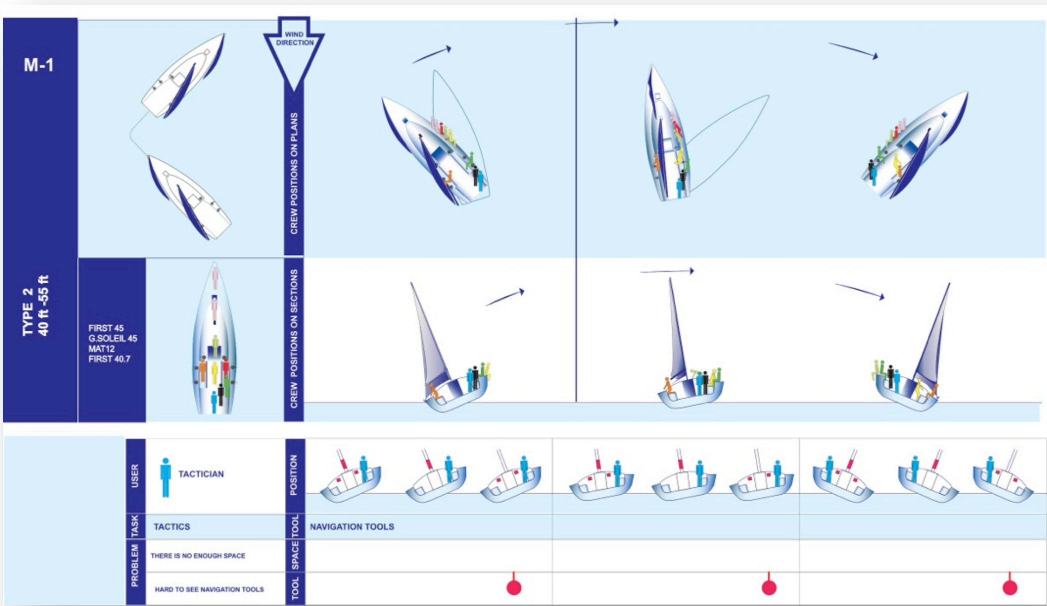


Figure 270: Work Analysis of Tactician in Type 2 Cockpit

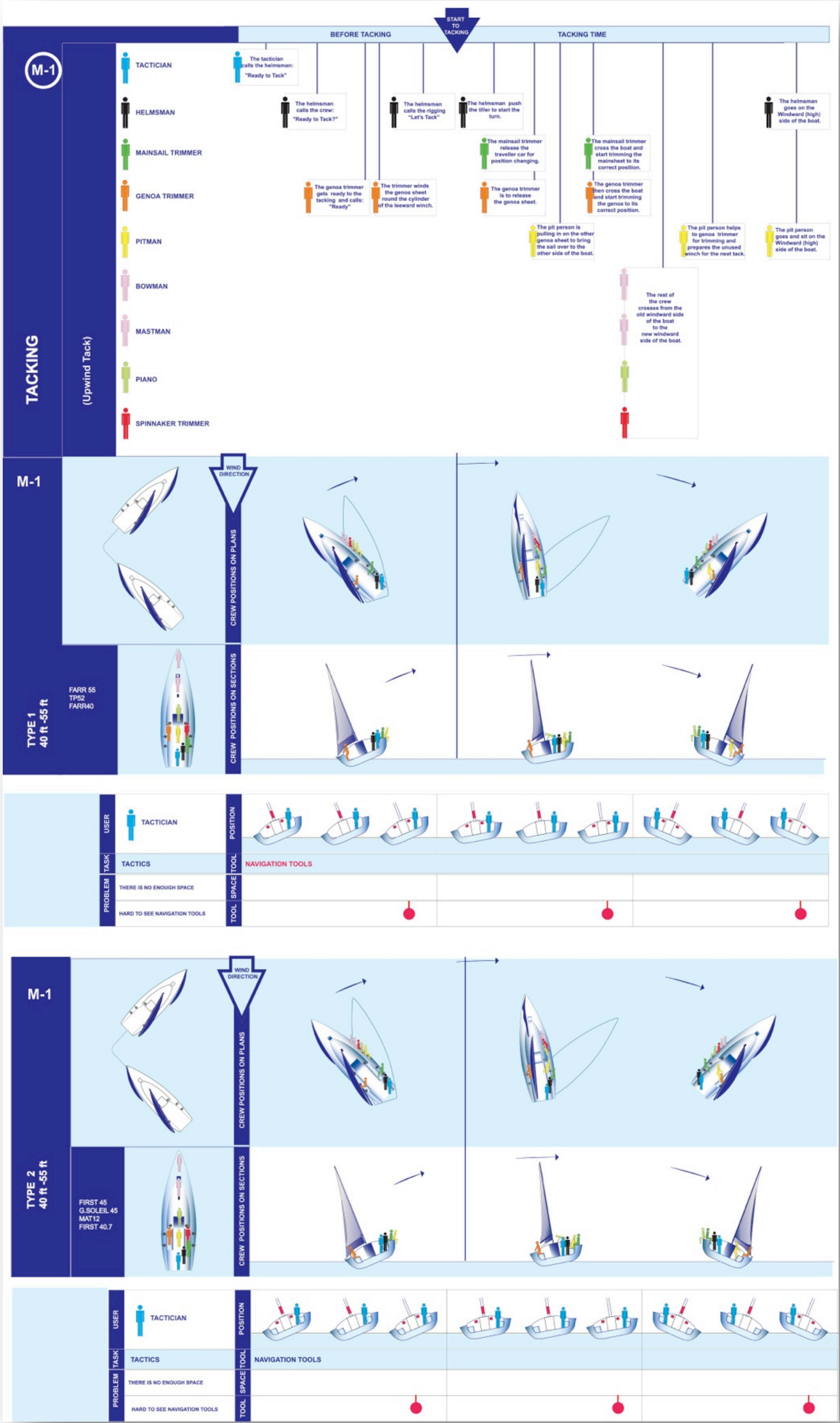


Figure 271: Work Analysis of Tactician for Type1/Type2 Cockpit Typology

4.2.2. Maneuver-2 (M2) and Maneuver-5 (M5): Tacking (from Close Hauled to Broad Reach)

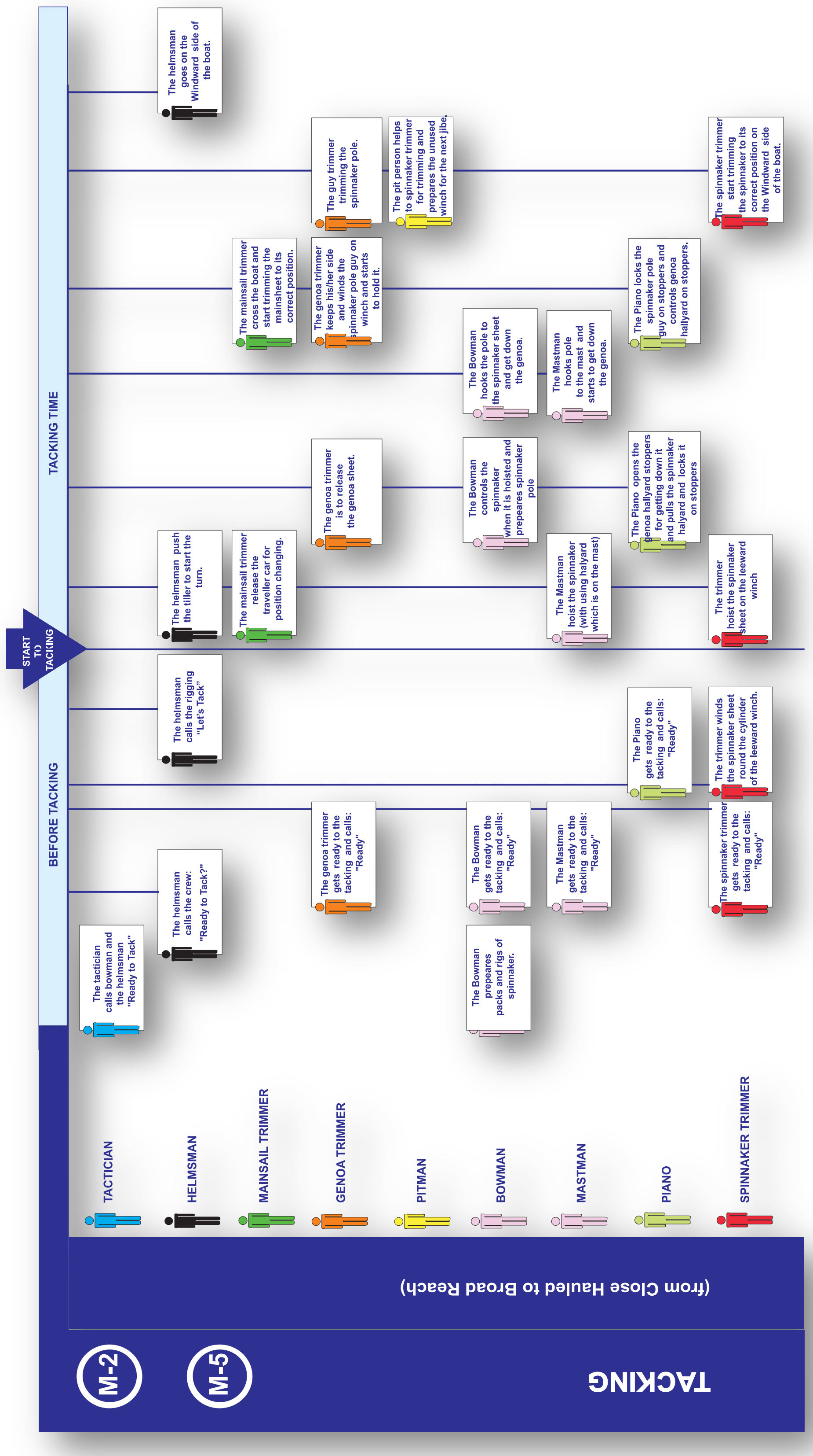


Figure 272: Work Analysis of All Team in Tacking Maneuver (From Close Hauled to Broad Reach)

4.2.2.1. Helmsman

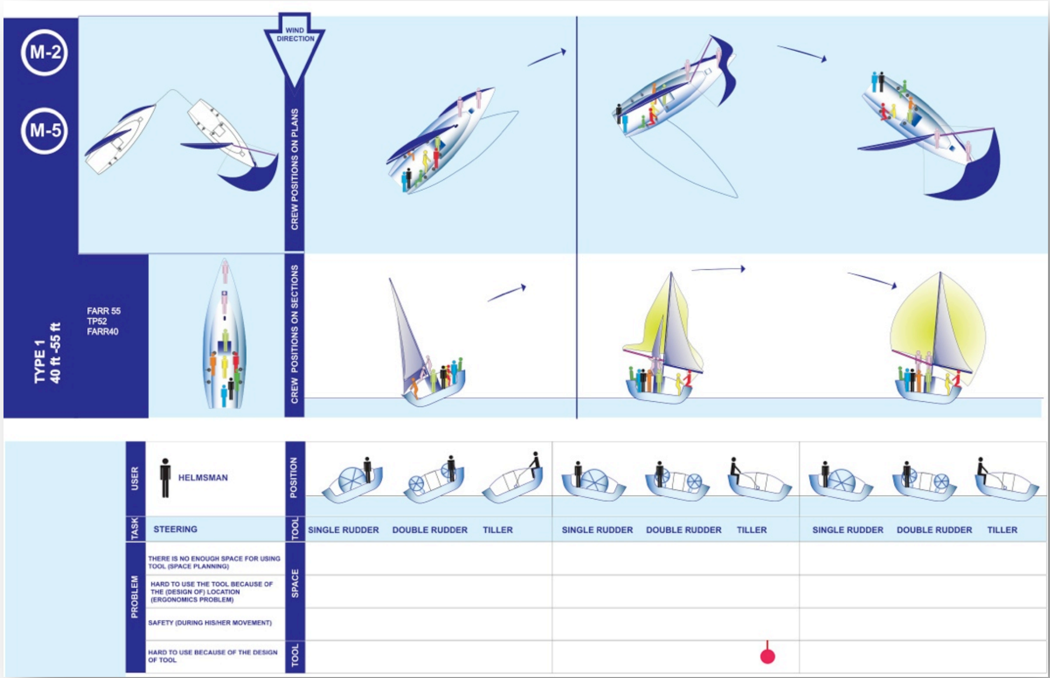


Figure 273: Work Analysis of Helmsman n in Type 1 Cockpit

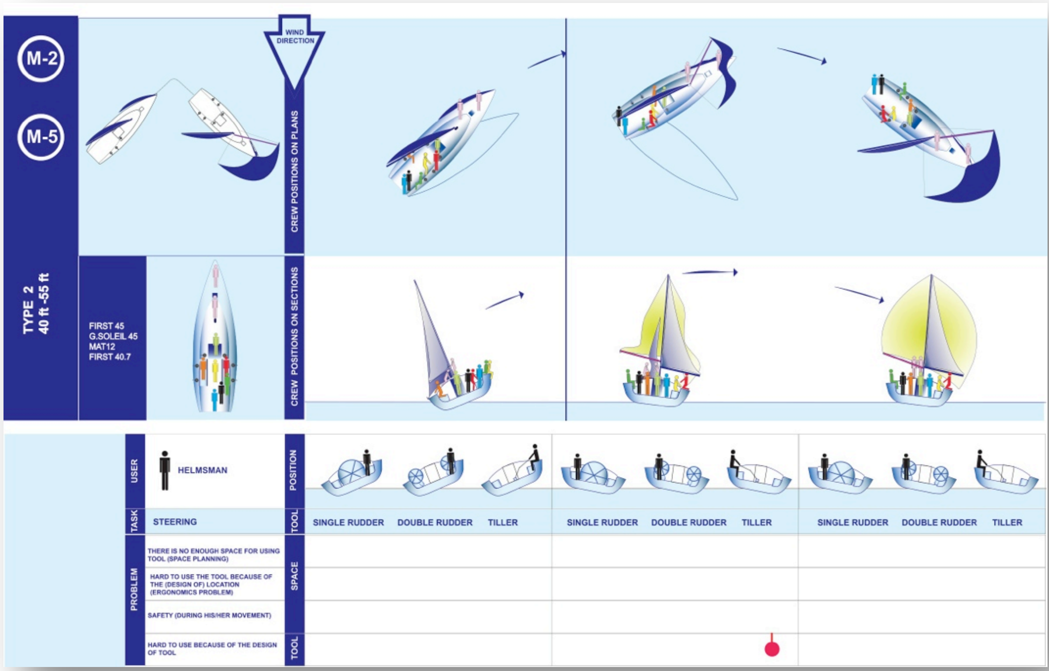


Figure 274: Work Analysis of Helmsman in Type 2 Cockpit

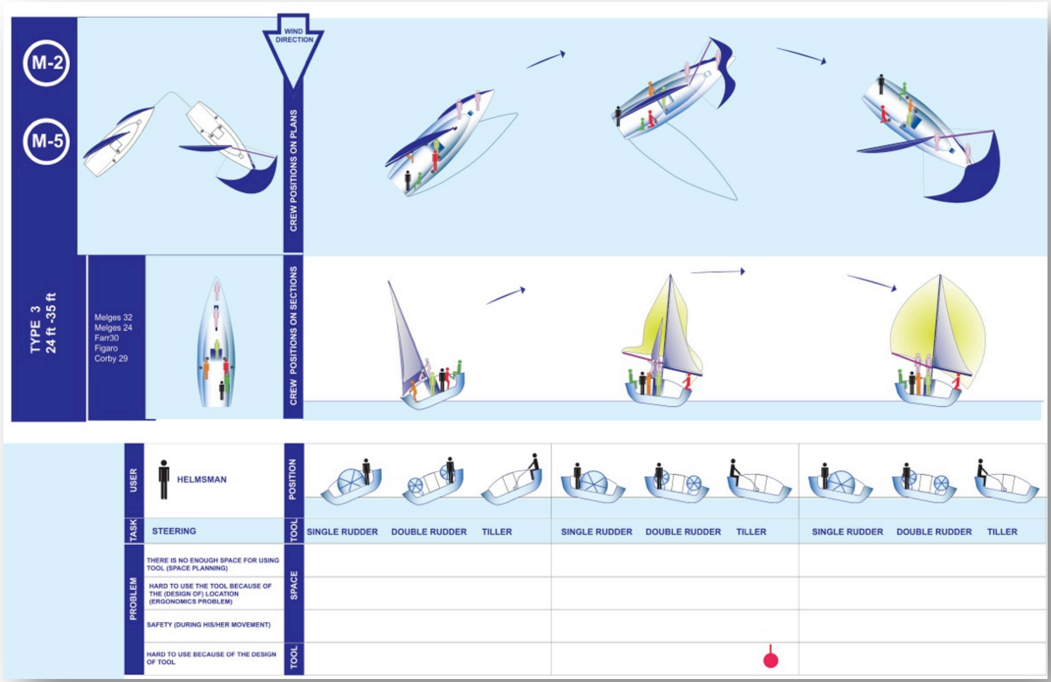


Figure 275: Work Analysis of Helmsman in Type 3 Cockpit

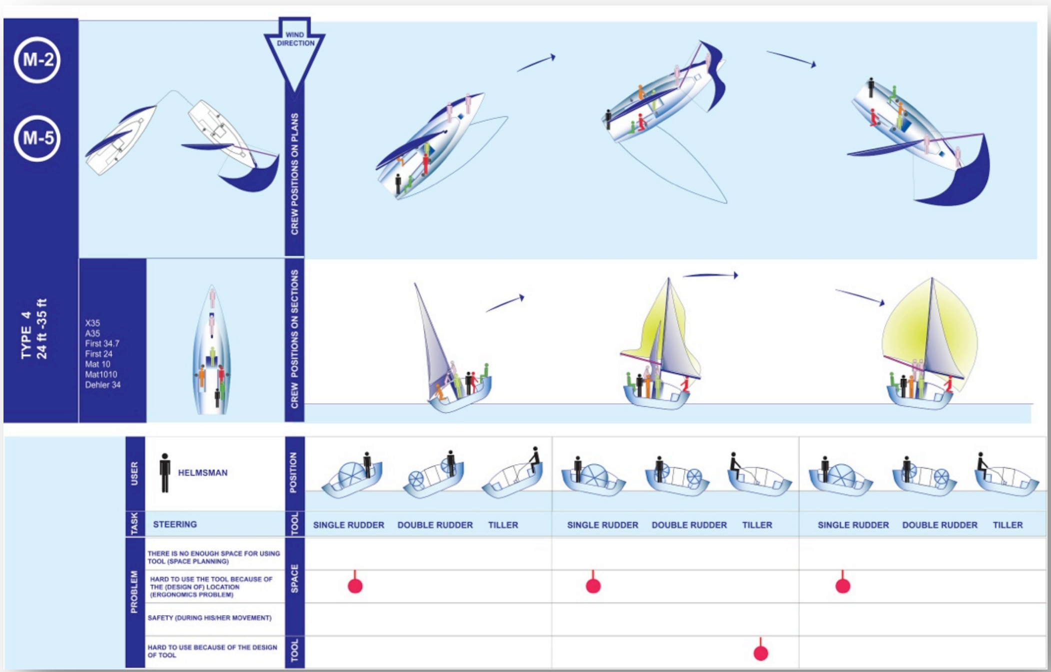


Figure 276: Work Analysis of Helmsman in Type 4 Cockpit

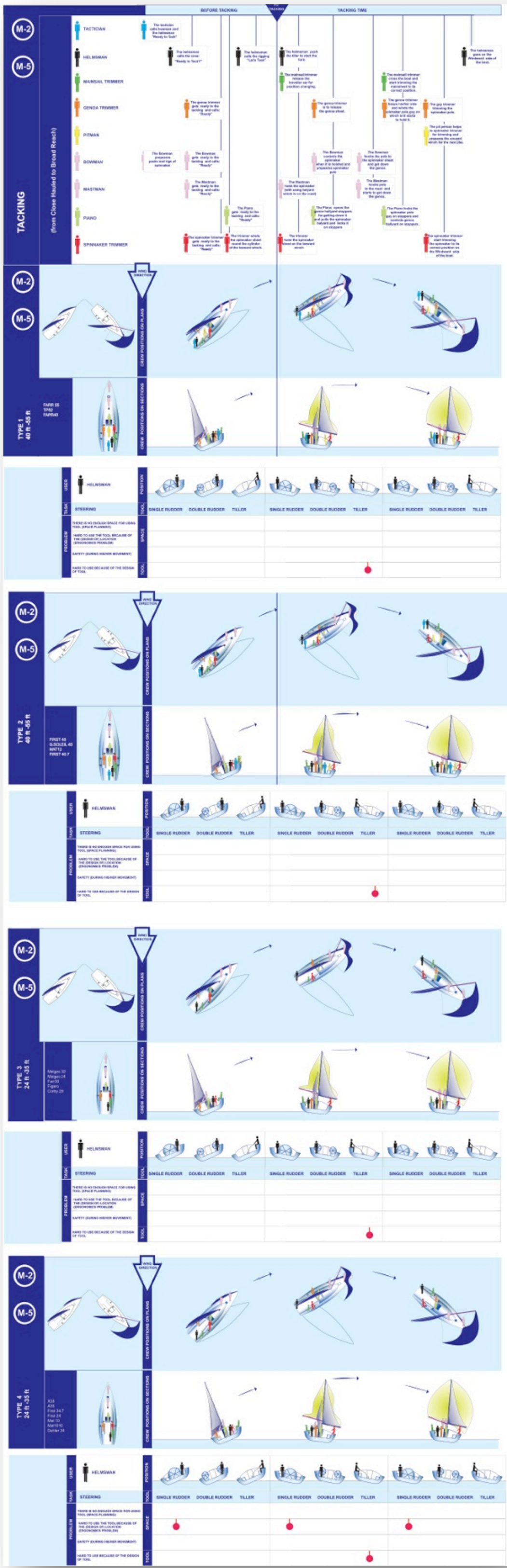


Figure 277: Work Analysis of Helmsman for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.2. Mainsail Trimmer

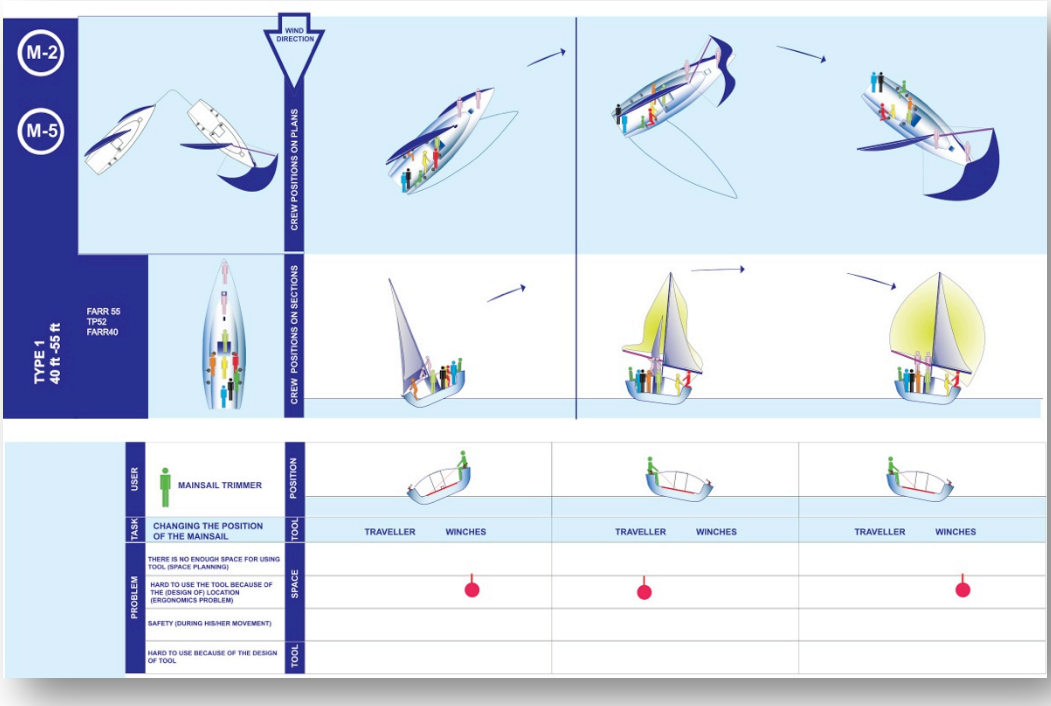


Figure 278: Work Analysis of Mainsail Trimmer in Type 1 Cockpit

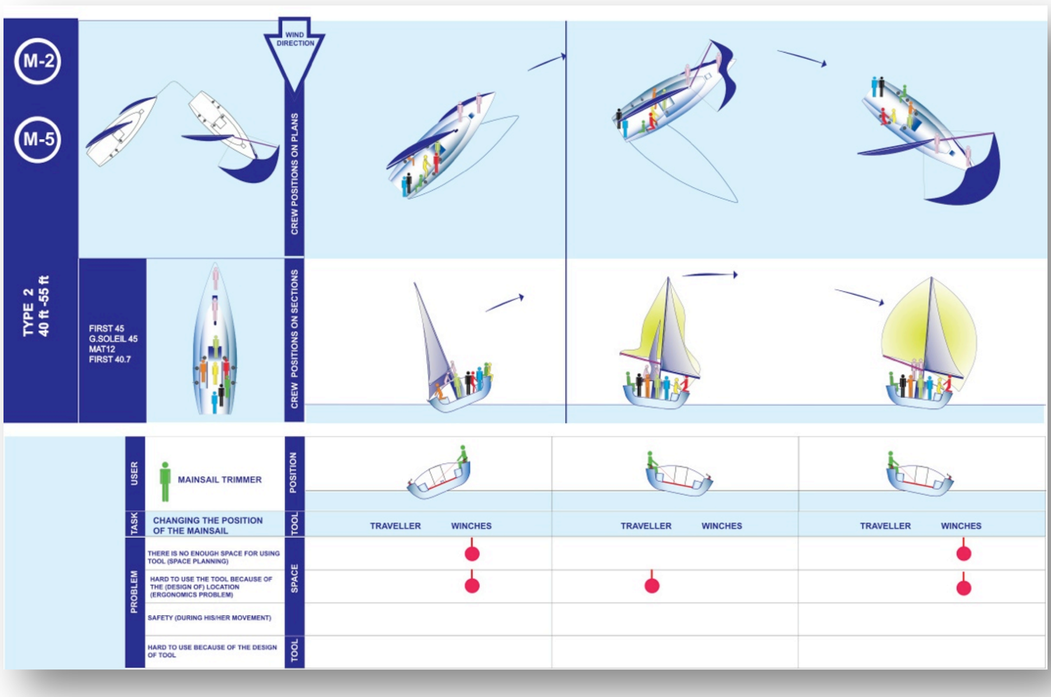


Figure 279: Work Analysis of Mainsail Trimmer in Type 2 Cockpit

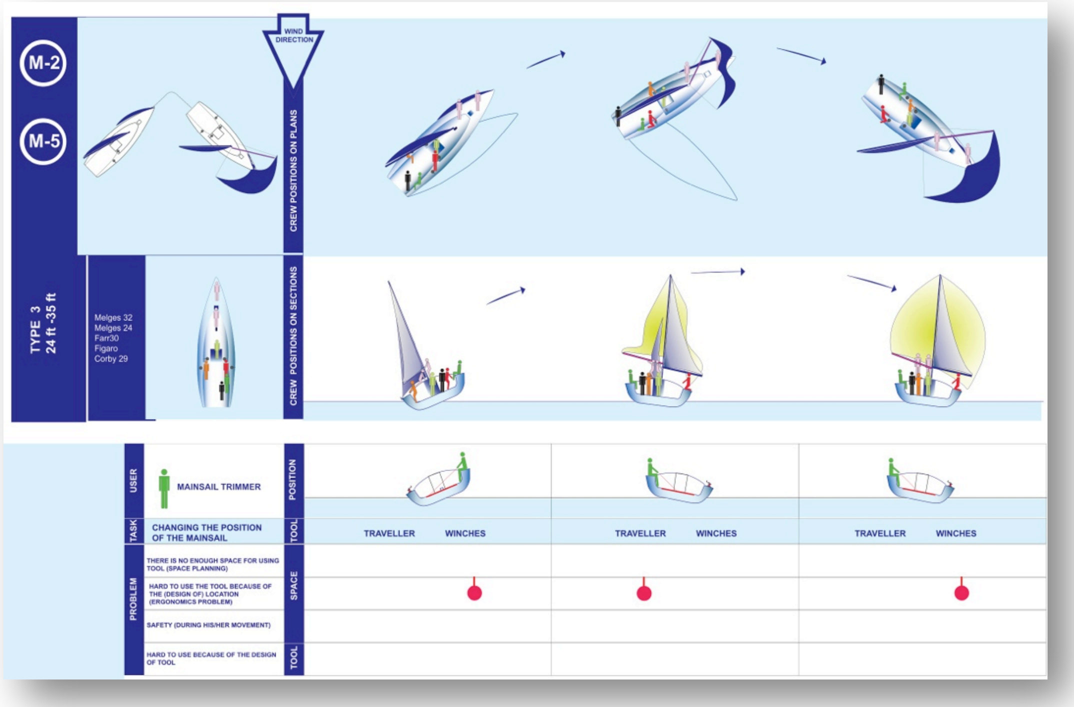


Figure 280: Work Analysis of Mainsail Trimmer in Type 3 Cockpit

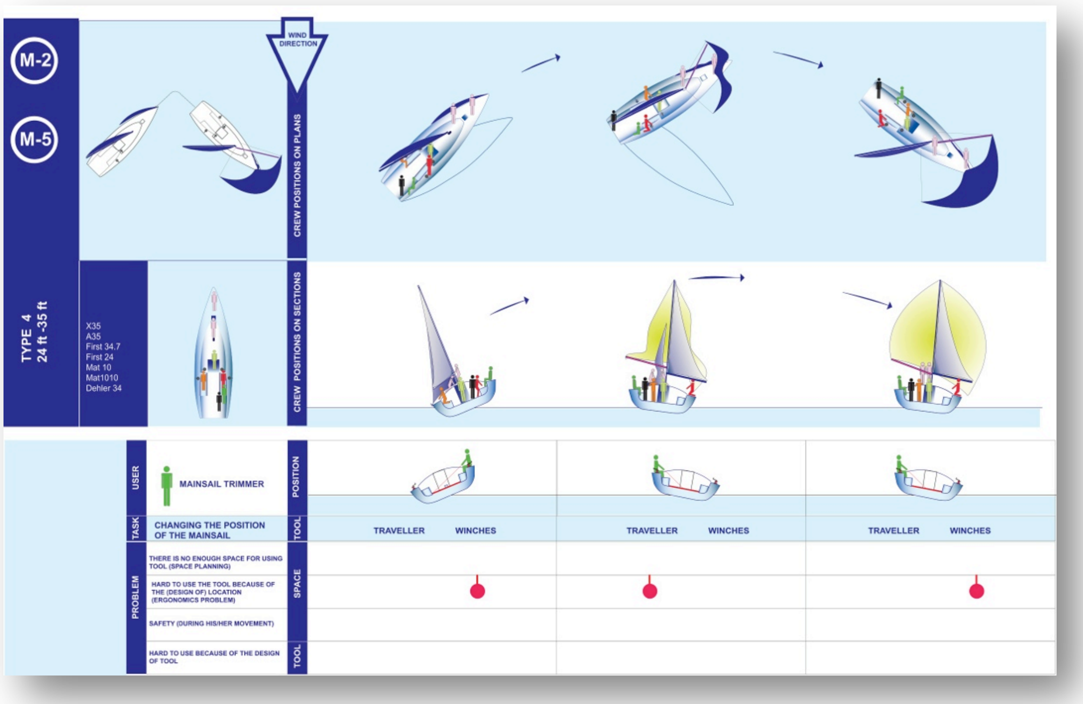


Figure 281: Work Analysis of Mainsail Trimmer in Type 4 Cockpit

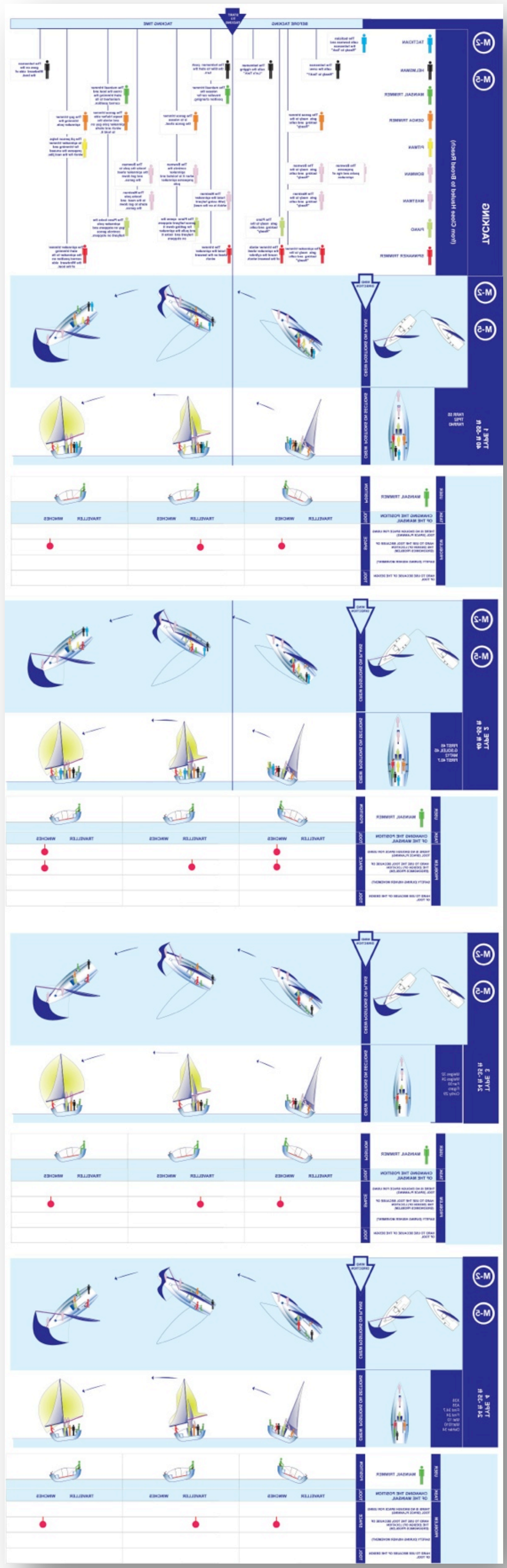


Figure 282: Work Analysis of Mainsail Trimmer for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.3. Genoa (Headsail) Trimmer

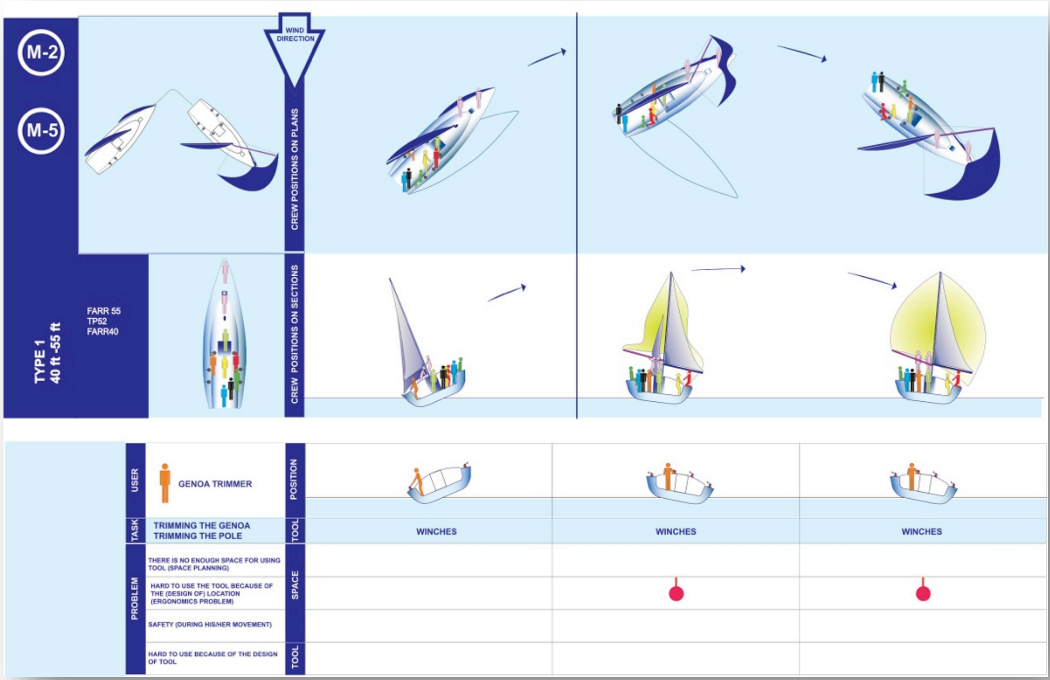


Figure 283: Work Analysis of Genoa (Headsail) Trimmer in Type 1 Cockpit

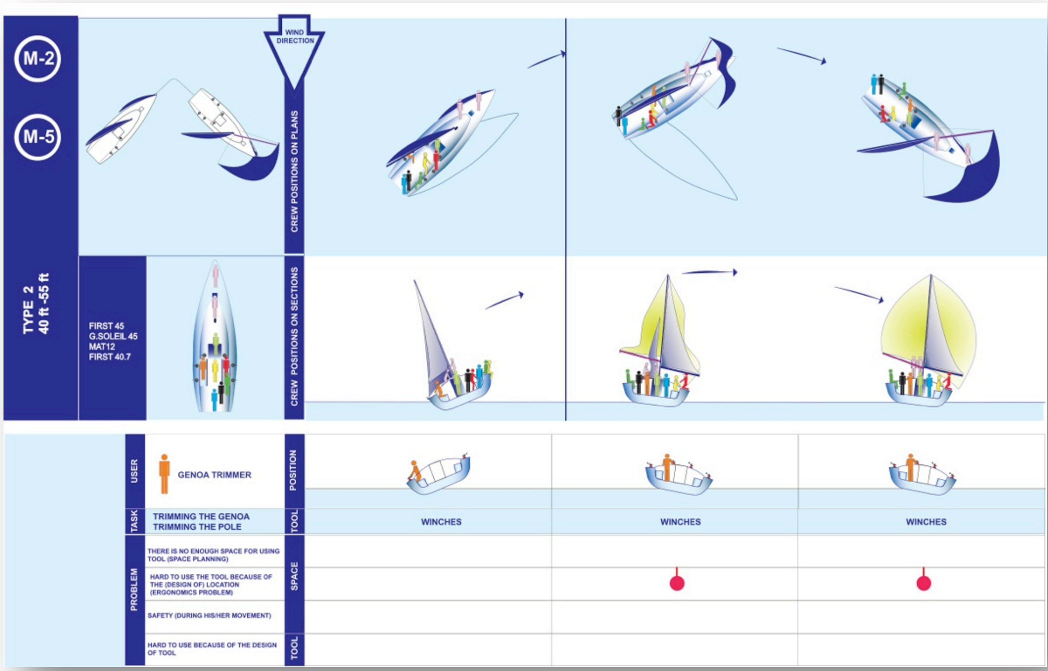


Figure 284: Work Analysis of Genoa (HeadSail) Trimmer in Type 2 Cockpi

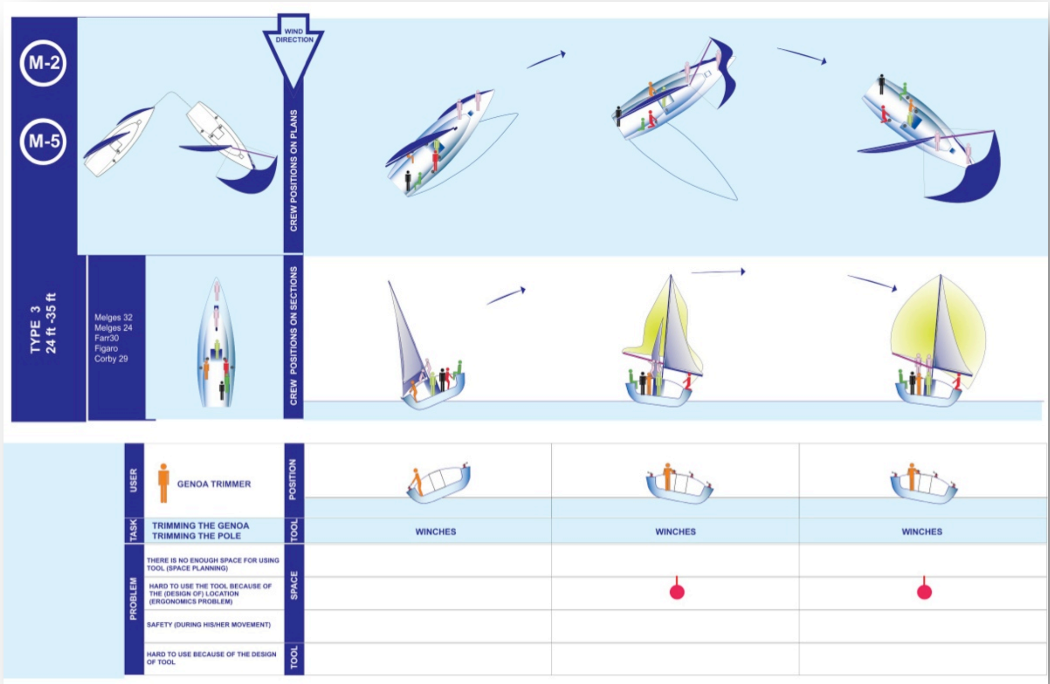


Figure 285: Work Analysis of Genoa (HeadSail) Trimmer in Type 3 Cockpit

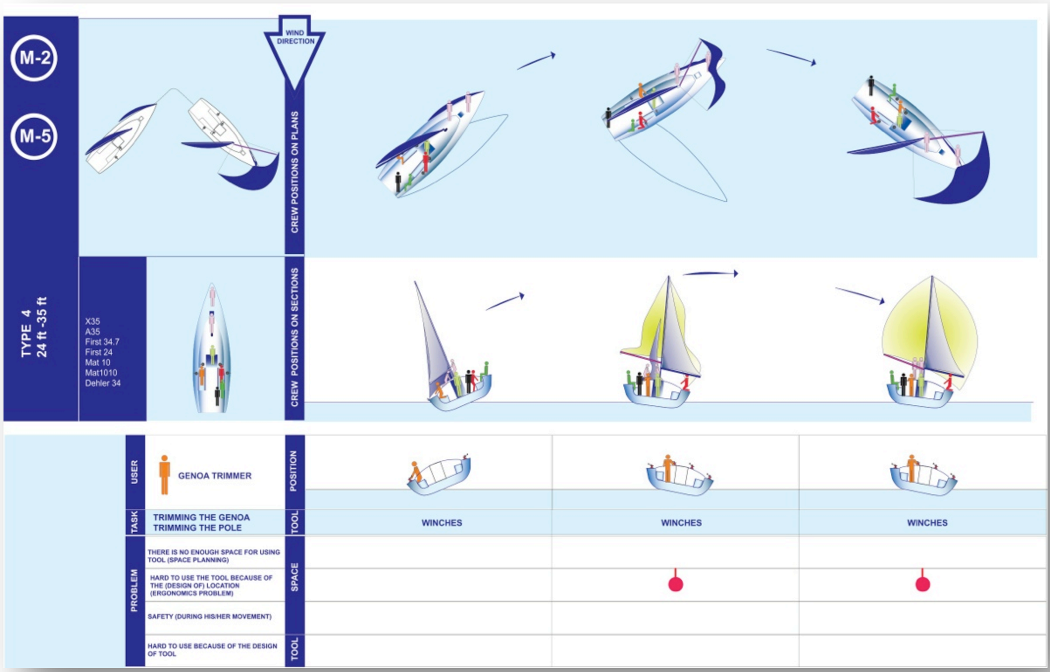


Figure 286: Work Analysis Genoa (HeadSail) Trimmer in Type 4 Cockpit

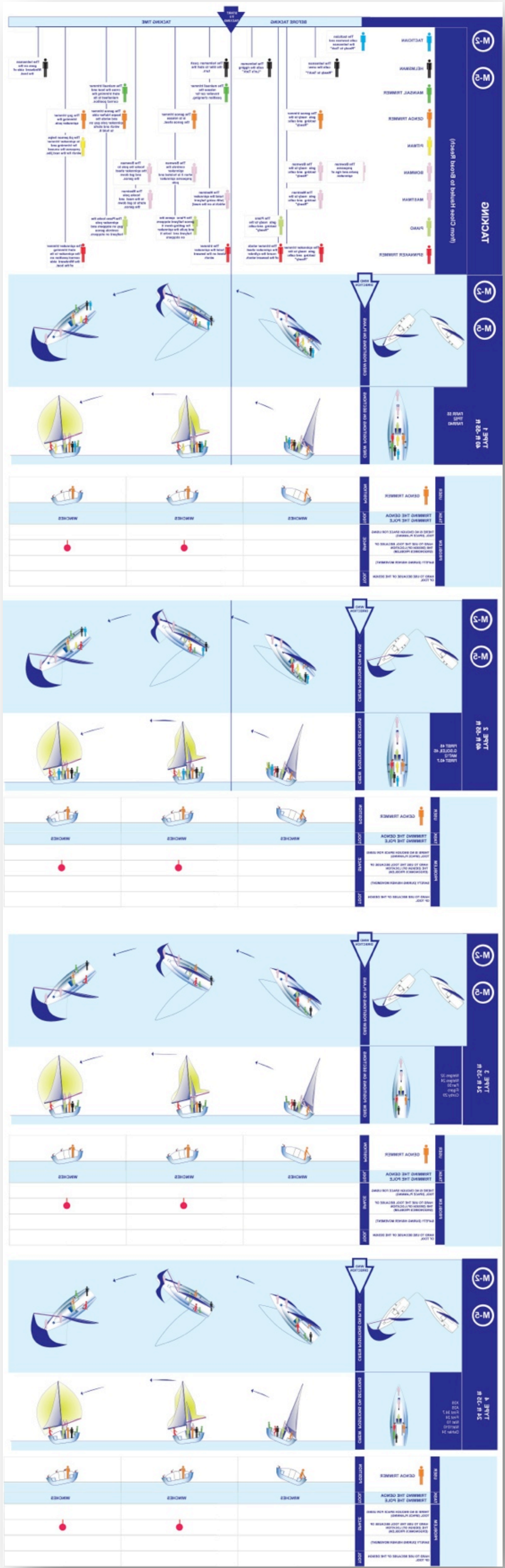


Figure 287 : Work Analysis of Genoa Trimmer for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.4. Pitman

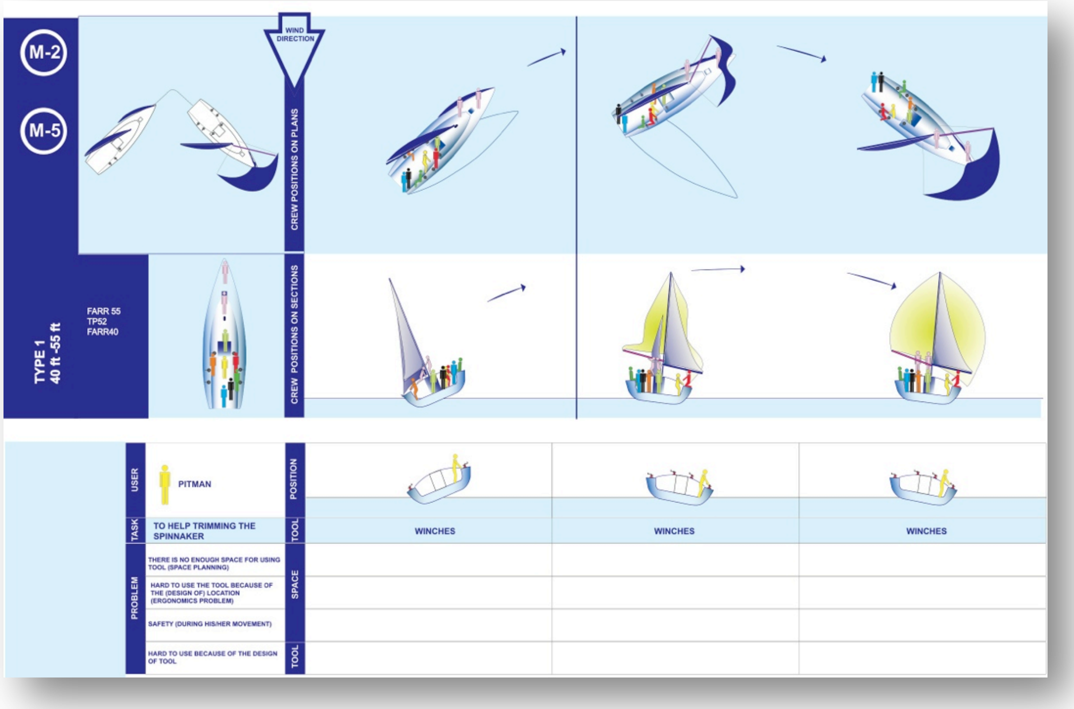


Figure 288: Work Analysis of Pitman in Type 1 Cockpit

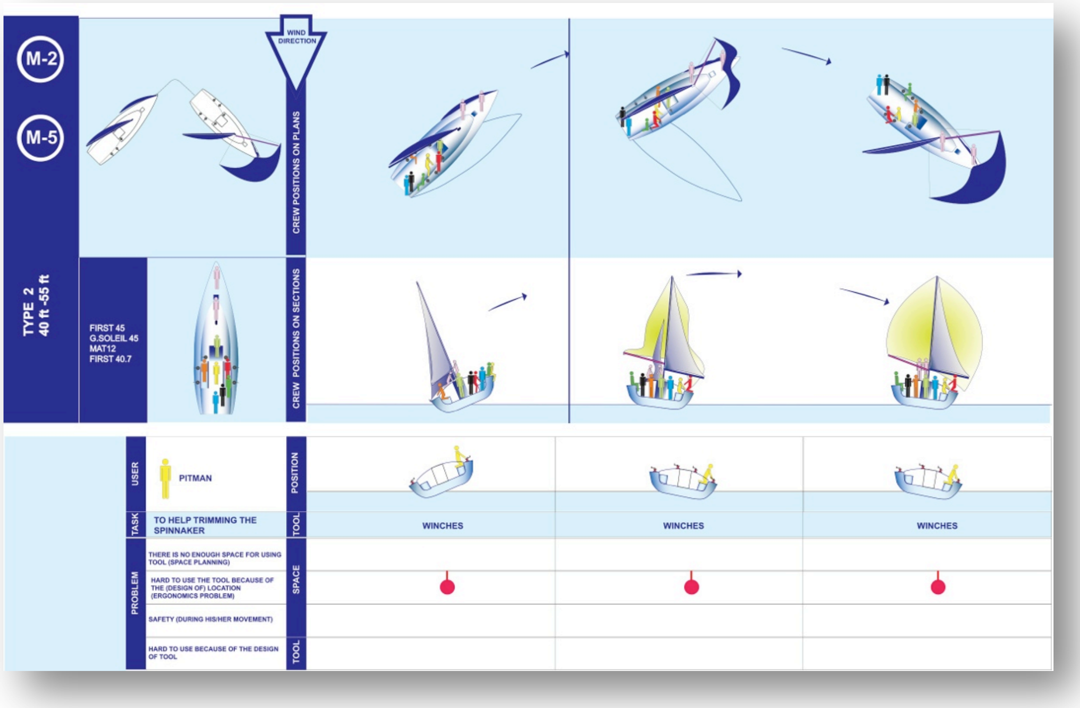


Figure 289: Work Analysis of Pitman in Type 2 Cockpit

4.2.2.5. Bowman

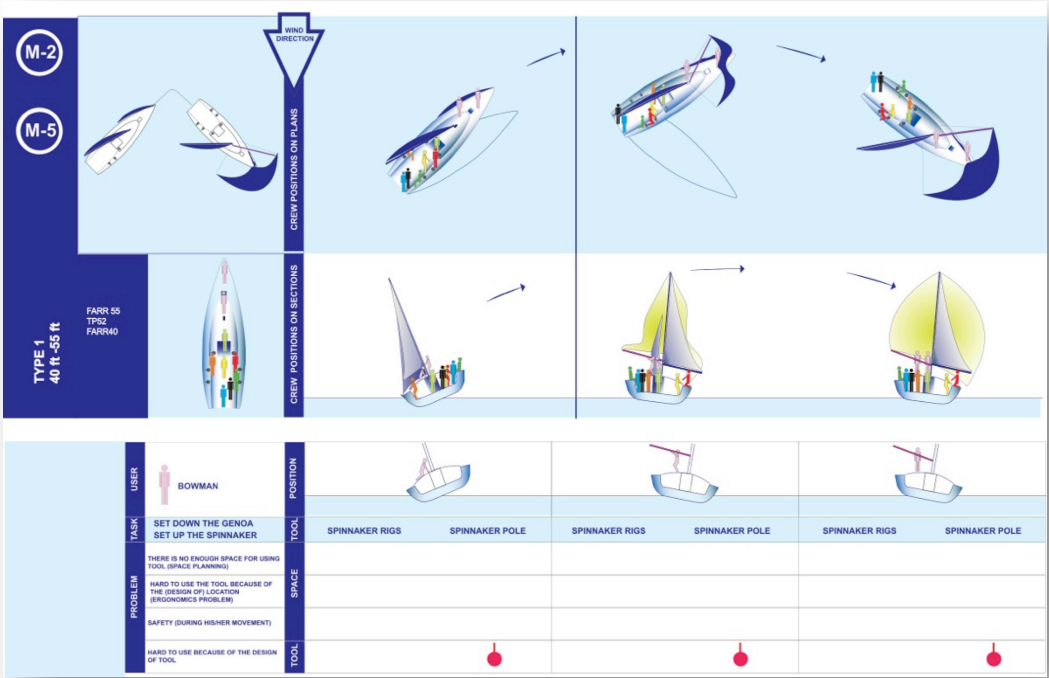


Figure 290: Work Analysis of Bowman in Type 1 Cockpit

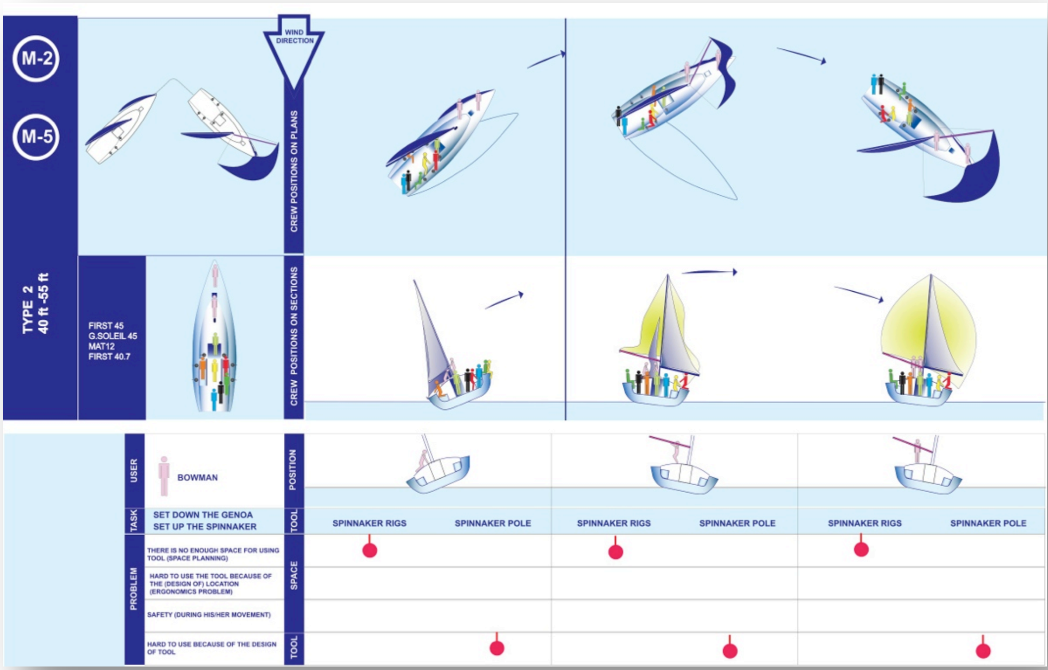


Figure 291: Work Analysis of Bowman in Type 2 Cockpit

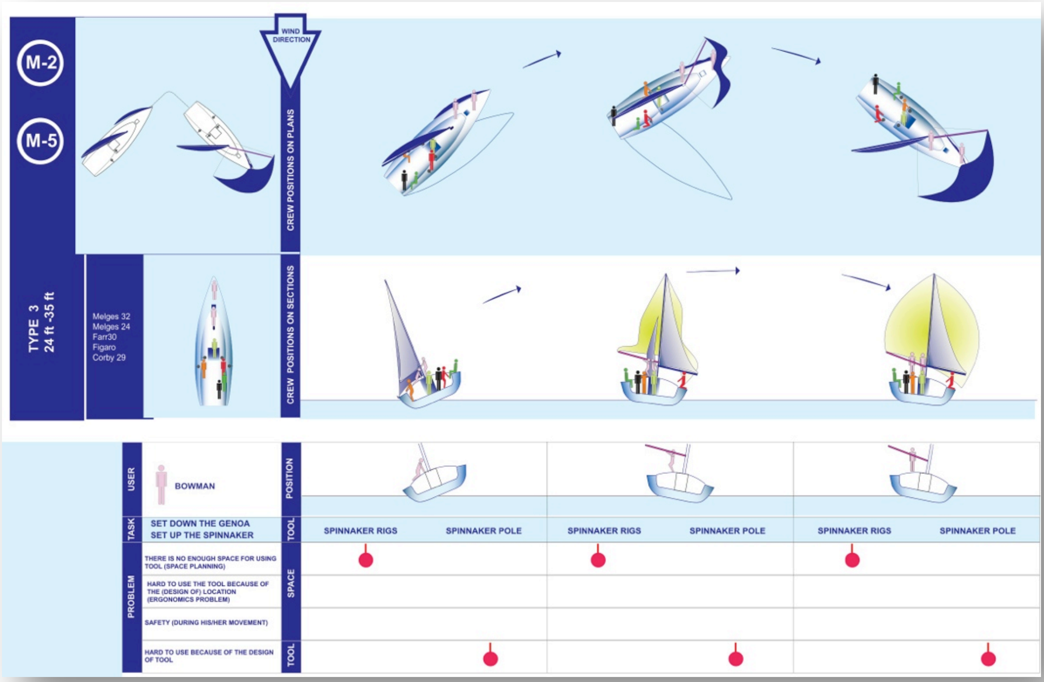


Figure 292: Work Analysis of Bowman in Type 3 Cockpit

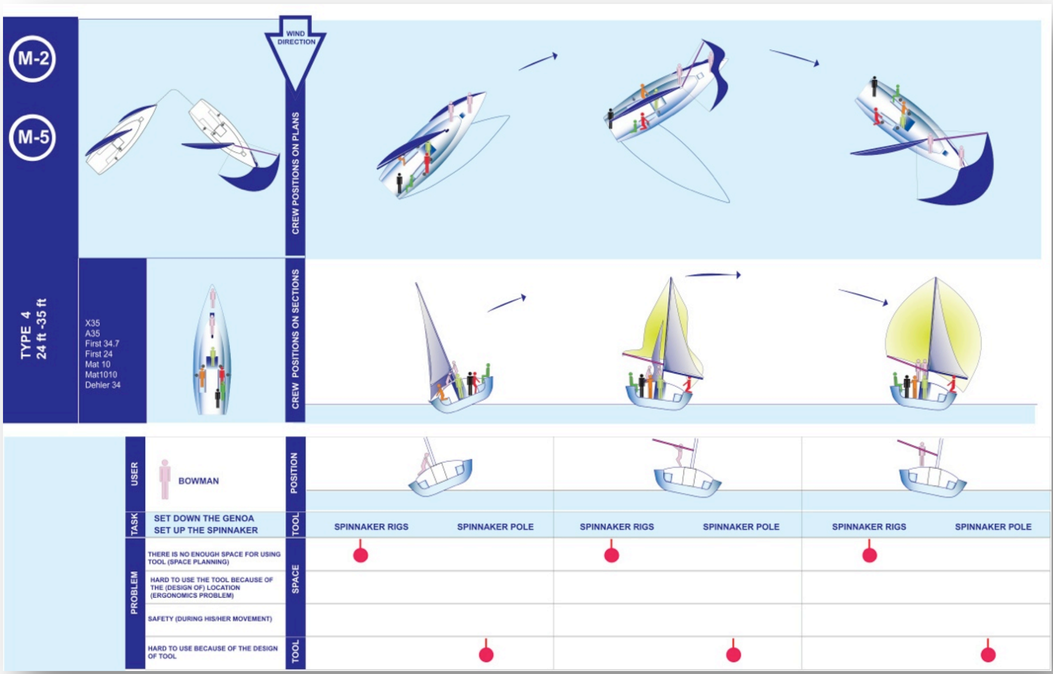


Figure 293: Work Analysis of Bowman in Type 4 Cockpit

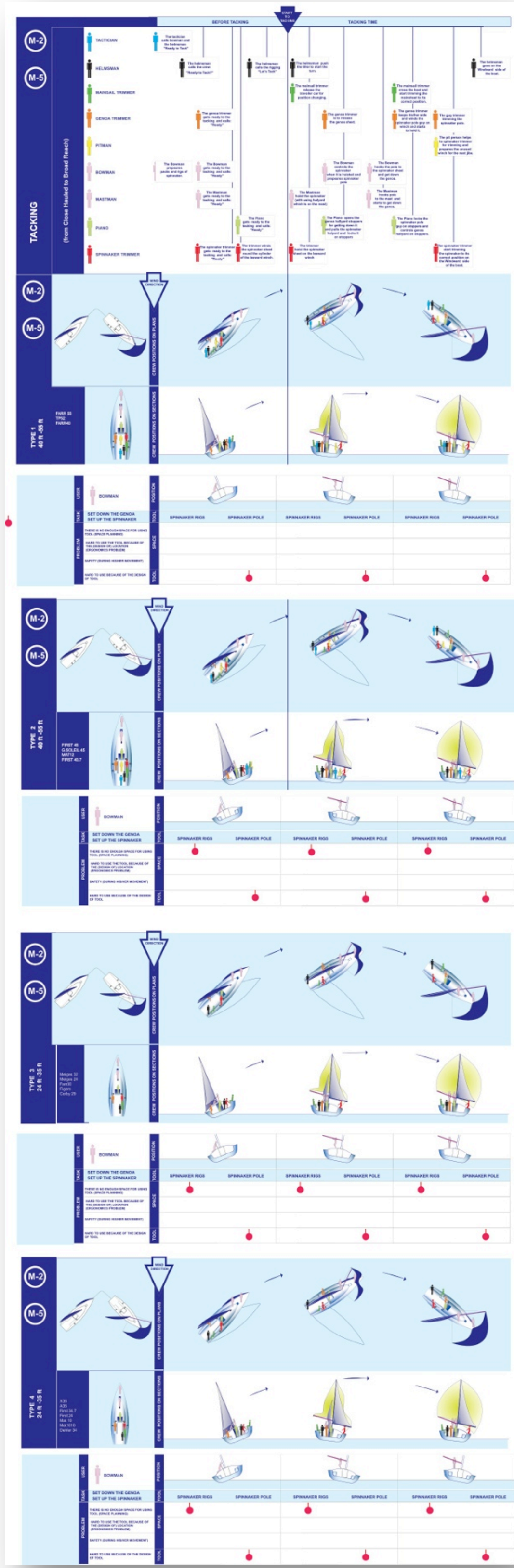


Figure 294: Work Analysis of Bowman for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.6. Mastman

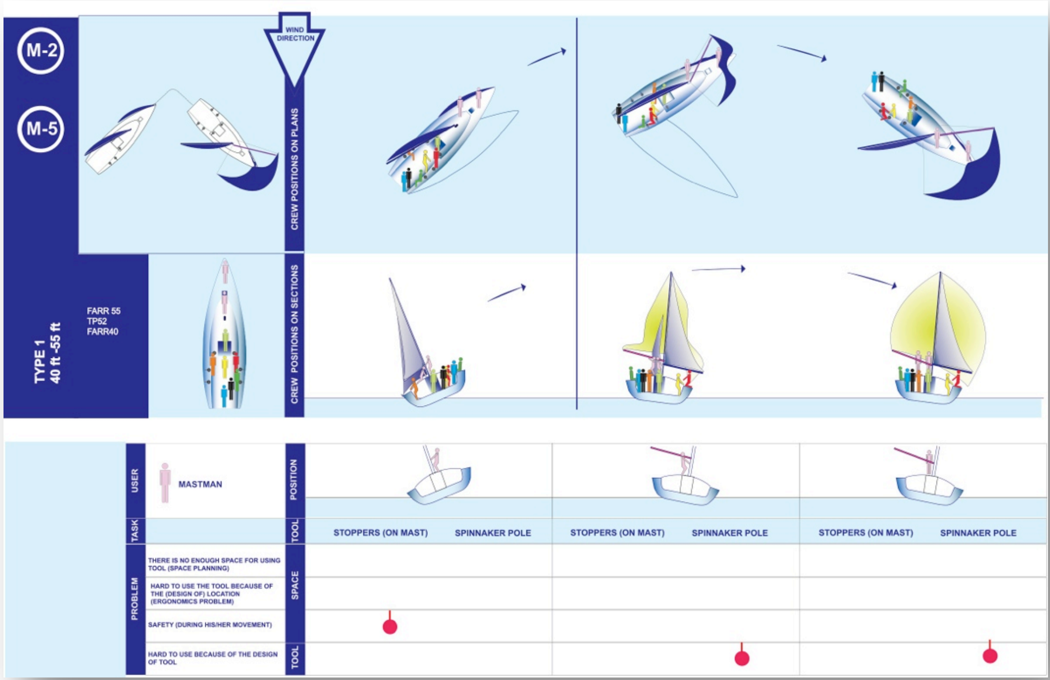


Figure 295: Work Analysis of Mastman in Type 1 Cockpit

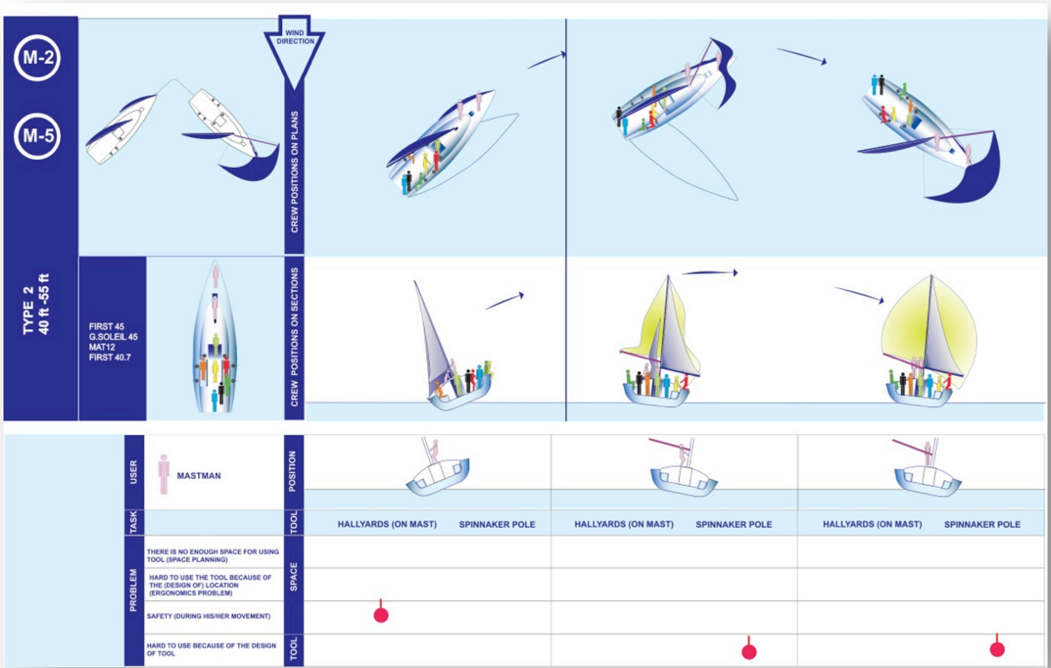


Figure 296: Work Analysis of Mastman in Type 2 Cockpit

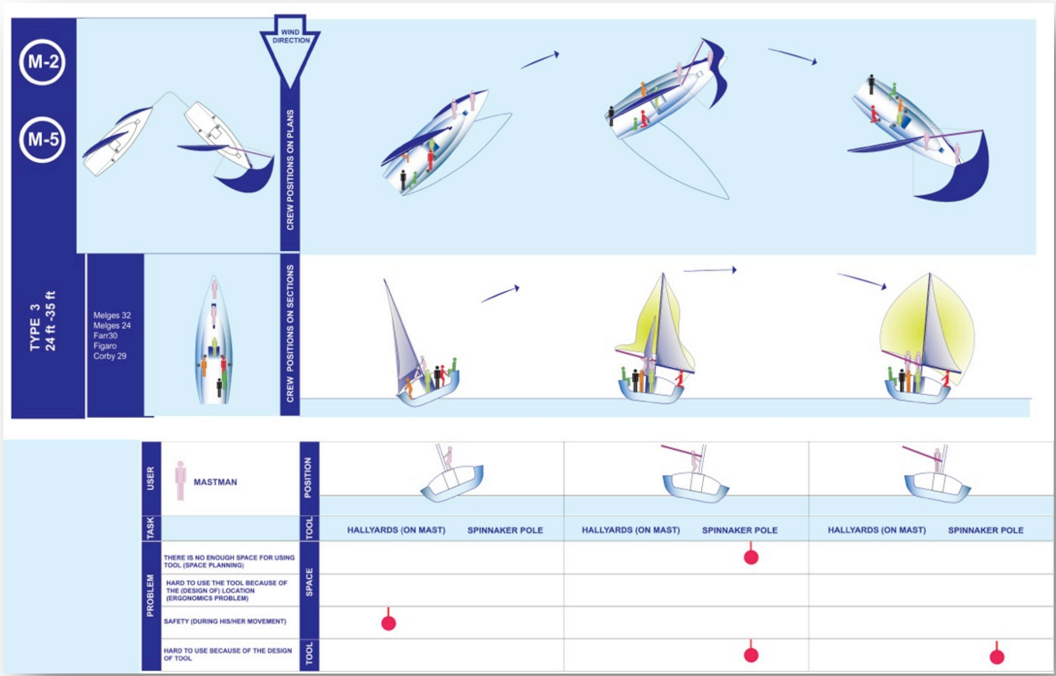


Figure 297: Work Analysis of Mastman in Type 3 Cockpit

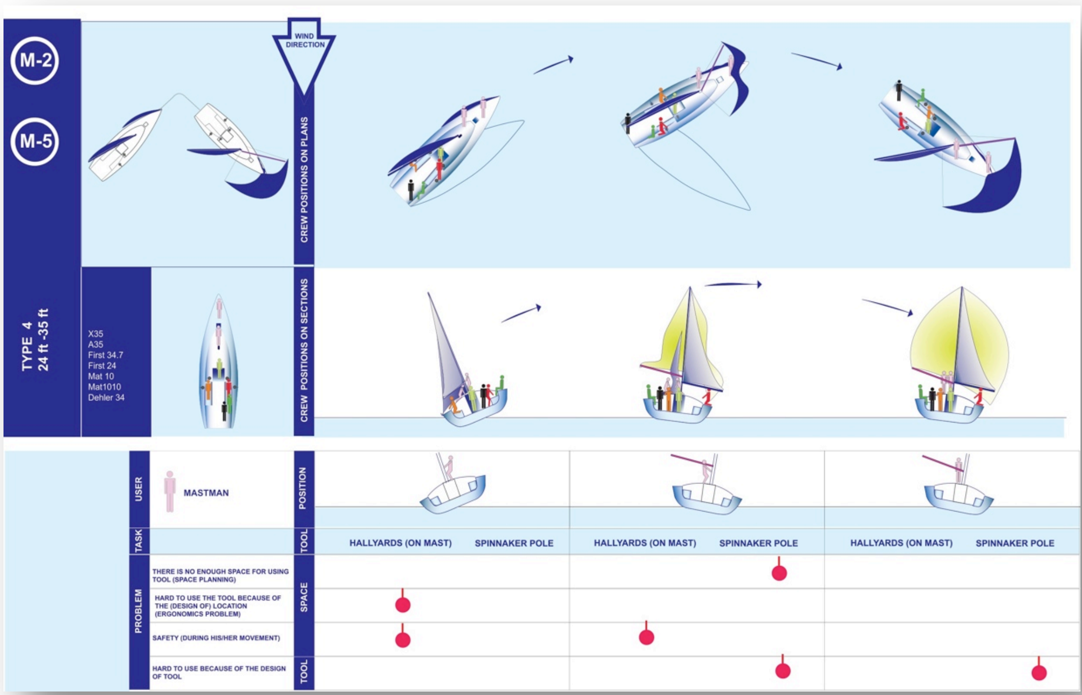


Figure 298: Work Analysis of Mastman in Type 4 Cockpit

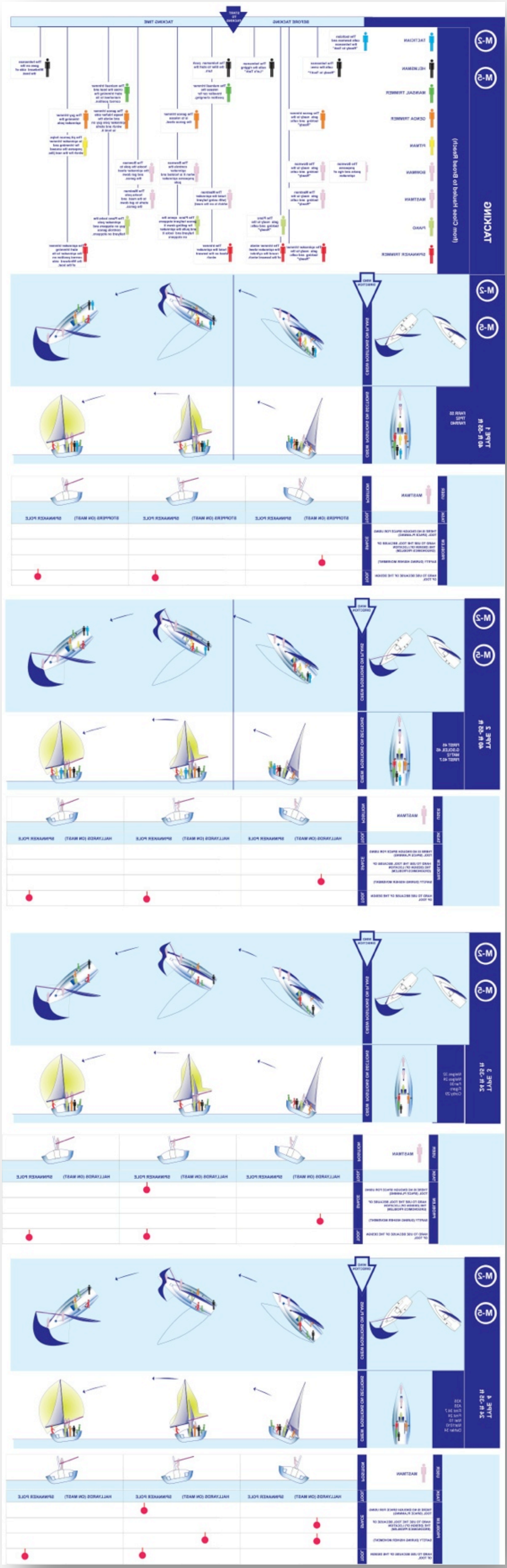


Figure 299: Work Analysis of Mastman for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.7. Piano

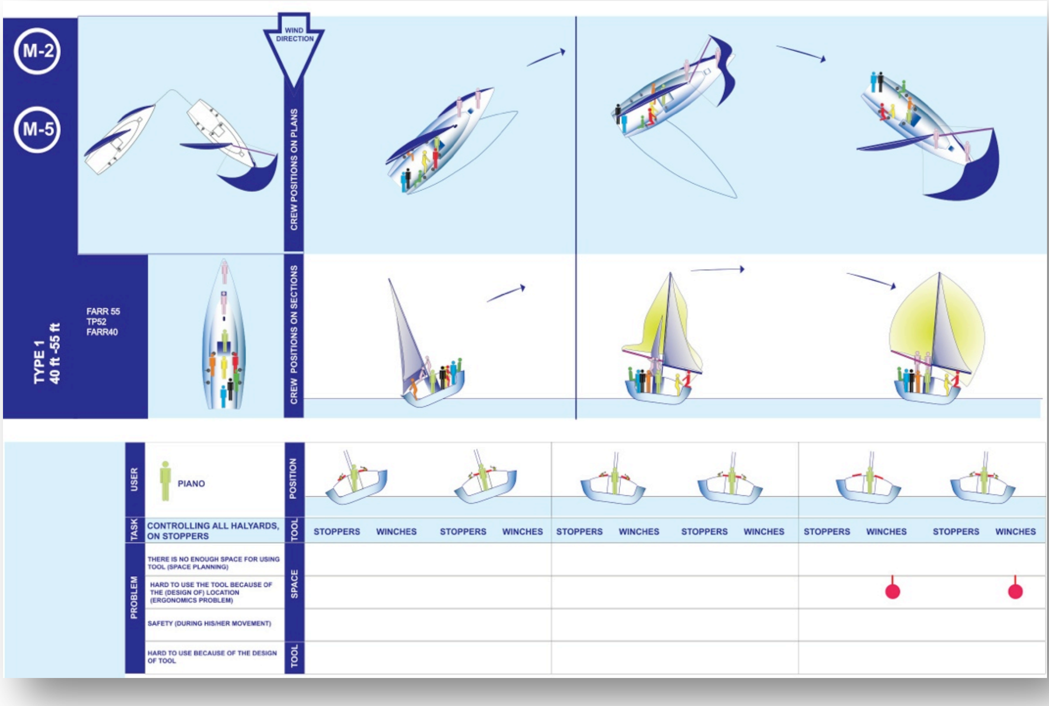


Figure 300: Work Analysis of Piano in Type 1 Cockpit

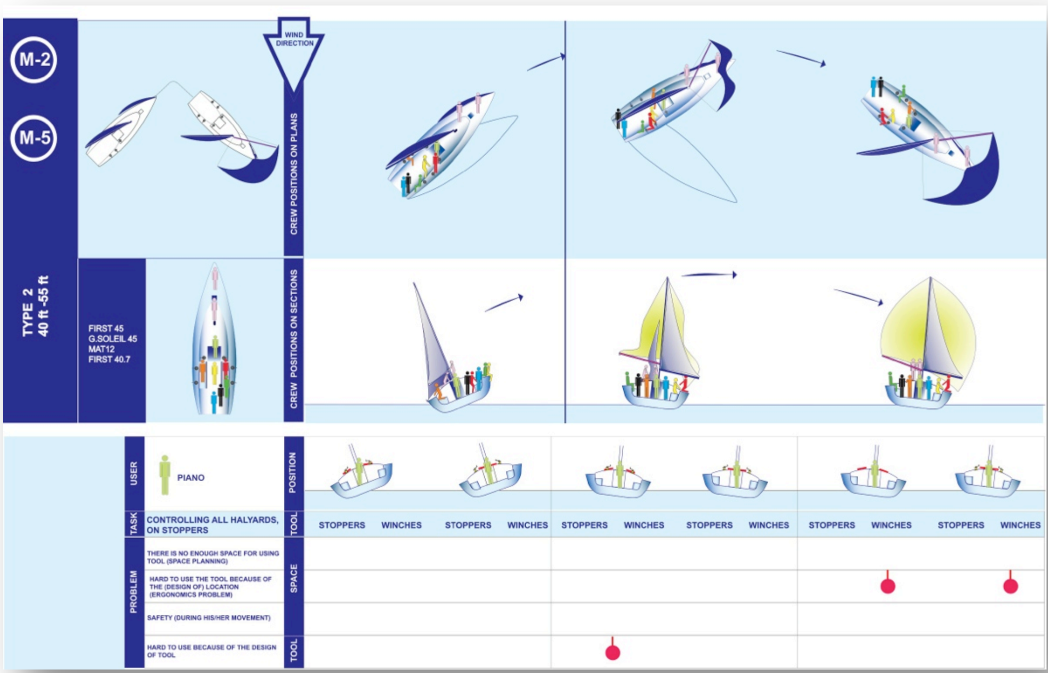


Figure 301: Work Analysis of Piano in Type 2 Cockpit

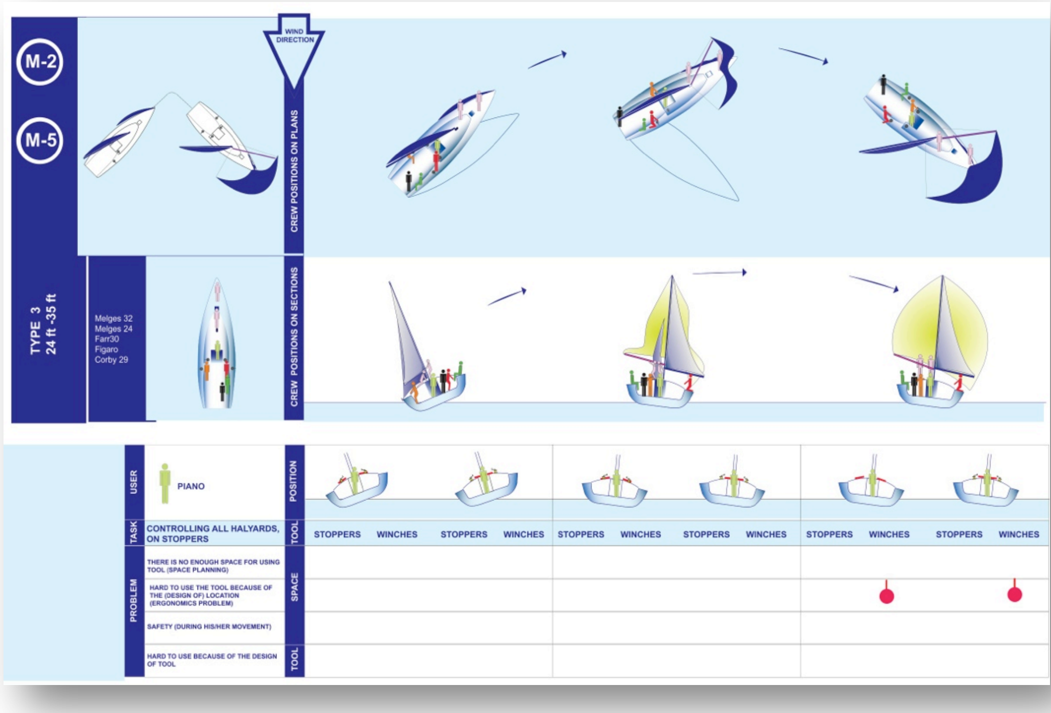


Figure 302: Work Analysis of Piano in Type 3 Cockpit

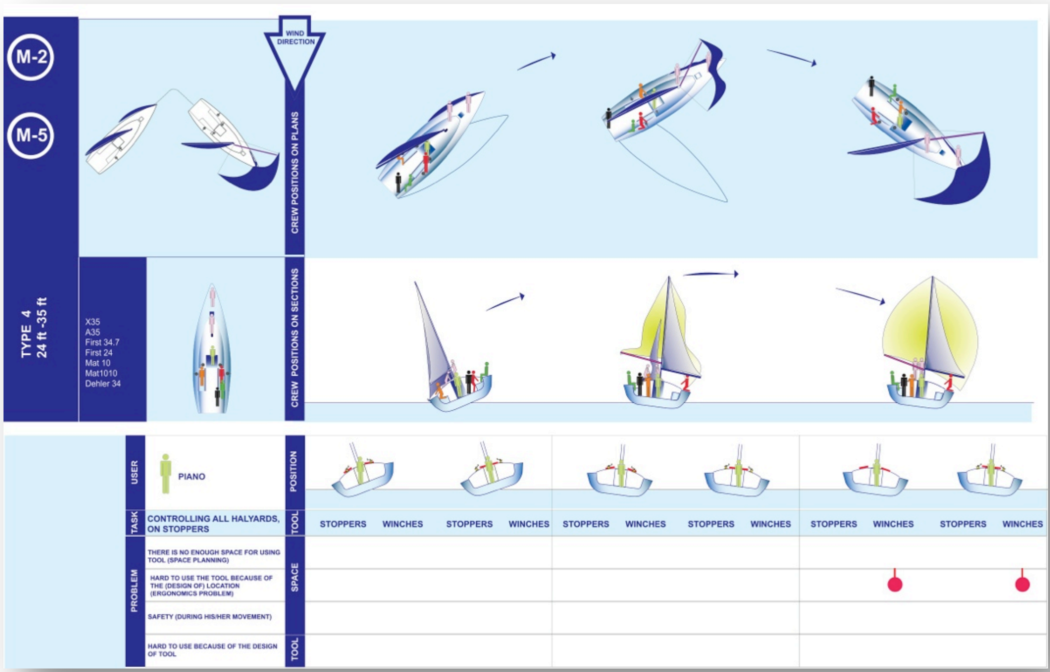


Figure 303: Work Analysis of Piano in Type 4 Cockpit

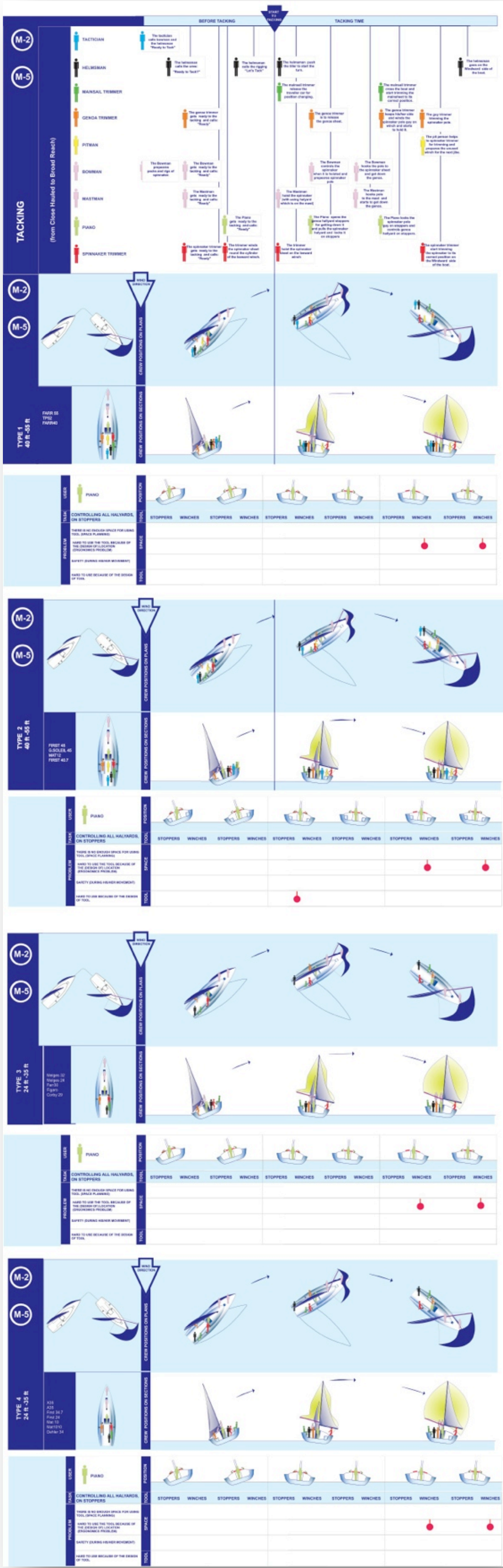


Figure 304: Work Analysis of Piano for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.8. Spinnaker Trimmer

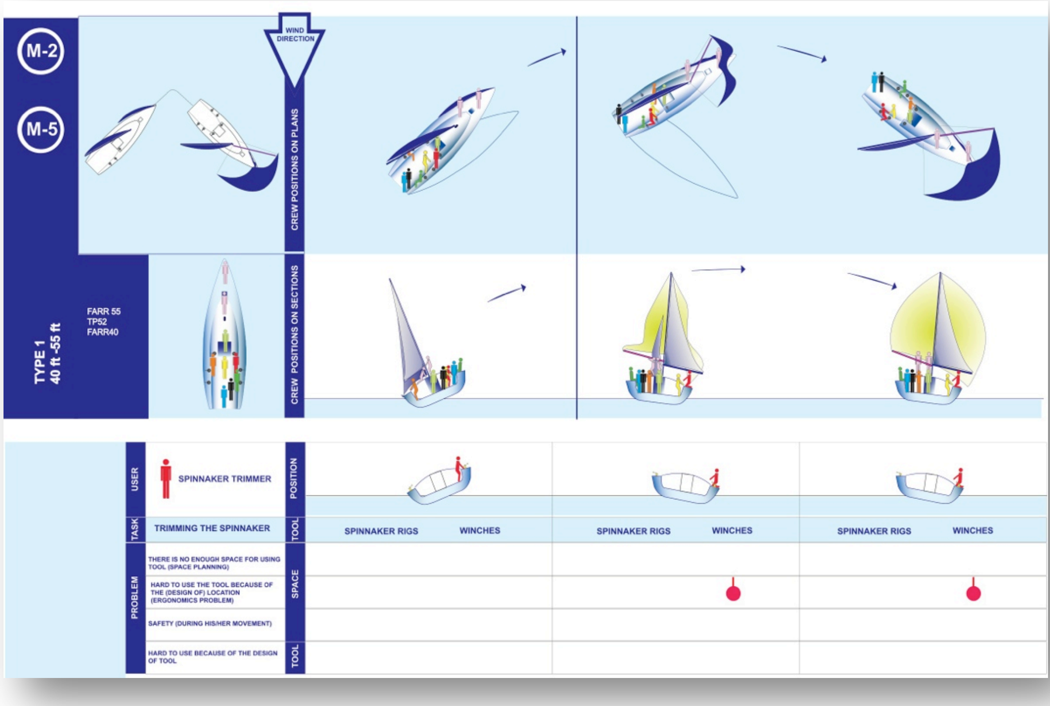


Figure 305: Work Analysis of Spinnaker Trimmer in Type 1 Cockpit

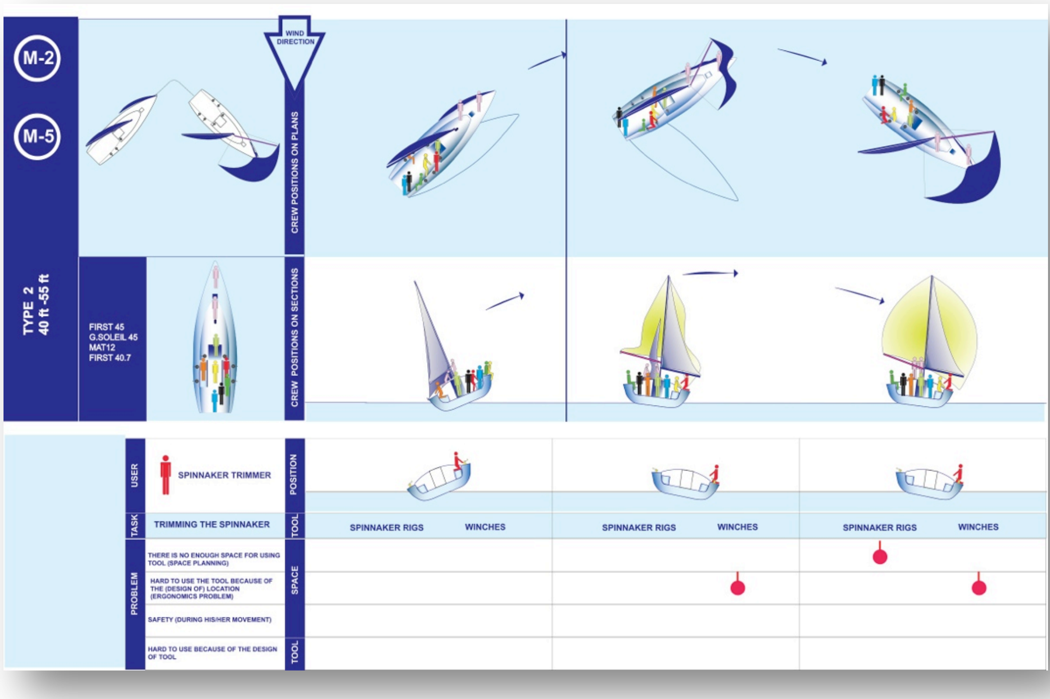


Figure 306: Work Analysis of Spinnaker Trimmer in Type 2 Cockpit

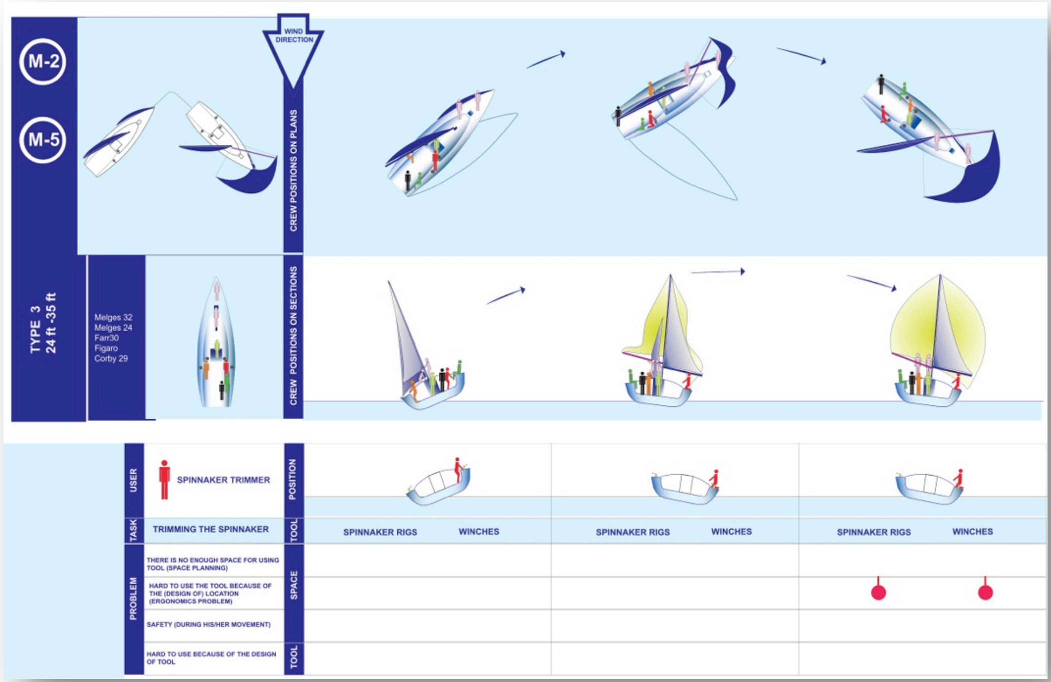


Figure 307: Work Analysis of Spinnaker Trimmer in Type 3 Cockpit

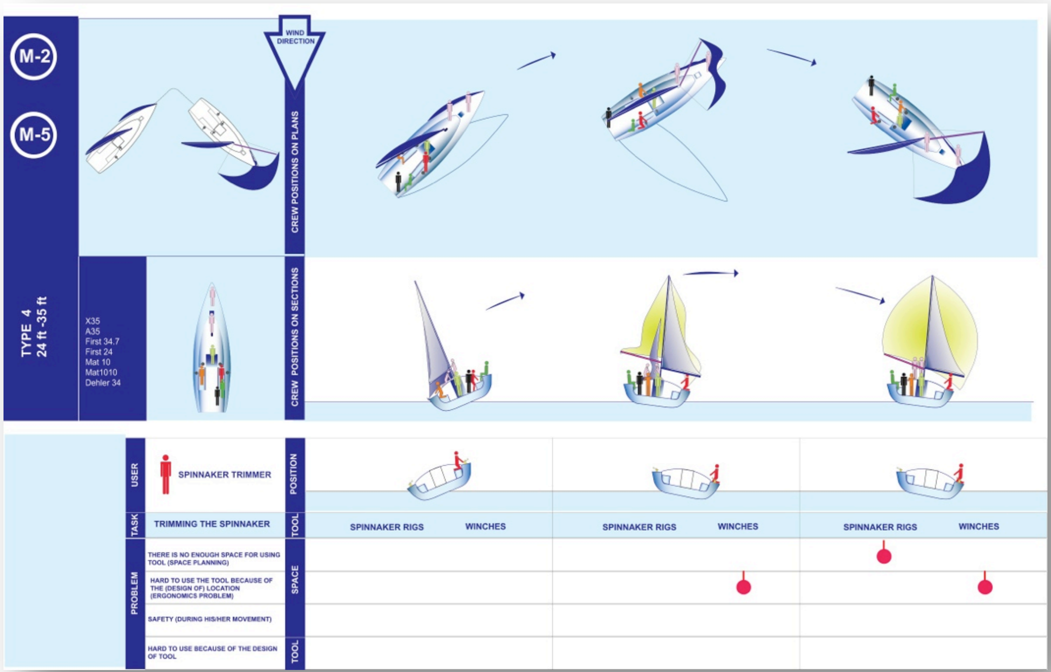


Figure 308: Work Analysis of Spinnaker Trimmer in Type 4 Cockpit

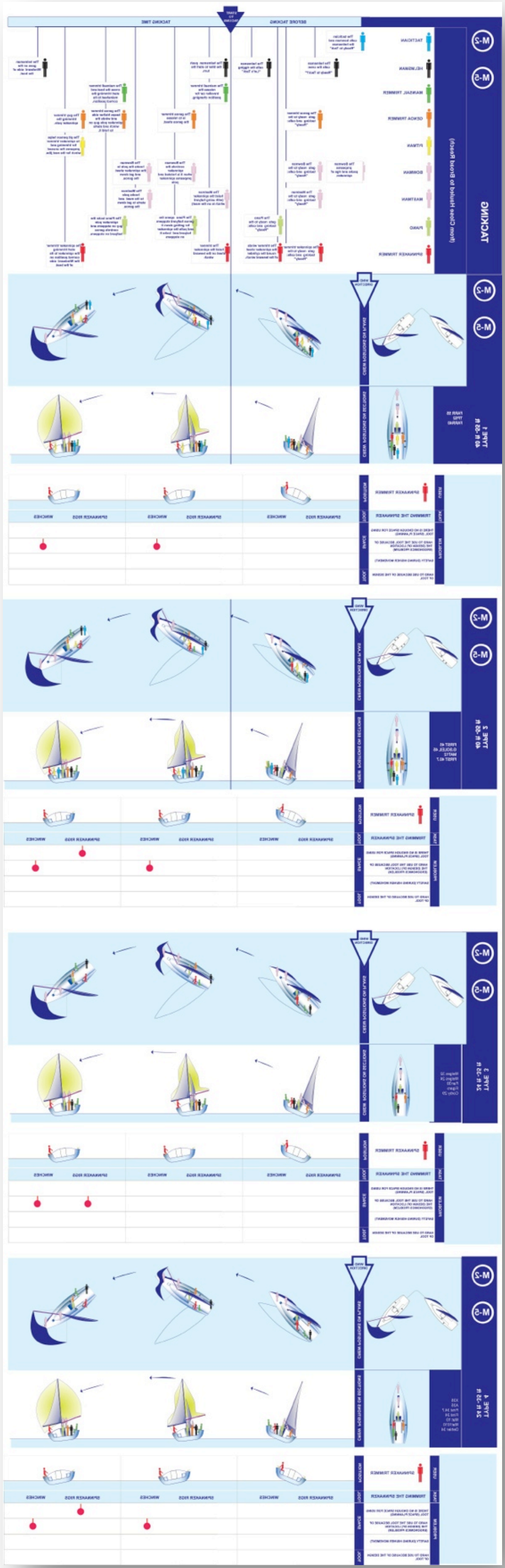


Figure 309: Work Analysis of Spinnaker Trimmer for Type1/Type2/ Type3/ Type4 Cockpit Typology

4.2.2.8. Tactician

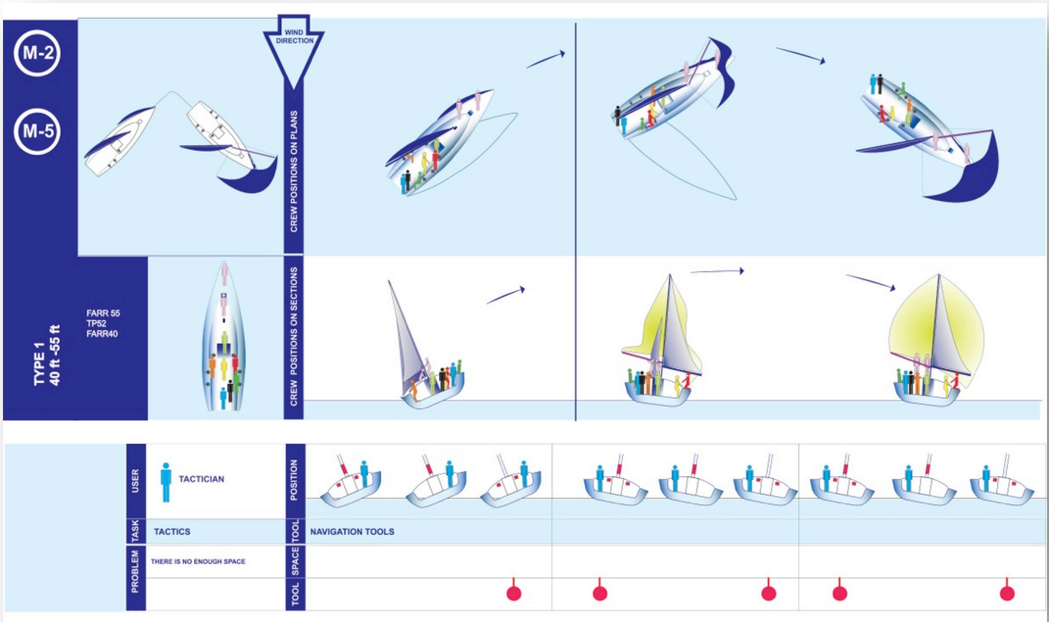


Figure 310: Work Analysis of Tactician in Type 1 Cockpit

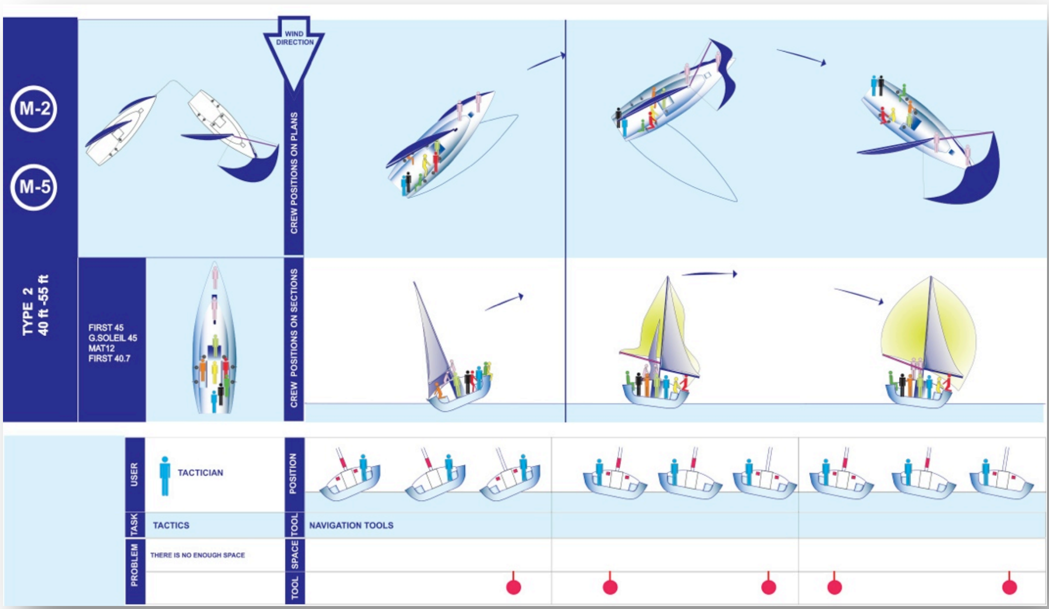


Figure 311: Work Analysis of Tactician in Type 2 Cockpit

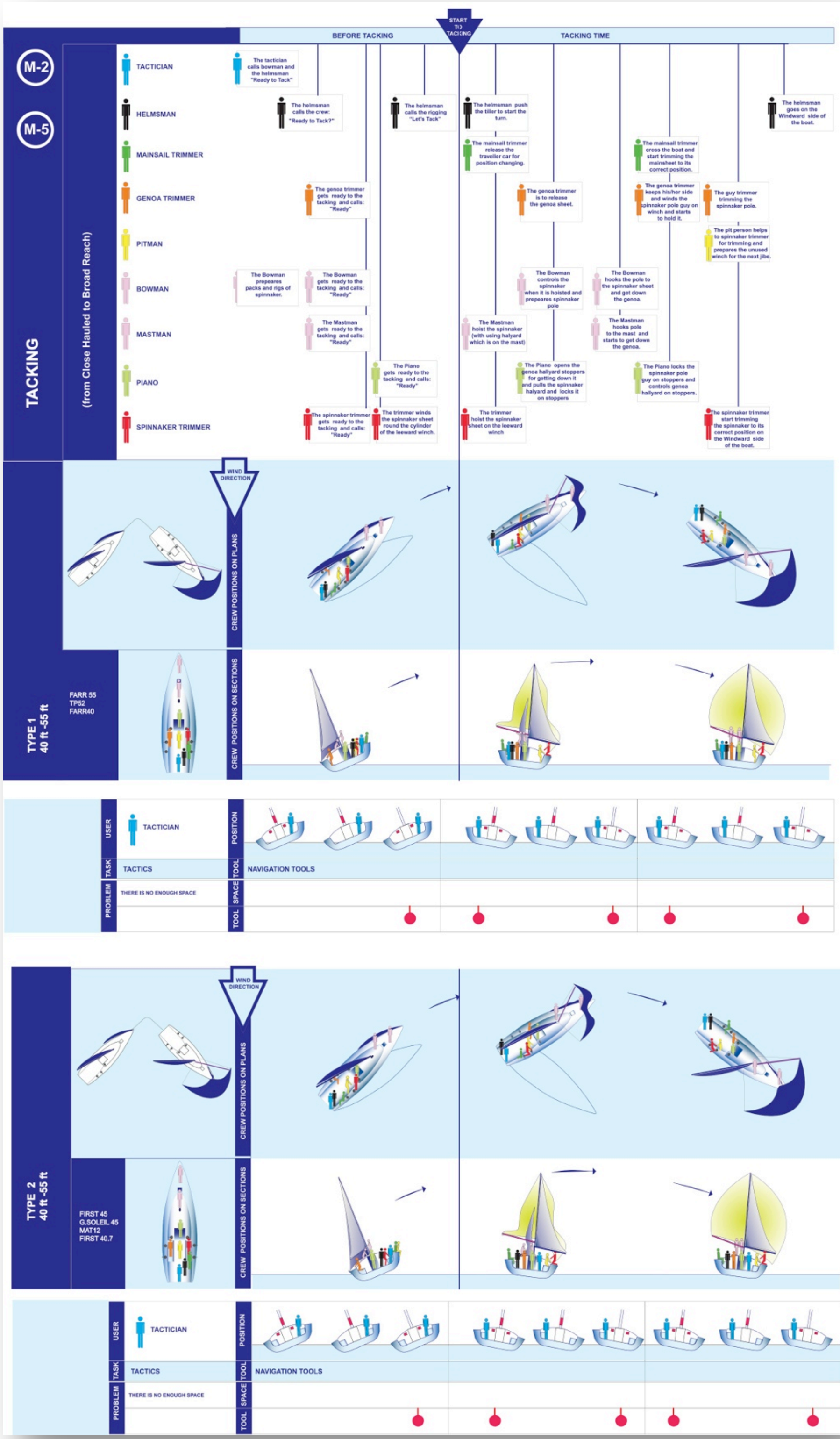


Figure 312: Work Analysis of Tactician for Type1/Type2 Cockpit Typology

4.2.3. Maneuver-3 (M3): Jibing (from Broad Reach to Broad Reach)

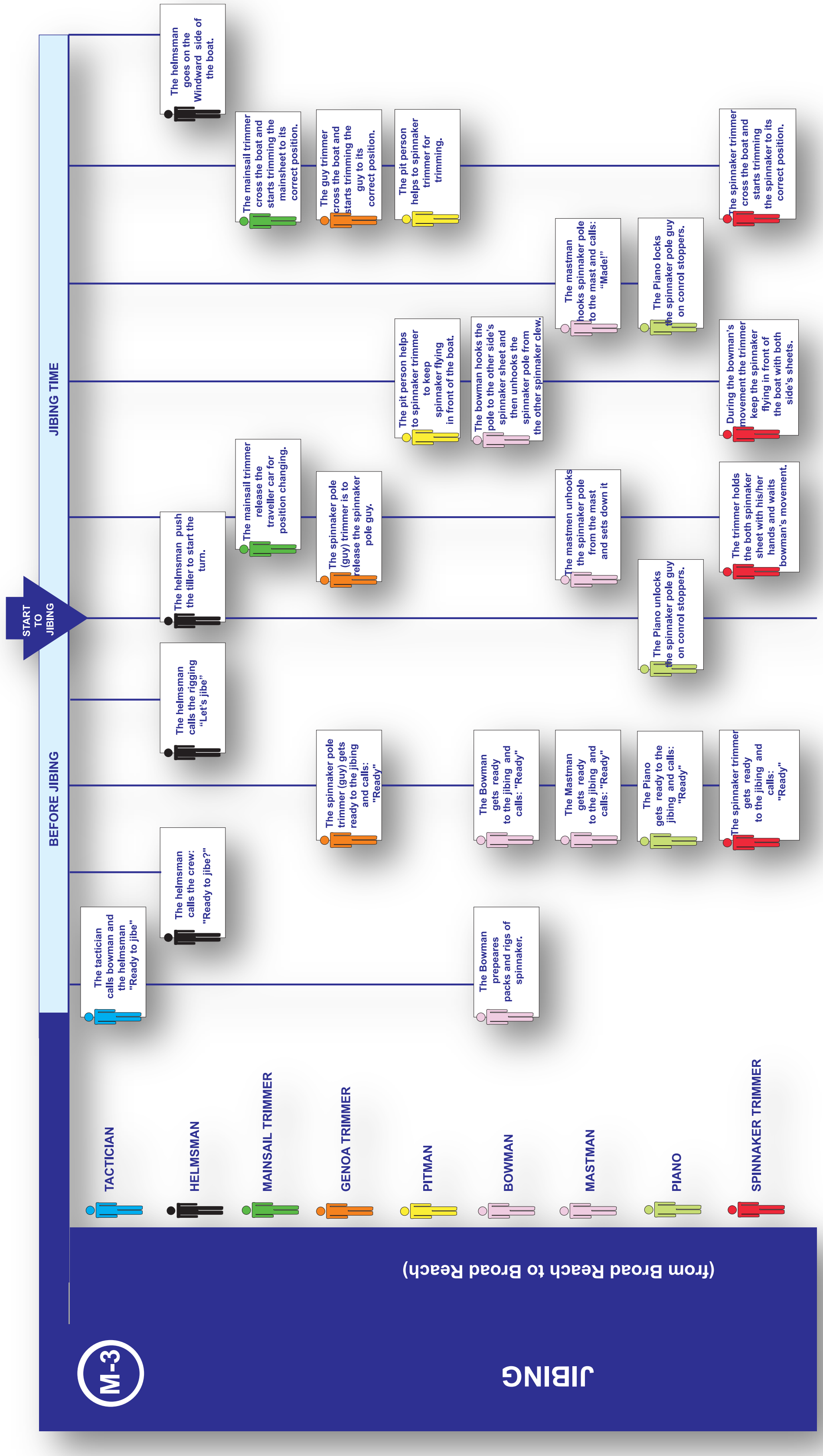


Figure 313 : Work Analysis of All Team in Jibing Maneuver (From Broad Reach to Broad ***Reach)***

4.2.3.1. Helmsman

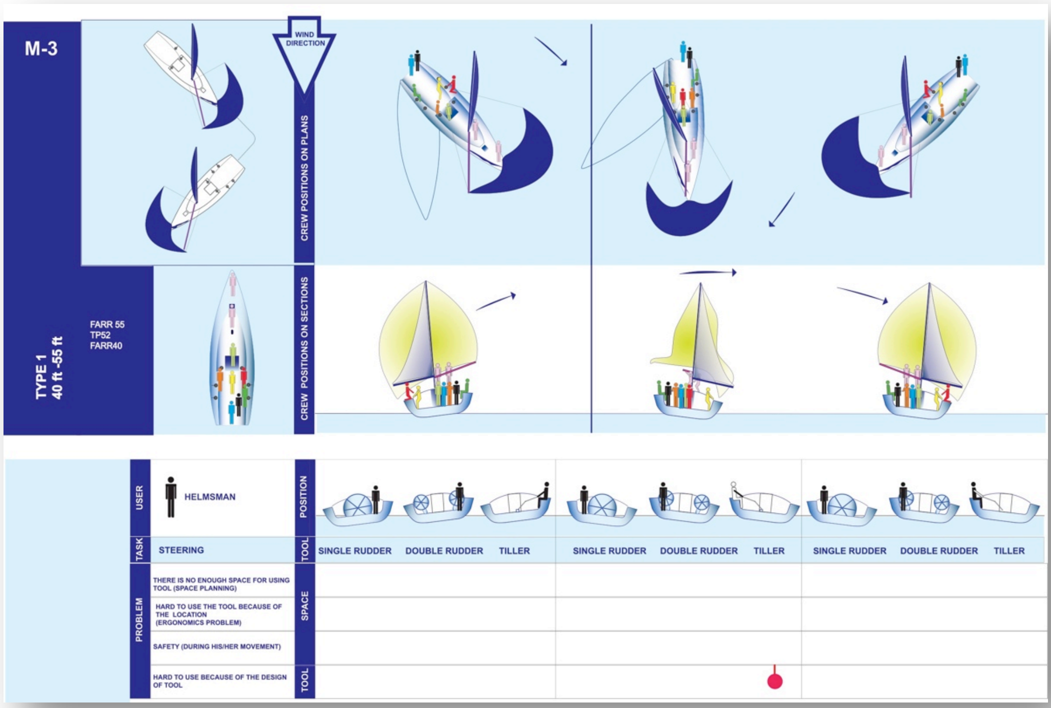


Figure 314: Work Analysis of Helmsman in Type 1 Cockpit

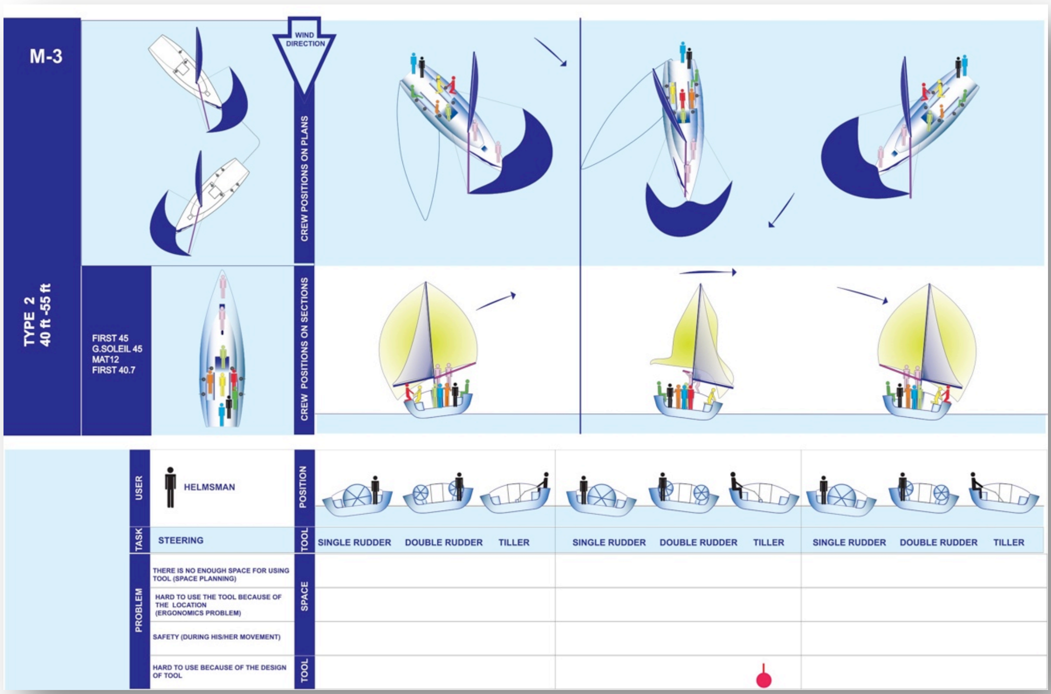


Figure 315: Work Analysis of Helmsman in Type 2 Cockpit

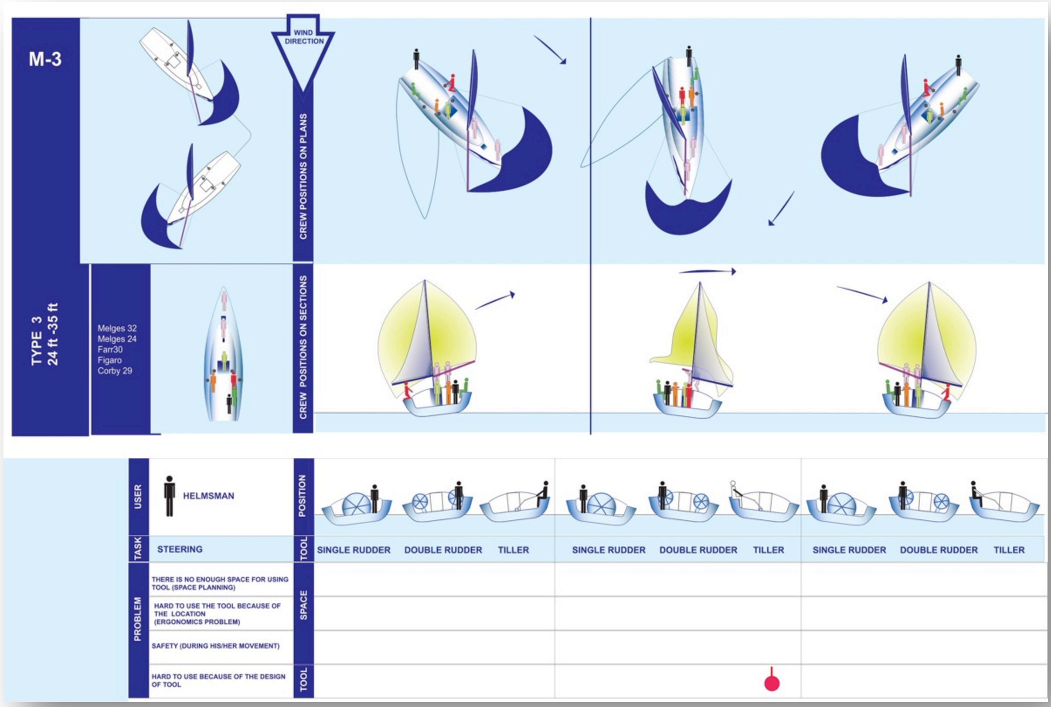


Figure 316: Work Analysis of Helmsman in Type 3 Cockpit

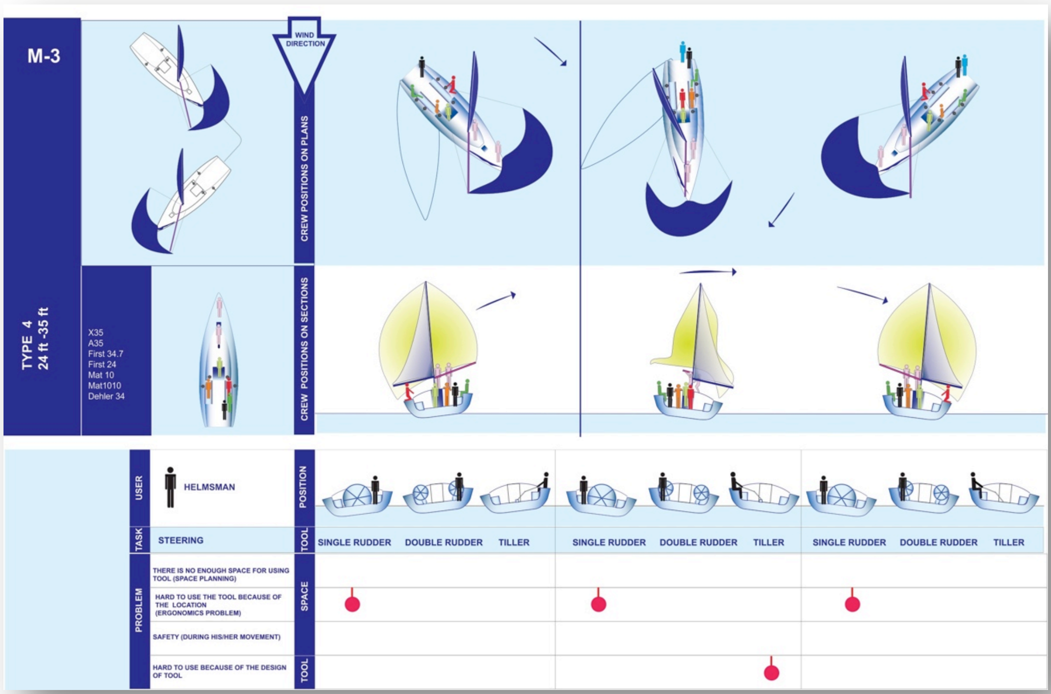


Figure 317: Work Analysis of Helmsman in Type 4 Cockpit

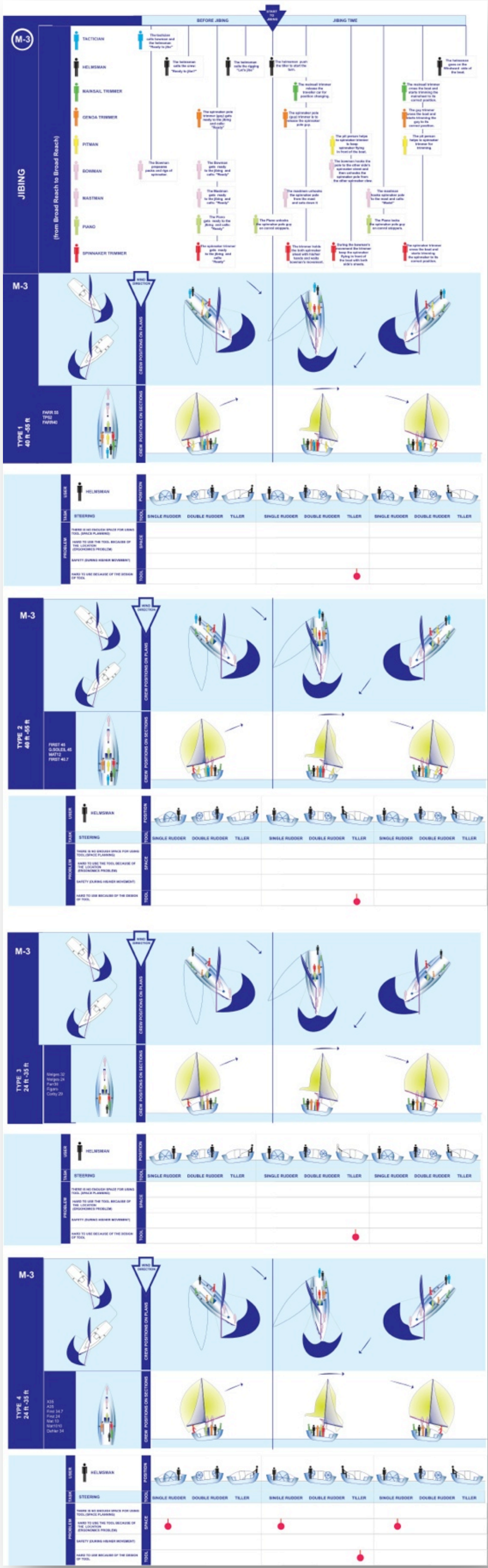


Figure 318: Work Analysis of Helmsman for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.2. Mainsail Trimmer

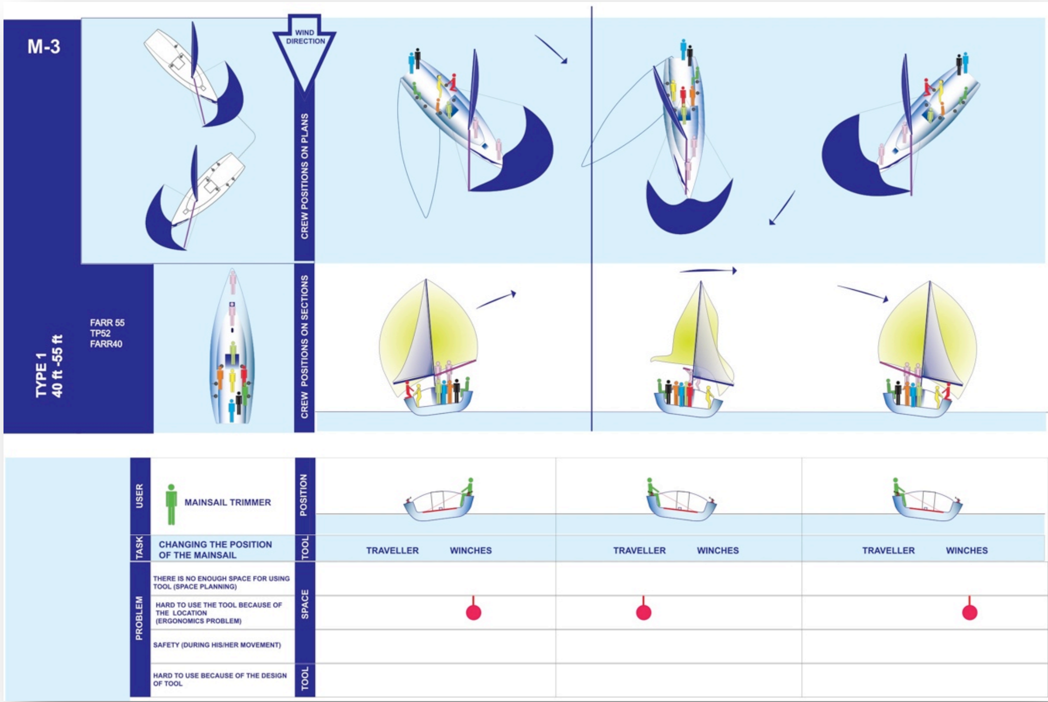


Figure 319: Work Analysis of Mainsail Trimmer in Type 1 Cockpit

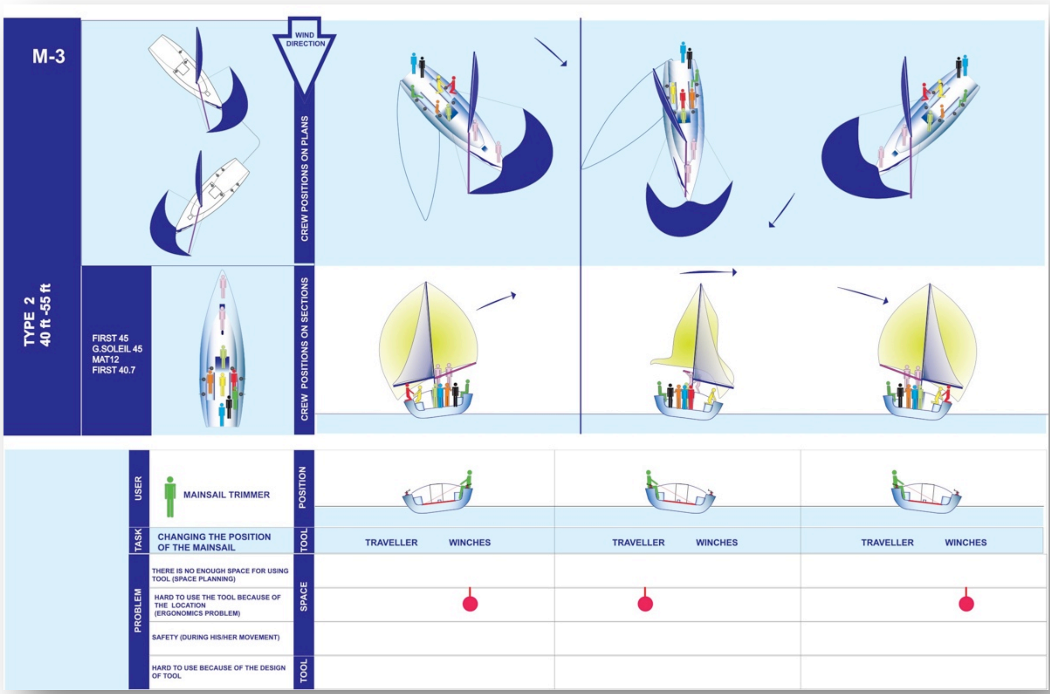


Figure 320: Work Analysis of Mainsail Trimmer in Type 2 Cockpit

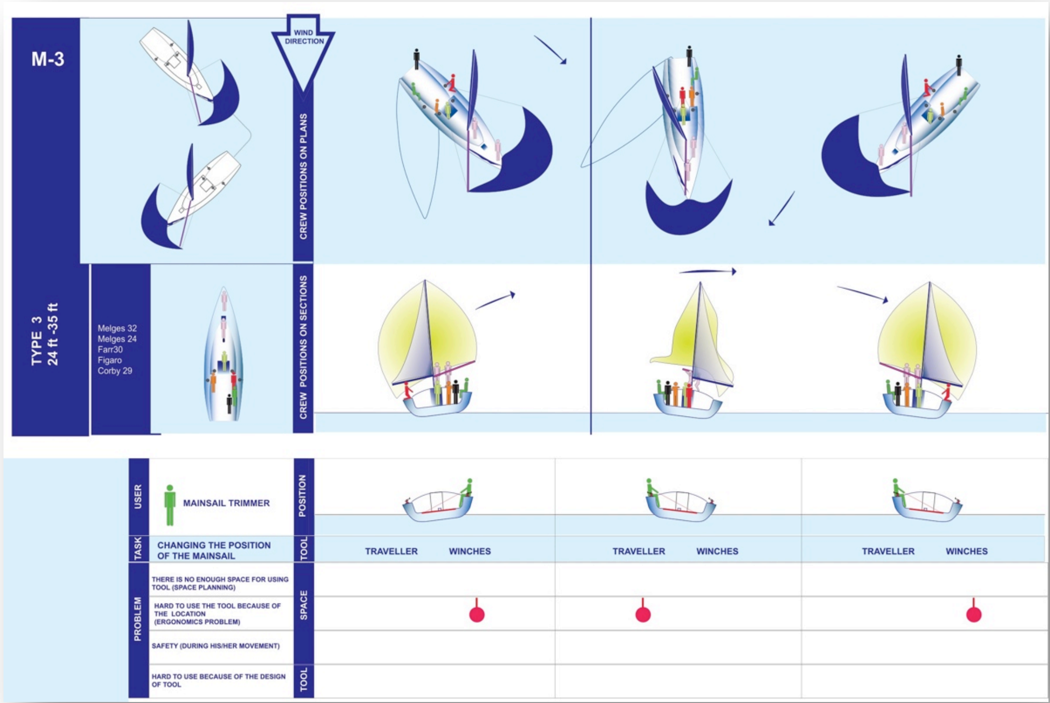


Figure 321: Work Analysis of Mainsail Trimmer in Type 3 Cockpit

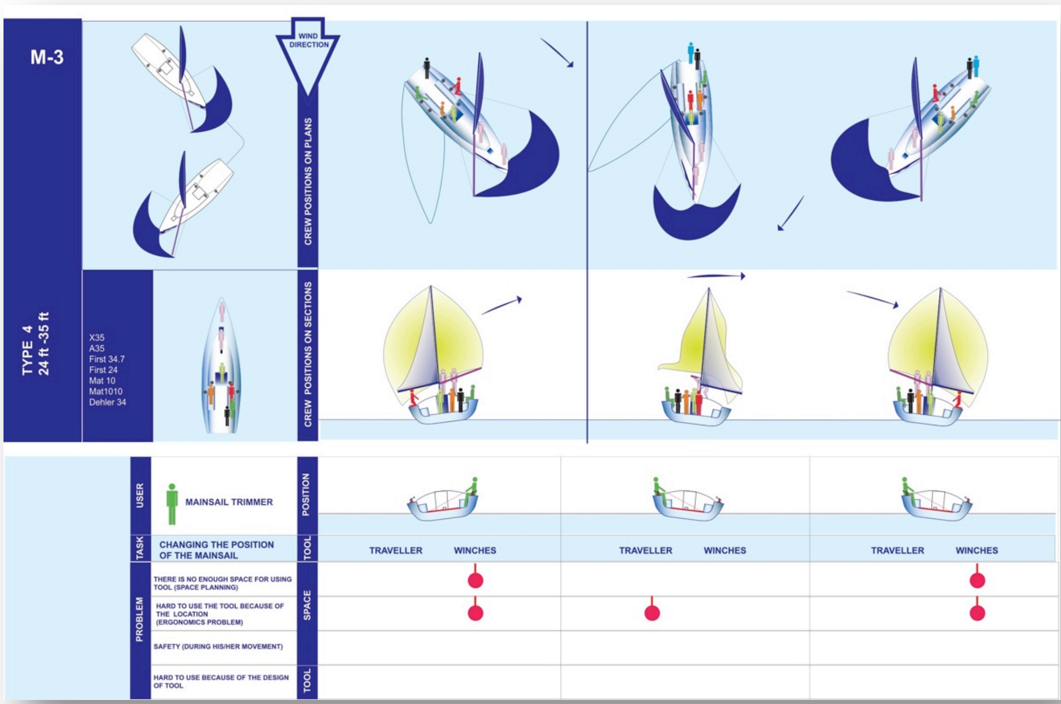


Figure 322: Work Analysis of Mainsail Trimmer in Type 4 Cockpit

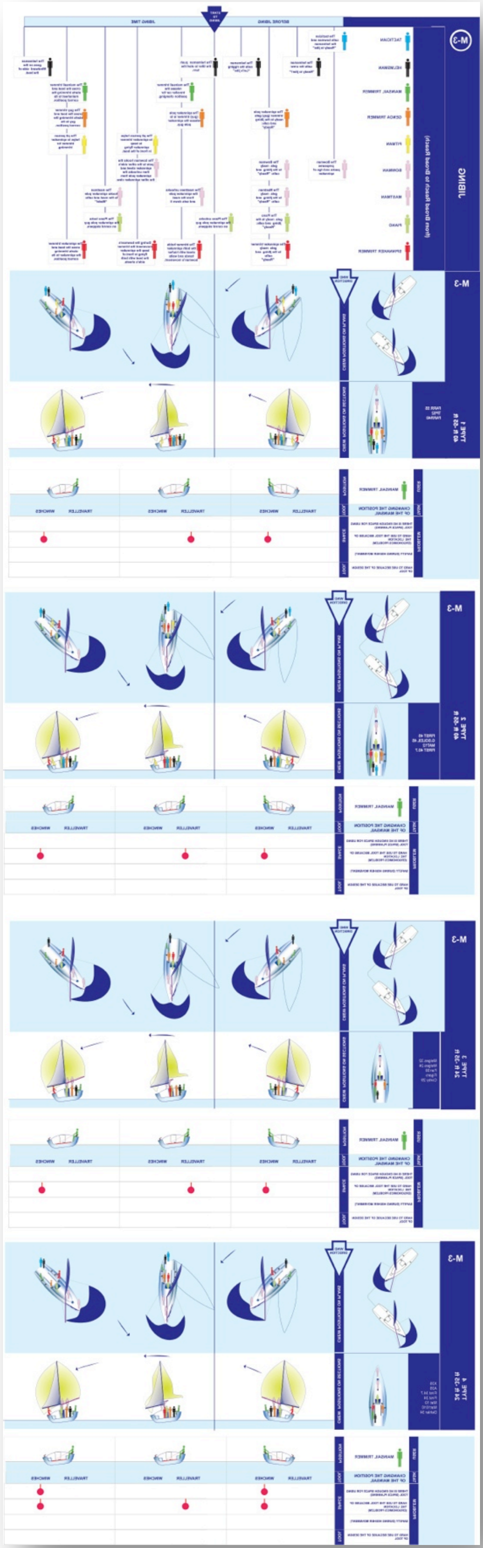


Figure 323: Work Analysis of Mainsail Trimmer for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.3. Genoa (Headsail) Trimmer

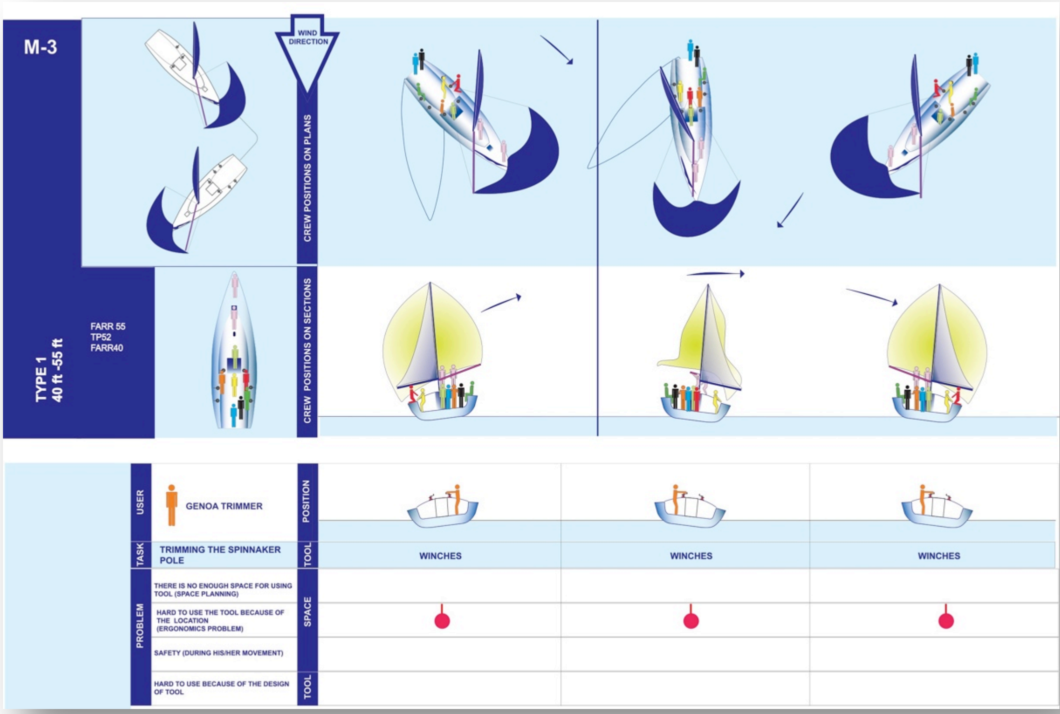


Figure 324: Work Analysis of Genoa Trimmer in Type 1 Cockpit

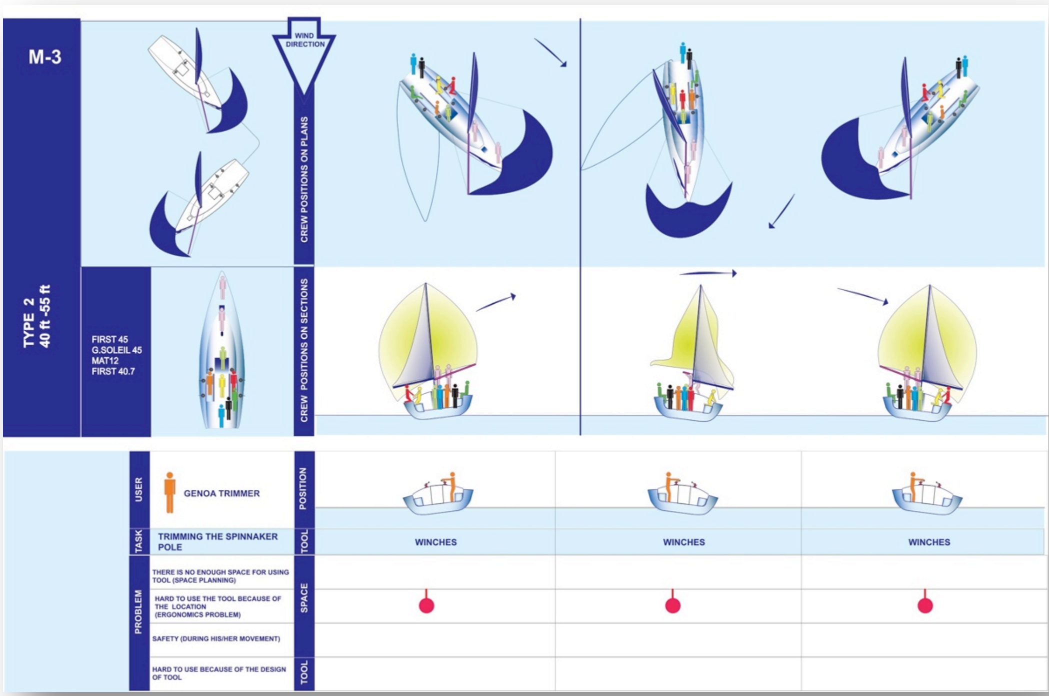


Figure 325: Work Analysis of Genoa Trimmer in Type 2 Cockpit

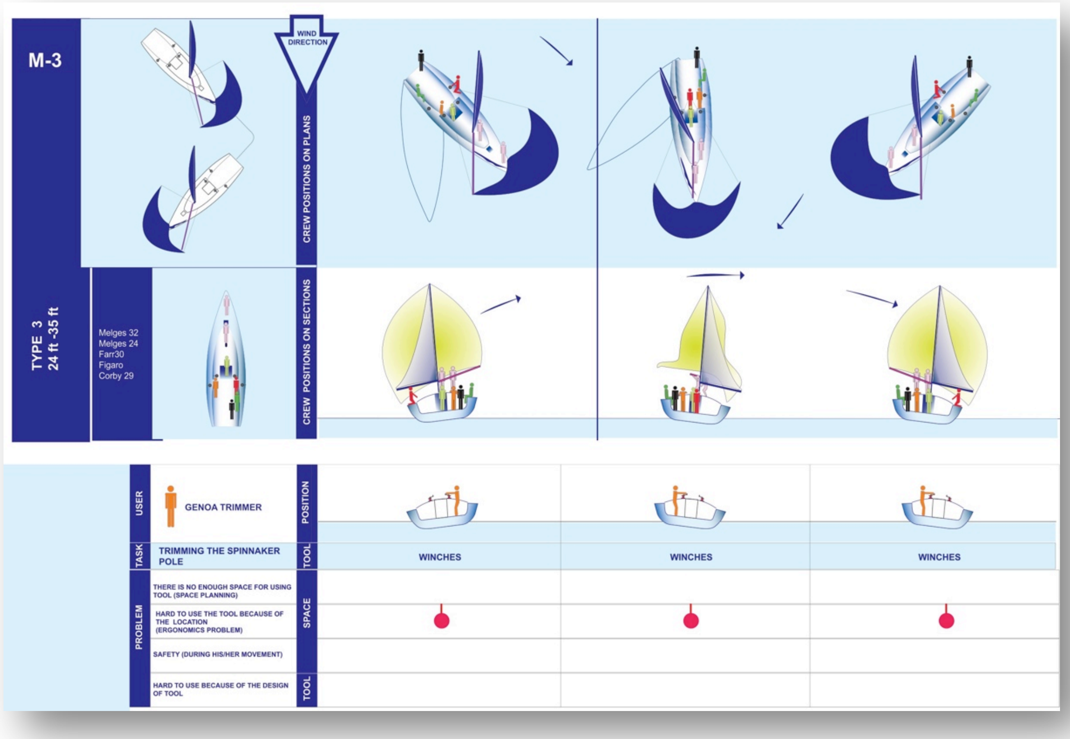


Figure 326: Work Analysis of Genoa Trimmer in Type 3 Cockpit

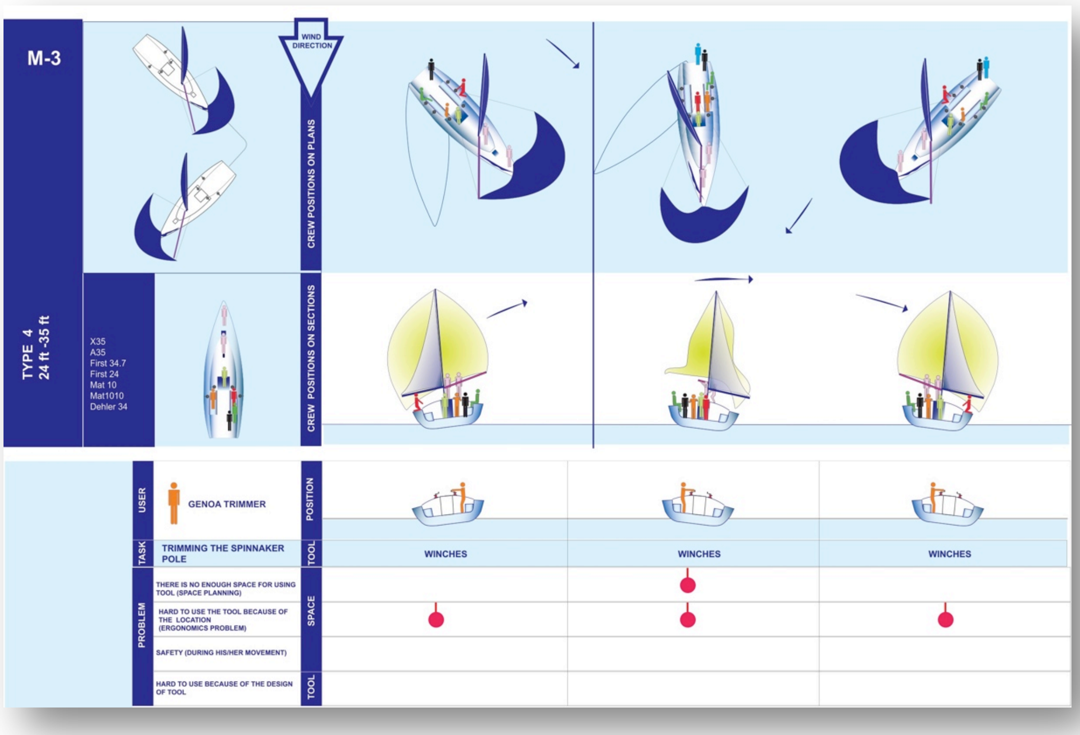


Figure 327: Work Analysis of Genoa Trimmer in Type 4 Cockpit

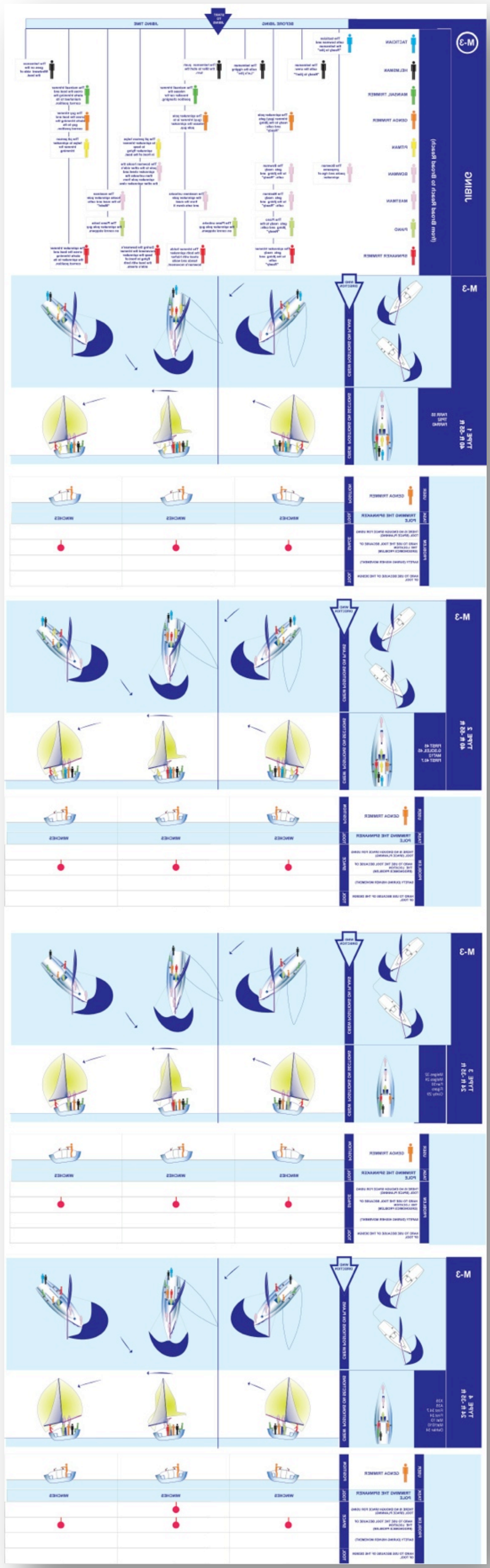


Figure 328: Work Analysis of Genoa Trimmer for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.4. Pitman

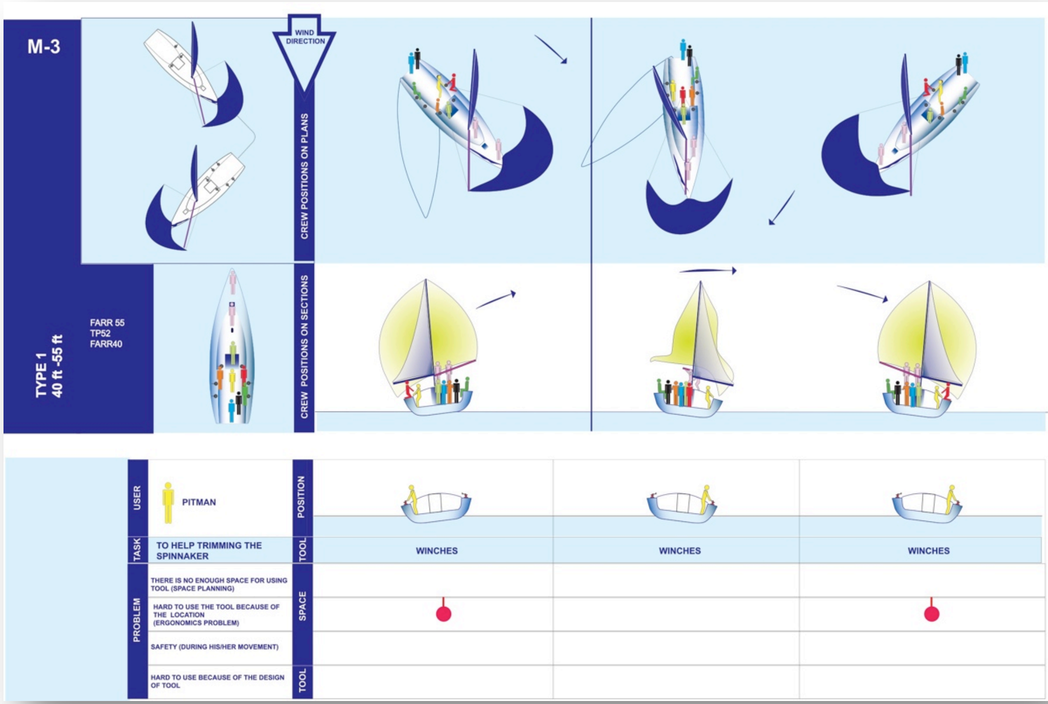


Figure 329: Work Analysis of Pitman in Type 1 Cockpit

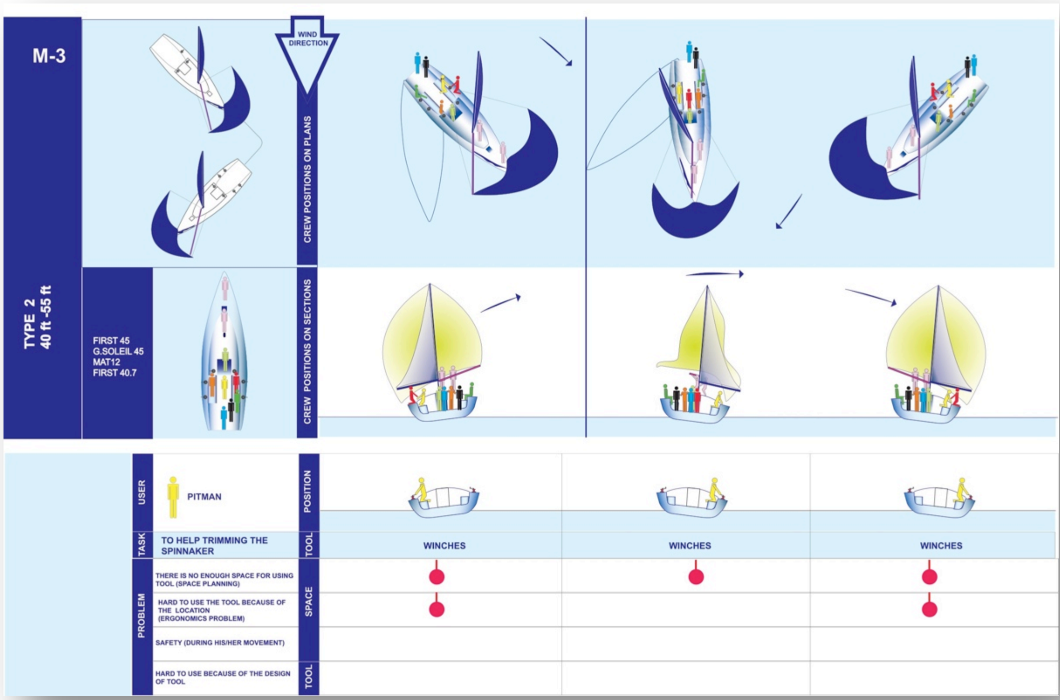


Figure 330: Work Analysis of Pitman in Type 2 Cockpit

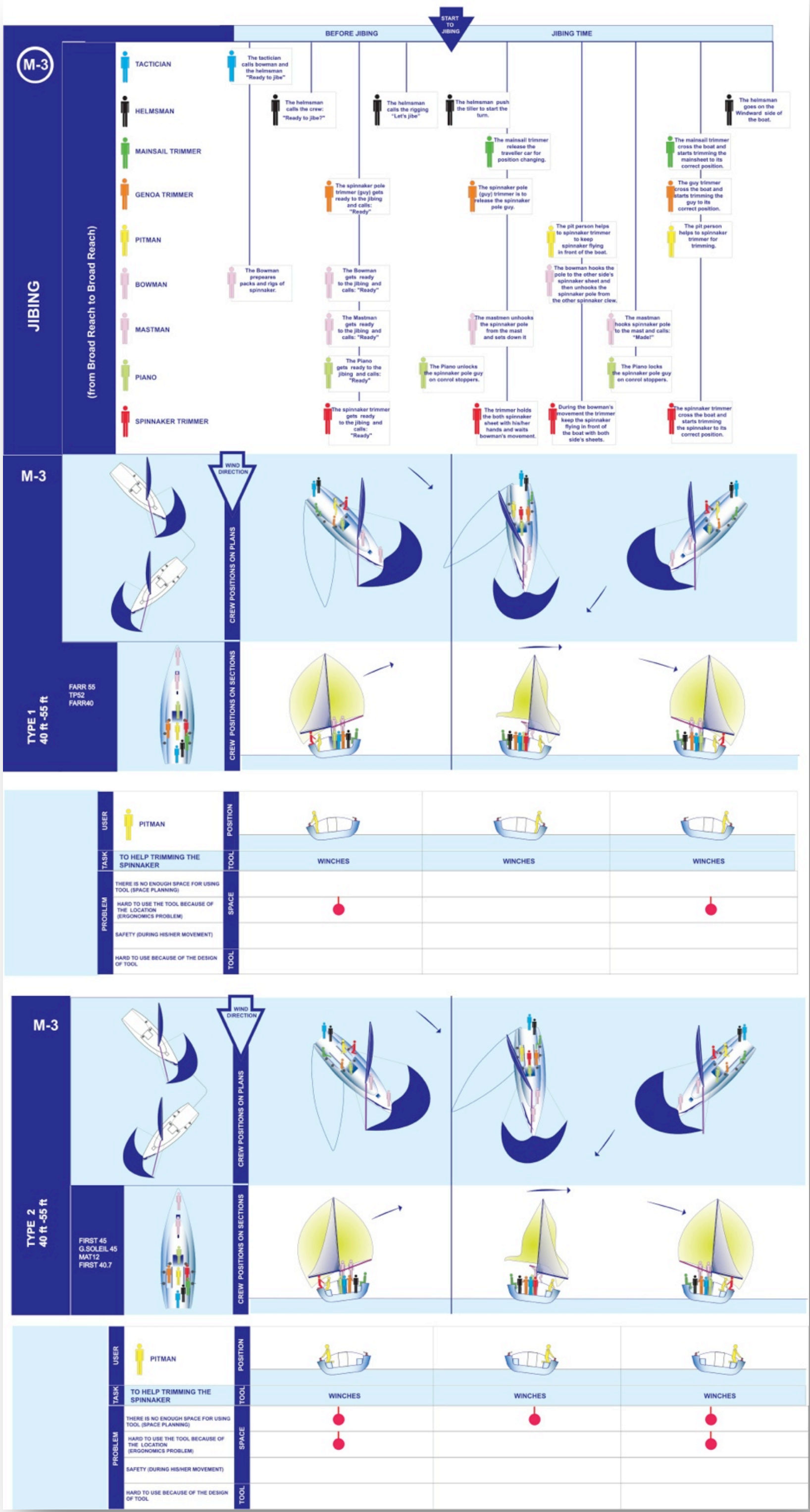


Figure 331: Work Analysis of Pitman for Type1/Type2 Cockpit Typology

4.2.3.5. Bowman

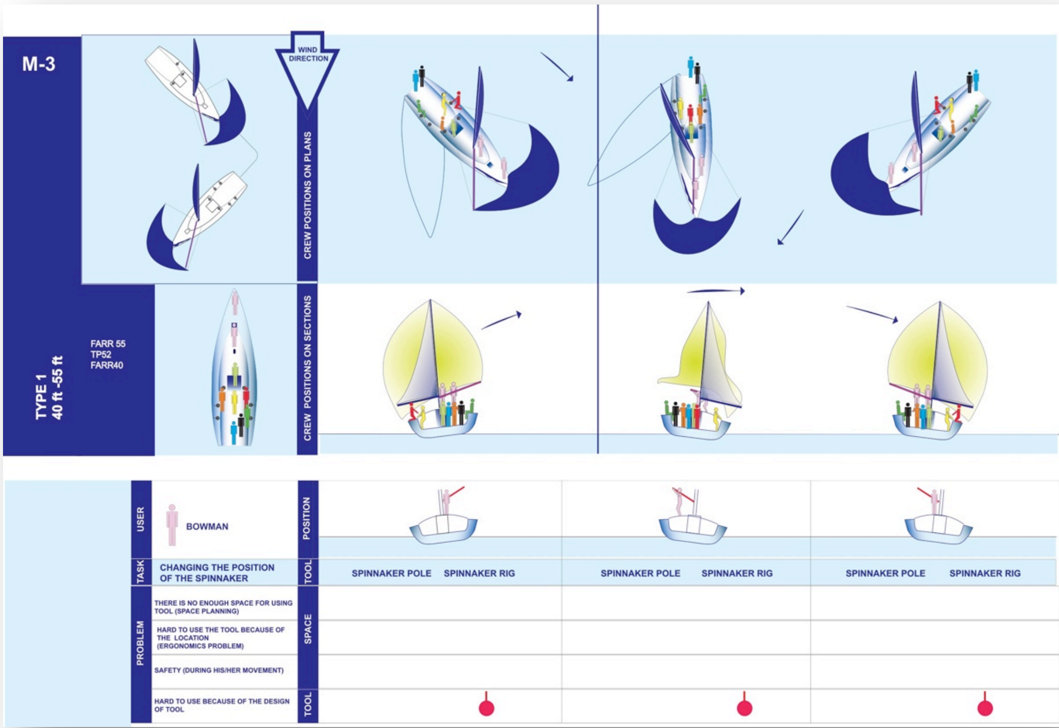


Figure 332: Work Analysis of Bowman in Type 1 Cockpit

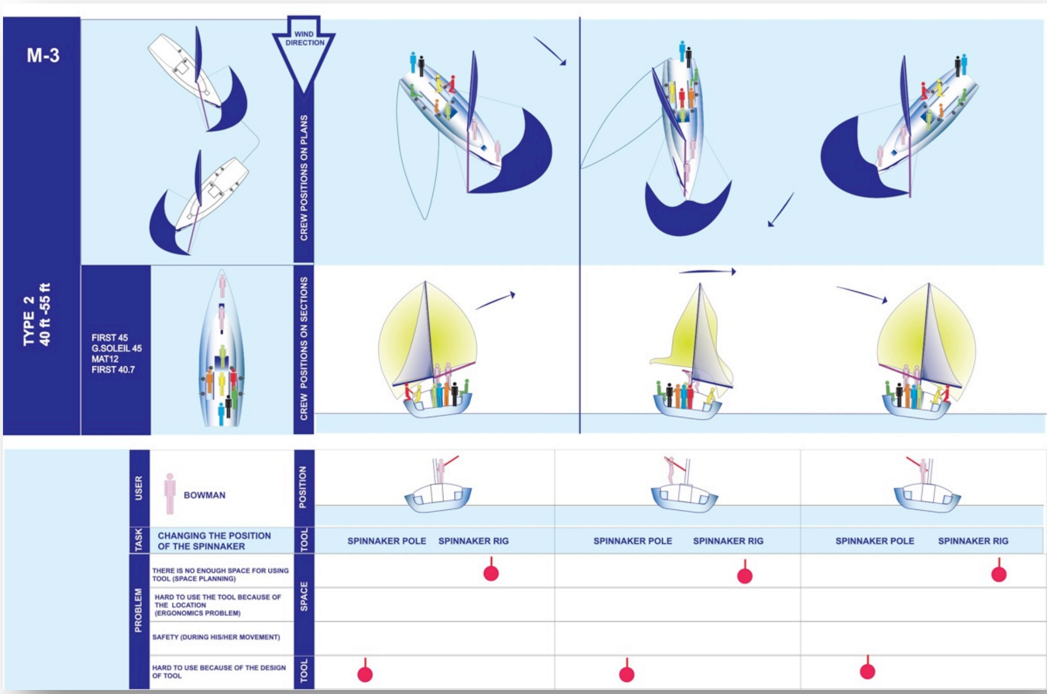


Figure 333: Work Analysis of Bowman in Type 2 Cockpit

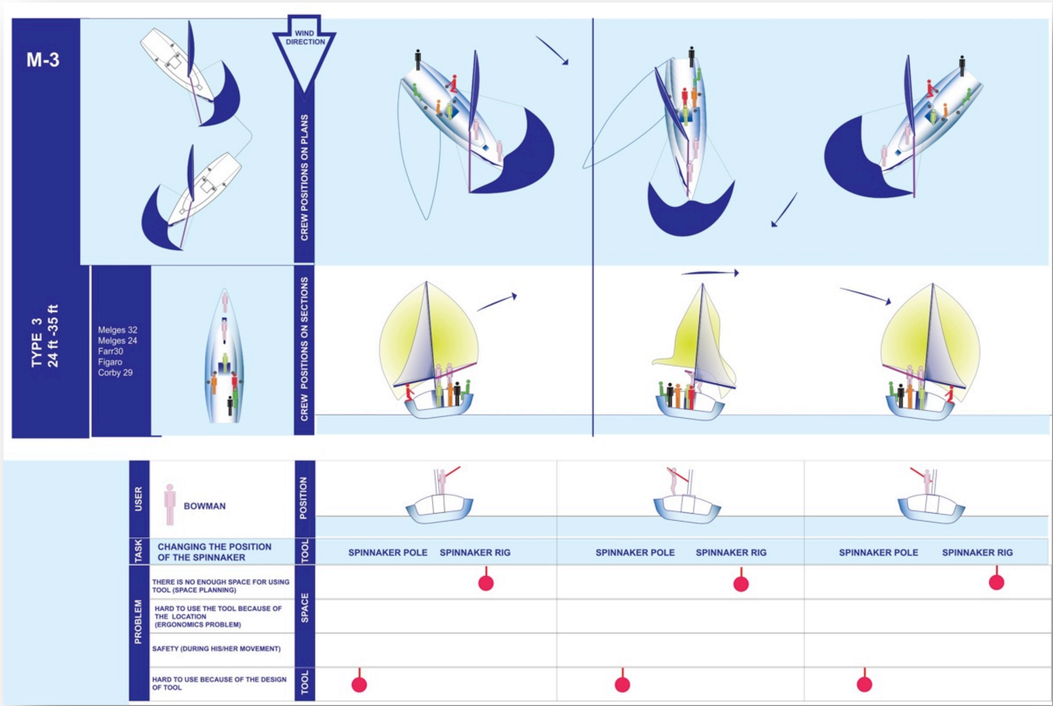


Figure 334: Work Analysis of Bowman in Type 3 Cockpit

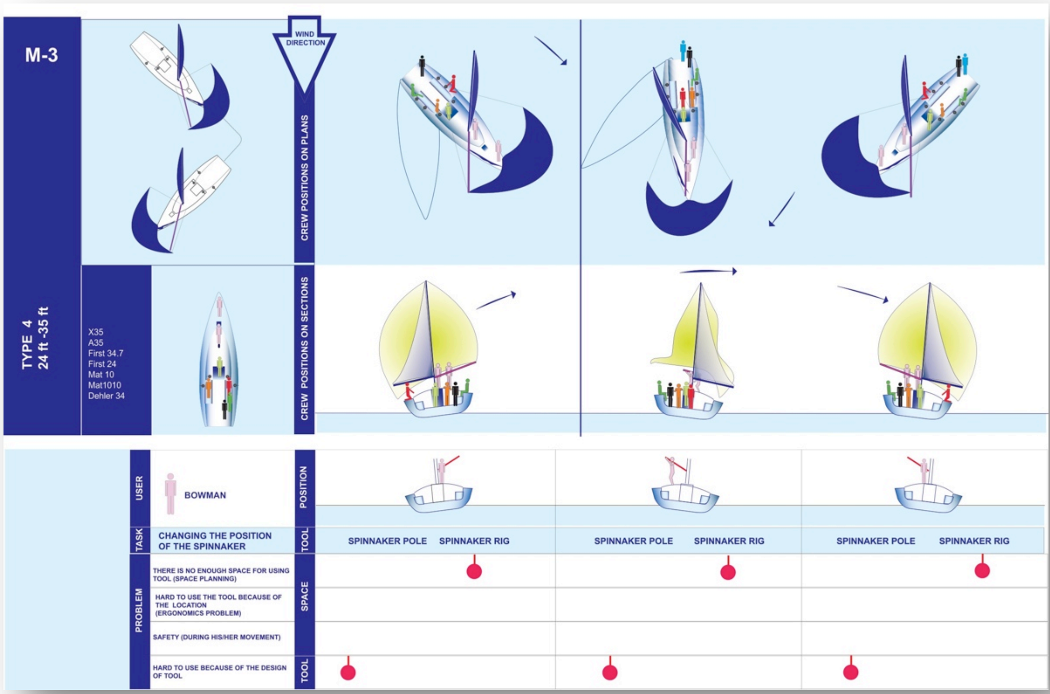


Figure 335: Work Analysis of Bowman in Type 4 Cockpit

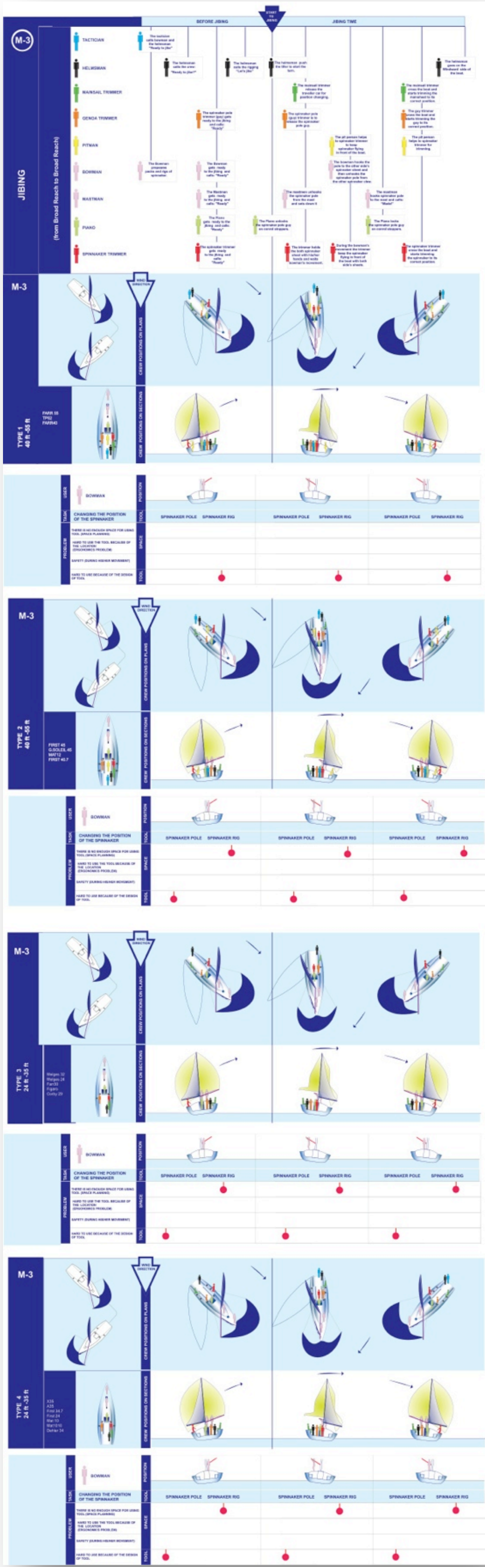


Figure 336: Work Analysis of Bowman for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.6. Mastman

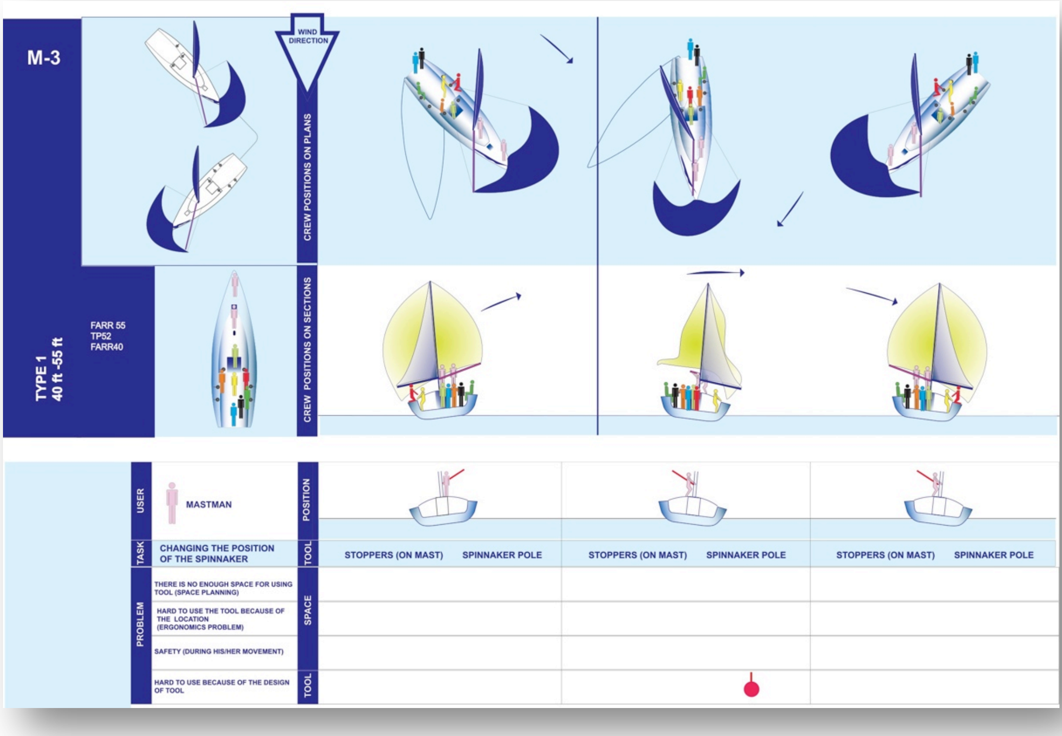


Figure 337: Work Analysis of Mastman in Type 1 Cockpit

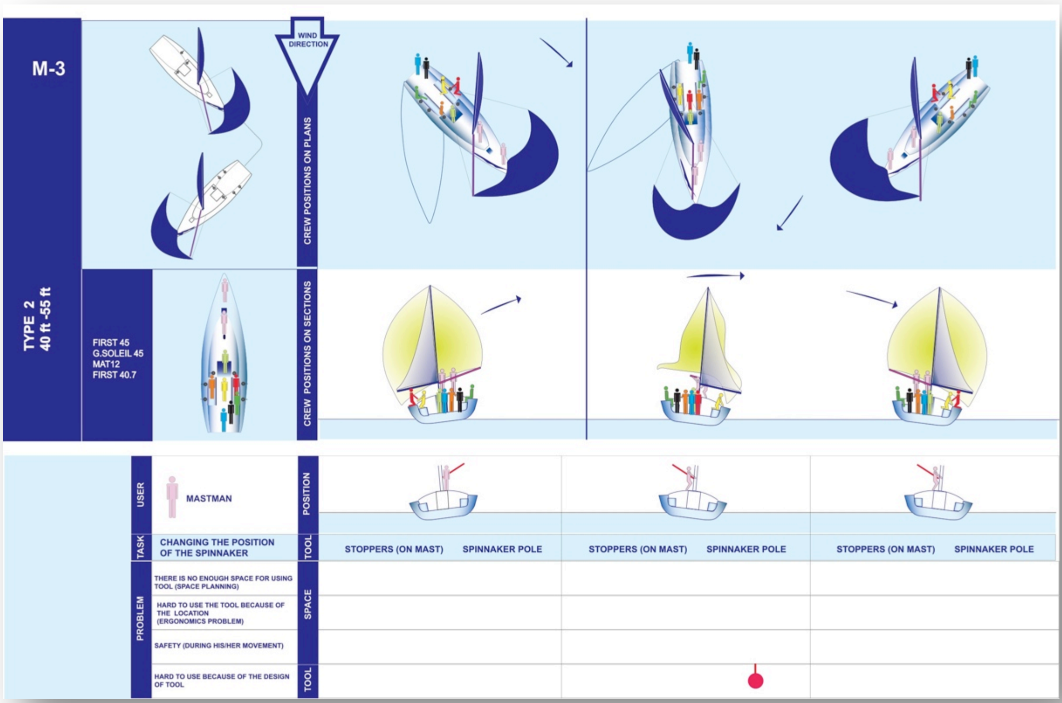


Figure 338: Work Analysis of Mastman in Type 2 Cockpit

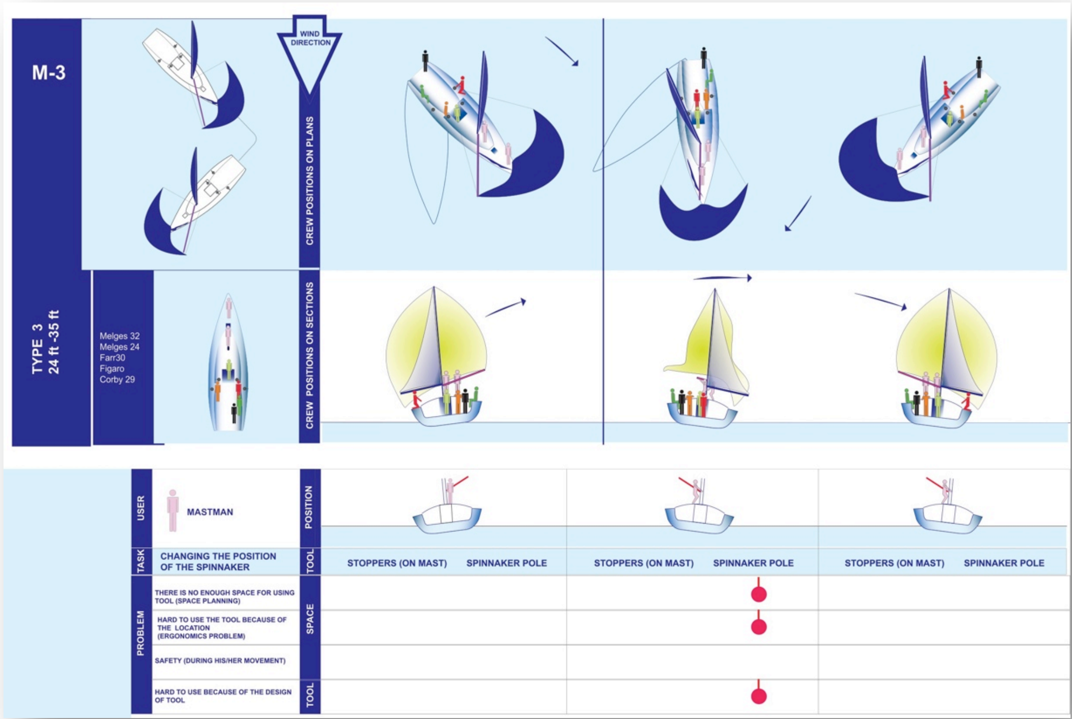


Figure 339: Work Analysis of Mastman in Type 3 Cockpit

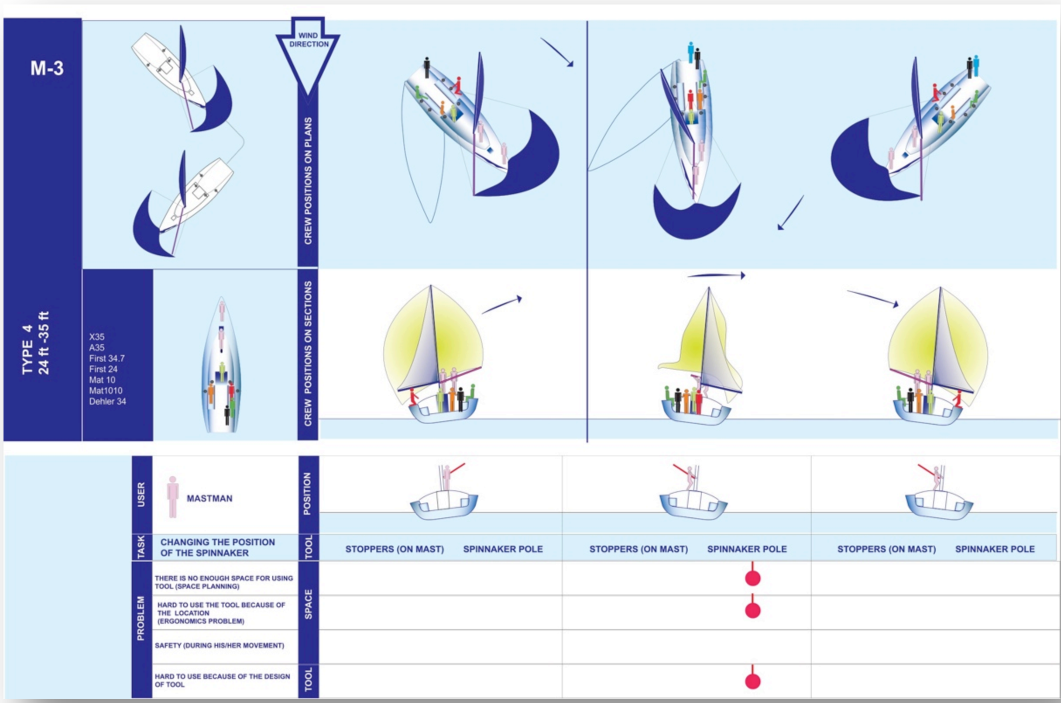


Figure 340: Work Analysis of Mastman in Type 4 Cockpit

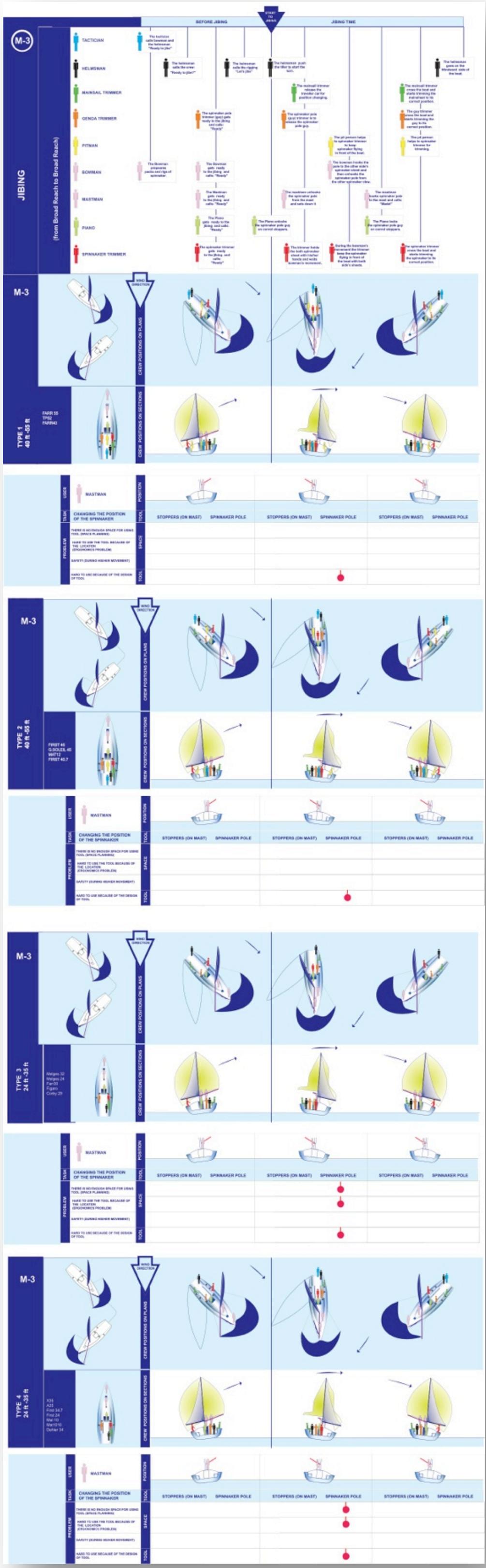


Figure 341: Work Analysis of Mastman for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.7. Piano

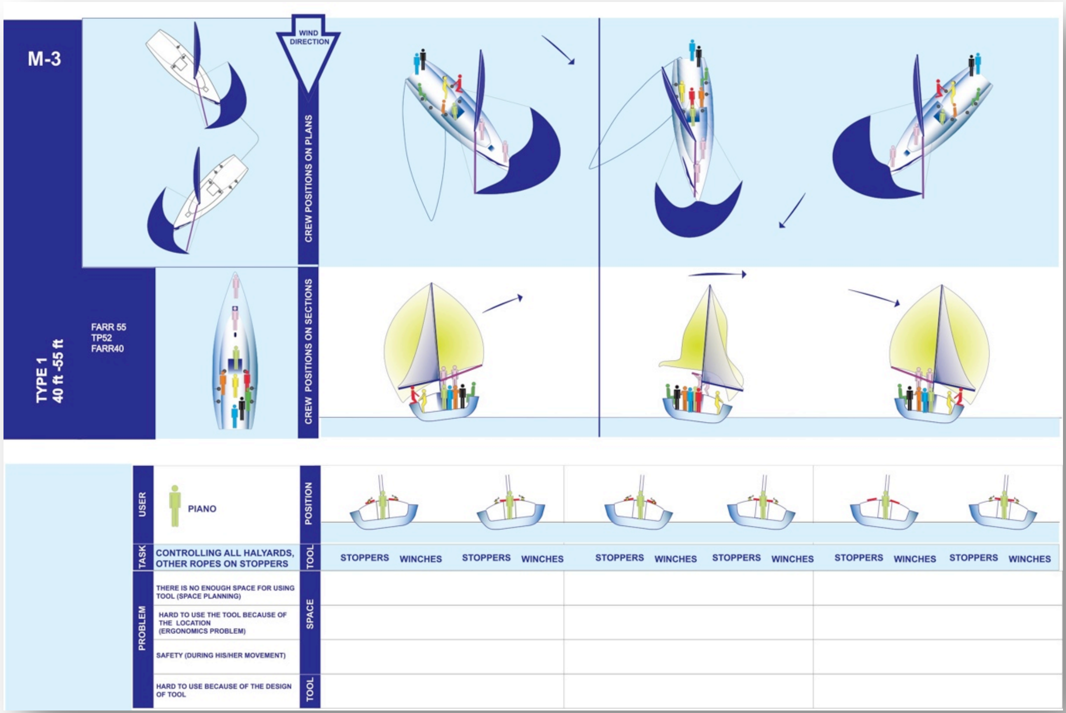


Figure 342: Work Analysis of Piano in Type 1 Cockpit

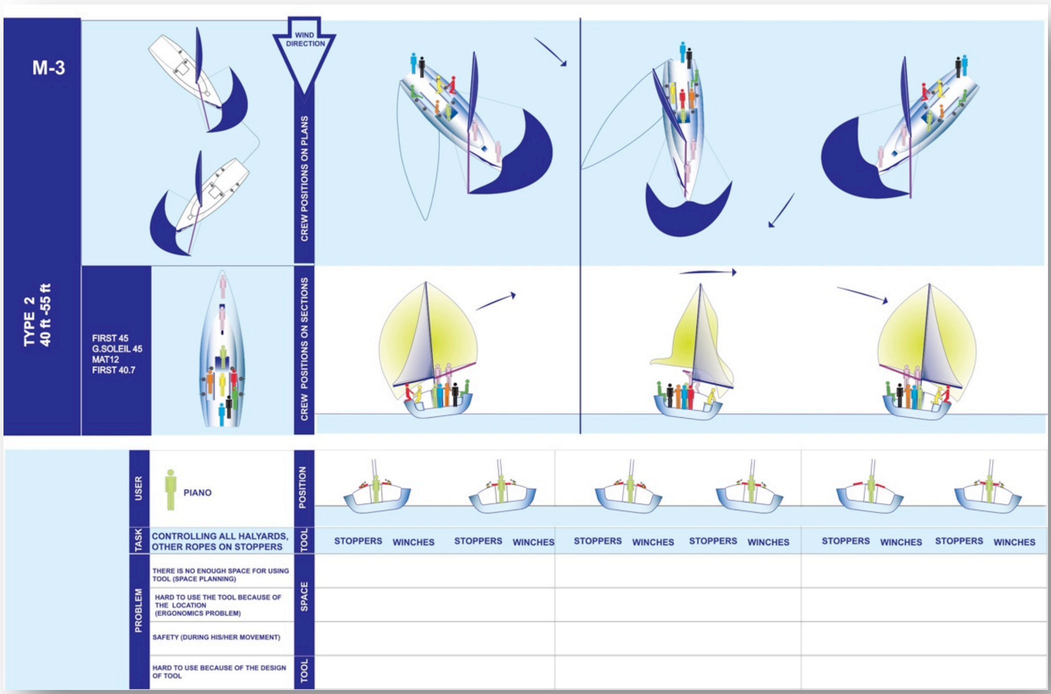


Figure 343: Work Analysis of Piano in Type 2 Cockpit

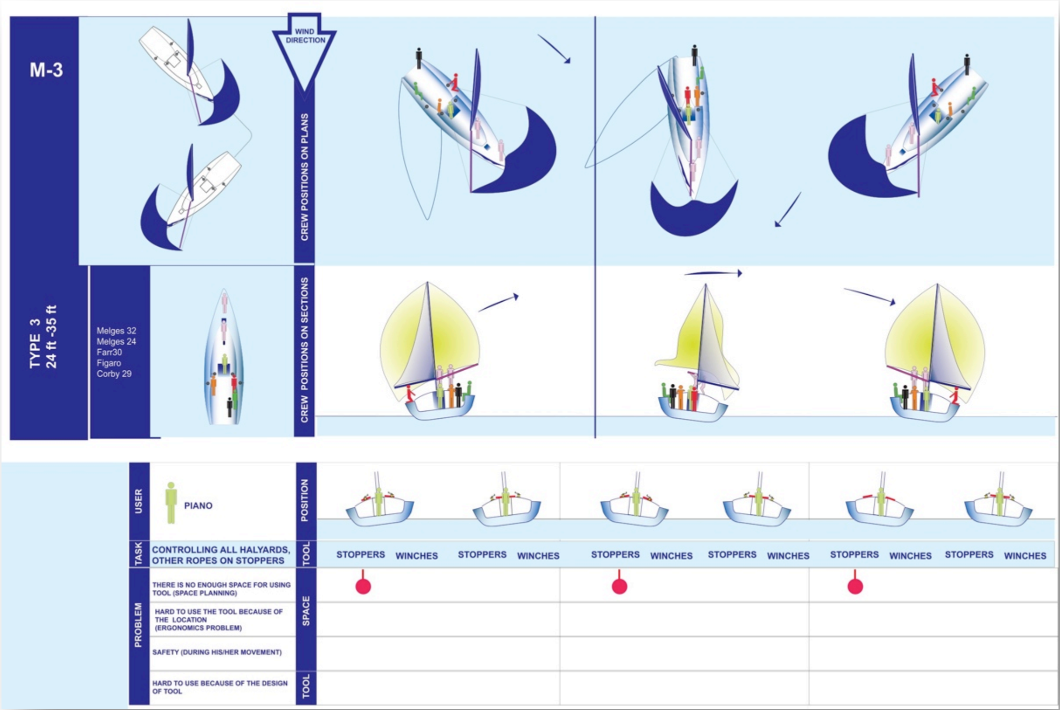


Figure 344: Work Analysis of Piano in Type 3 Cockpit

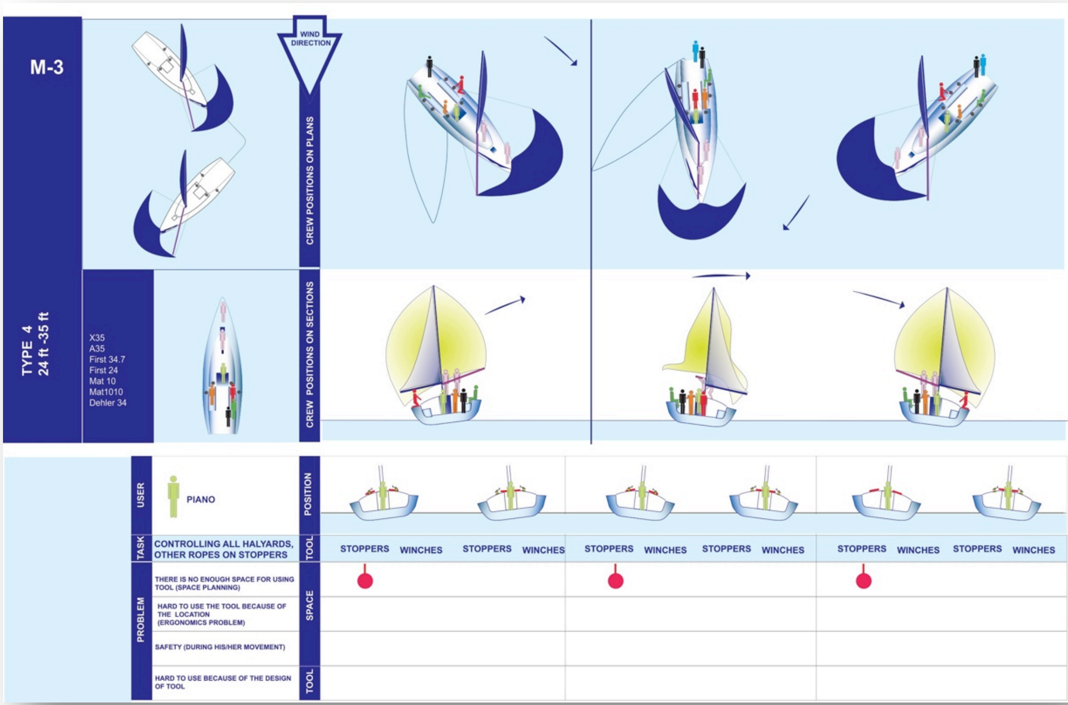


Figure 345: Work Analysis of Piano in Type 4 Cockpit

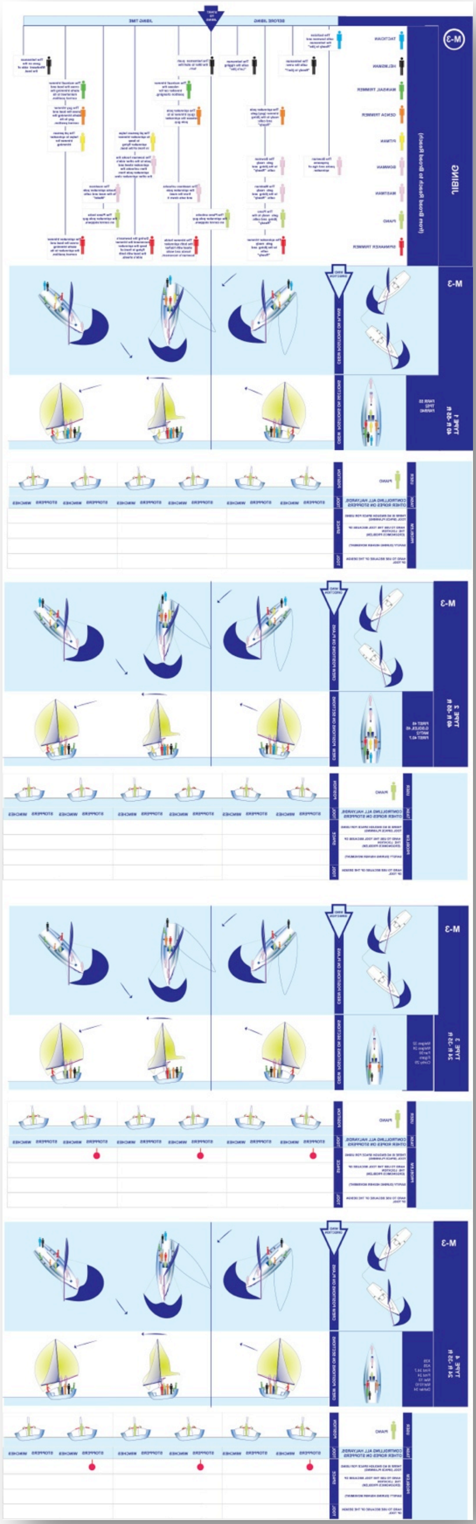


Figure 346: Work Analysis of Piano for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.8. Spinnaker Trimmer

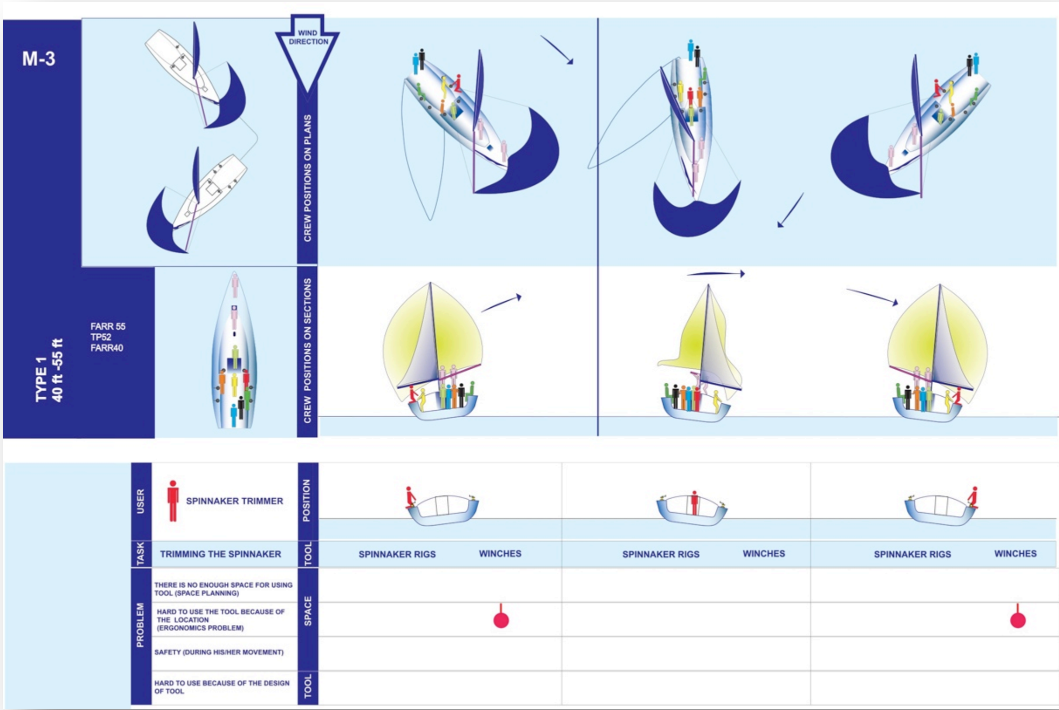


Figure 347: Work Analysis of Spinnaker Trimmer in Type 1 Cockpit

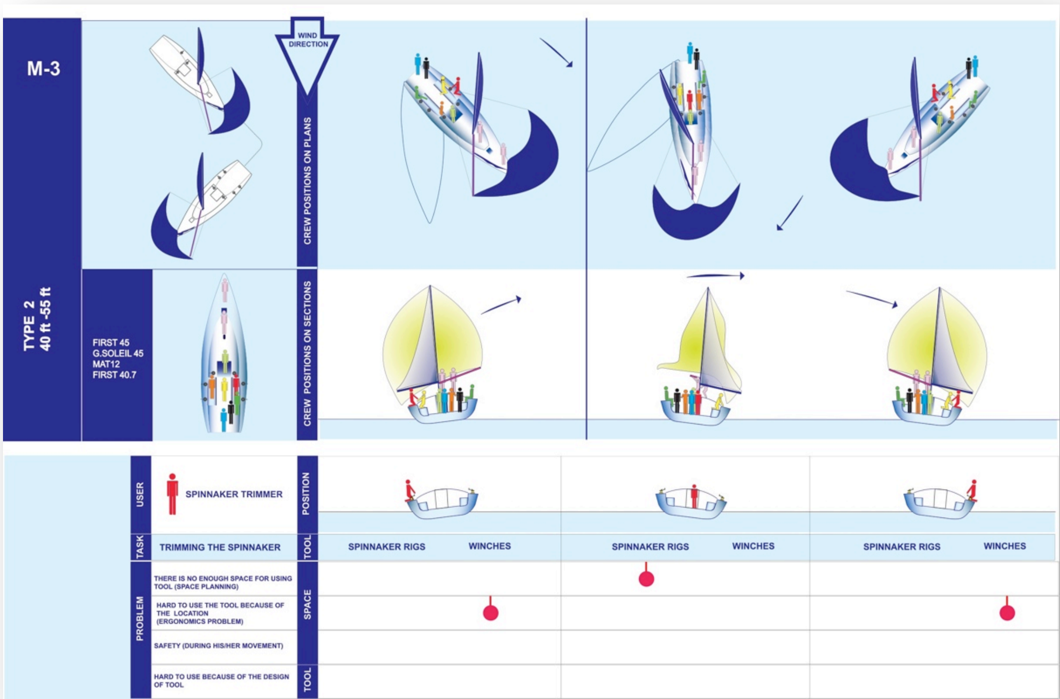


Figure 348: Work Analysis of Spinnaker Trimmer in Type 2 Cockpit

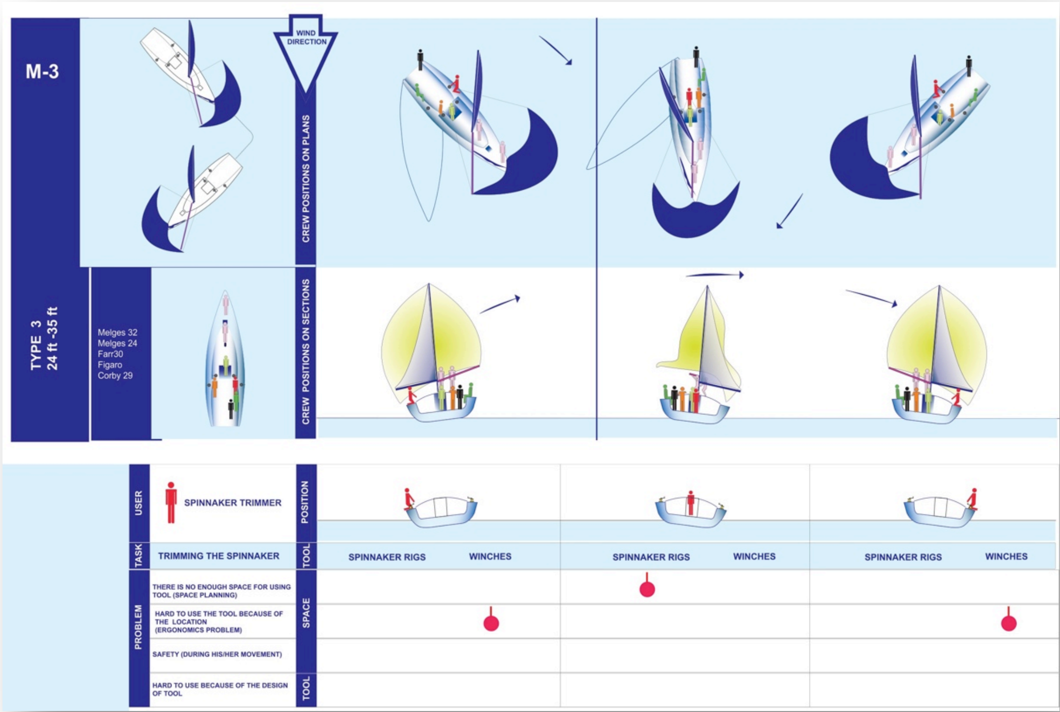


Figure 349: Work Analysis of Spinnaker Trimmer in Type 3 Cockpit

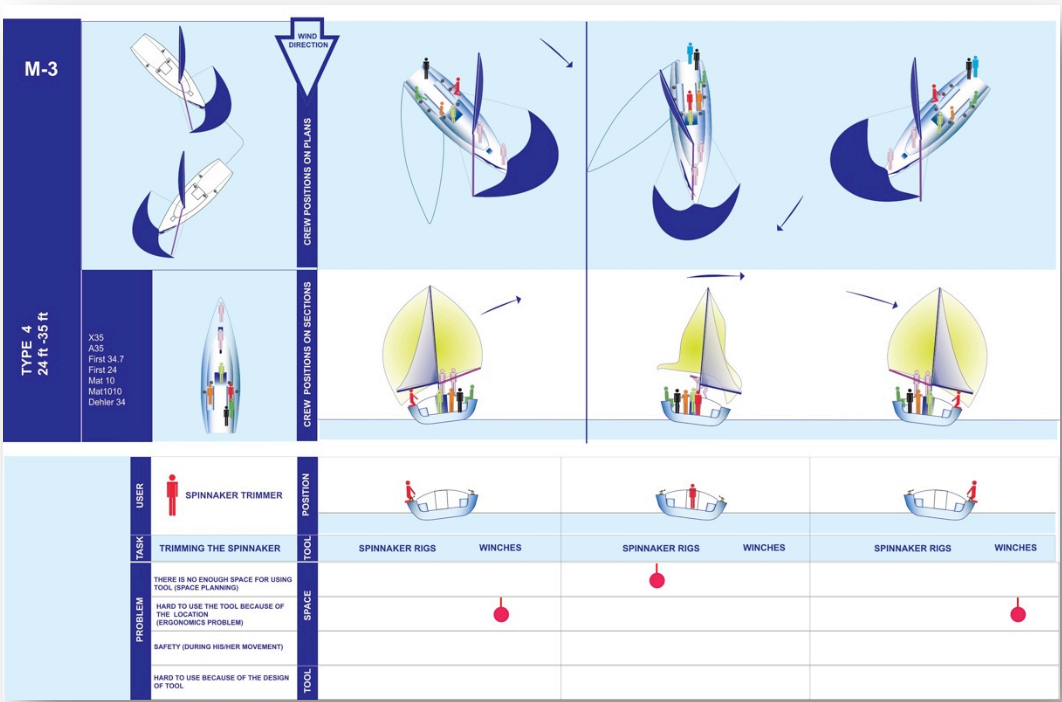


Figure 350: Work Analysis of Spinnaker Trimmer in Type 4 Cockpit

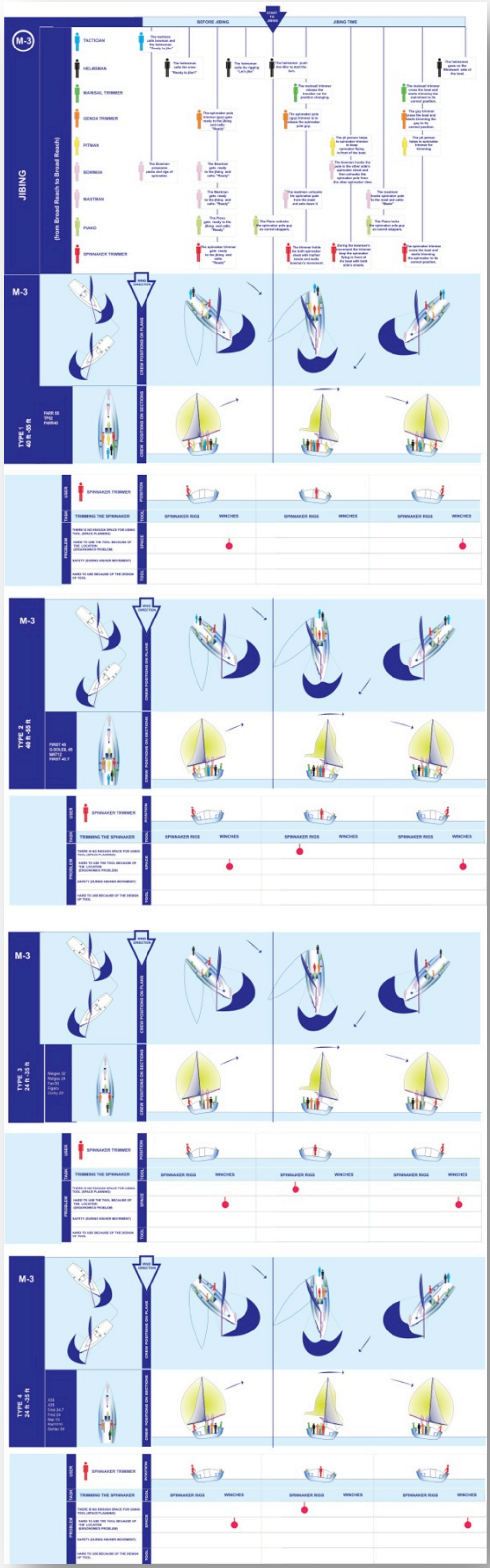


Figure 351: Work Analysis of Spinnaker Trimmer for Type1/Type2/Type3/Type4 Cockpit Typology

4.2.3.9. Tactician

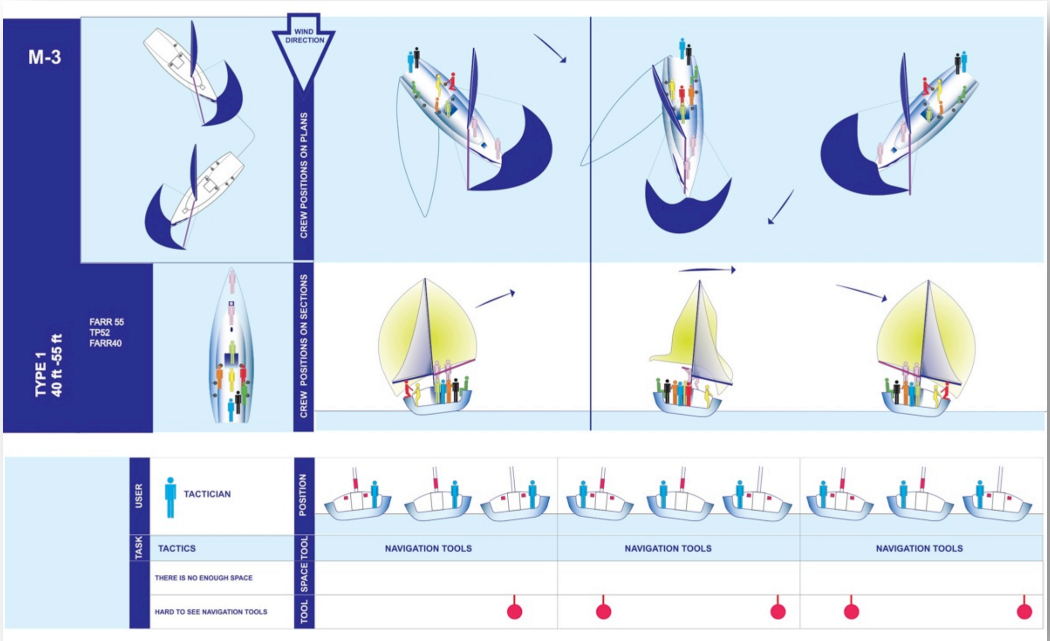


Figure 352: Work Analysis of Tactician in Type 1 Cockpit

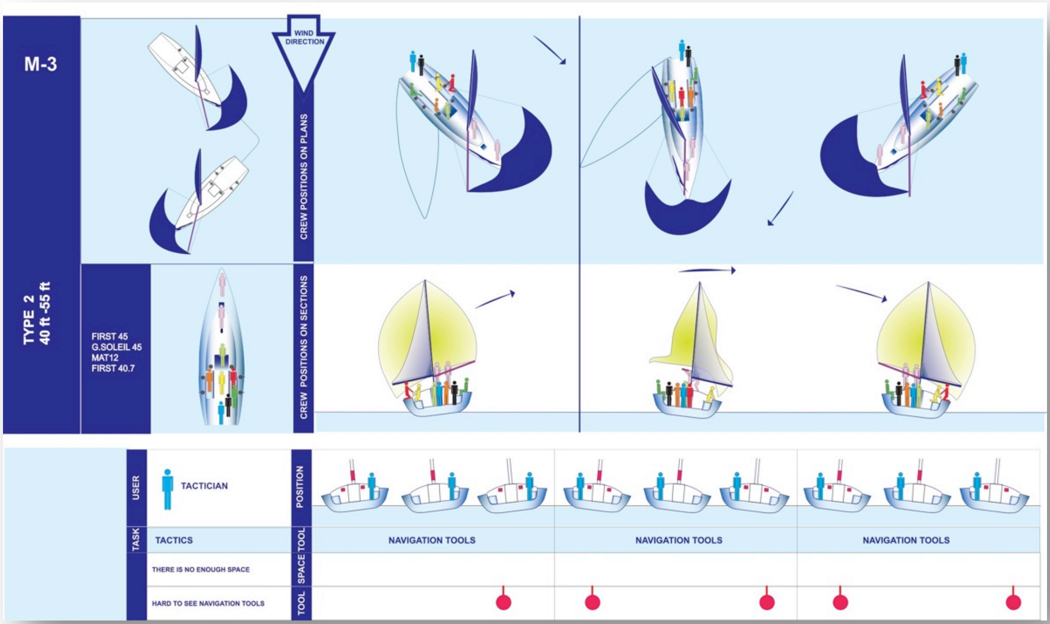


Figure 353: Work Analysis of Tactician in Type 2 Cockpit

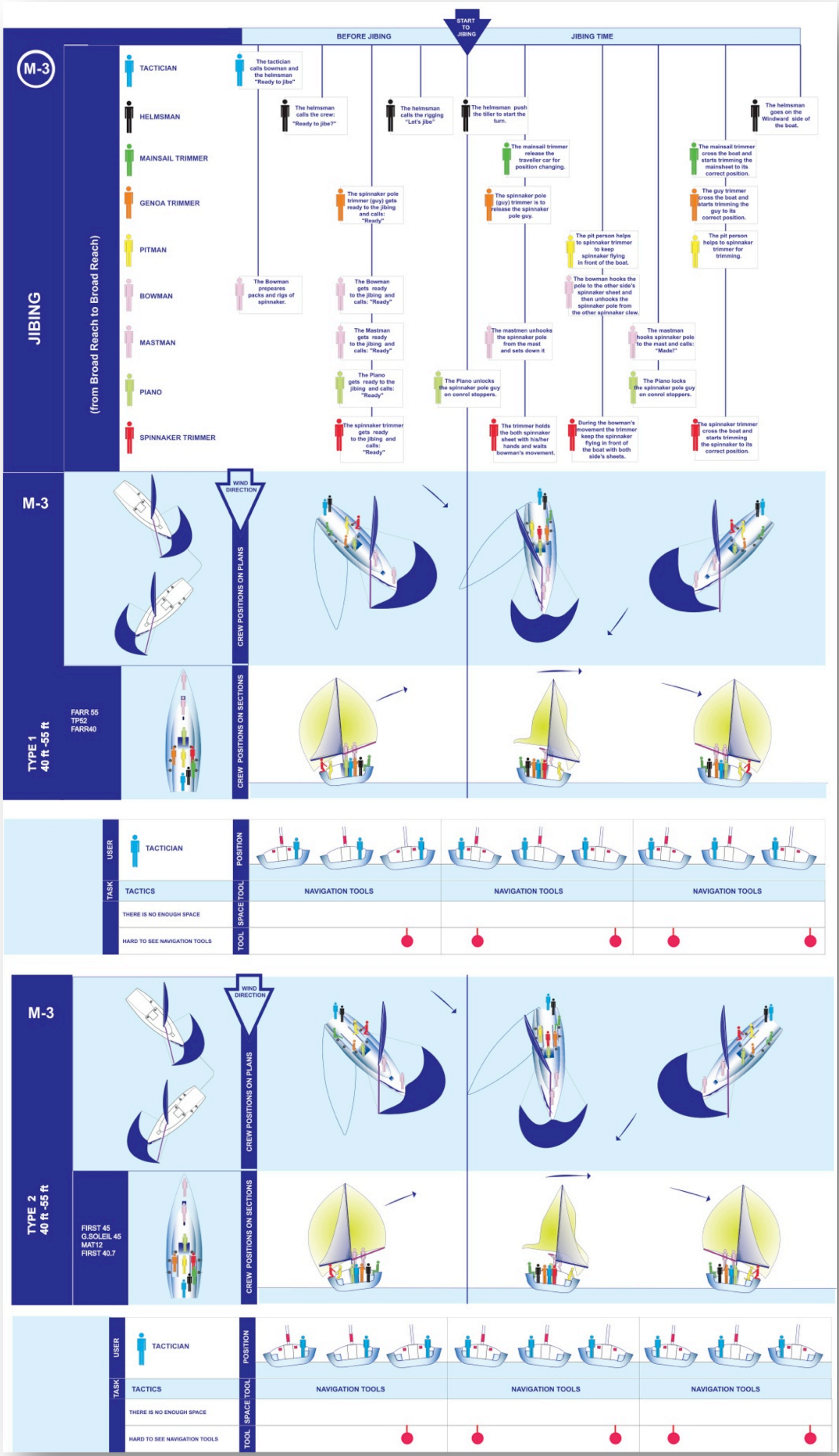


Figure 354: Work Analysis of Tactician for Type1/Type2 Cockpit Typology

4.3. Analysis of the Findings

The experimental data collected in the third phase basically allowed the validation of the previous theoretical literature regarding the task analysis. This section presents the experimental results of the study, analysis the data with supporting arguments from the theoretical setting and discusses the findings in order to reveal the problems that are elicited by users' task patterns.

4.3.1. Results

The results reported below are designed to address the issue of problems of the users that are using different tools during boat handling. In order to do so, the all problems of the users were listed and categorized according to the questions found in the survey. This chart helped to determine the problems that are beyond the scope of this study, and limit the study on the user.

Users mentioned their problems in particular, "usage of some tools" and "design of tools' locations", "deficient workspace and intersection between two or more users workspaces", "skid deck surfaces and missing foot-stops" for all maneuver. Direct observation confirmed the same critical points as the work analysis.

Four main points have been categorized for all tasks and users. These are;

- Functionality of Space
- Usage of Tools
- General Space Organization
- Safety on Board

MAIN PROBLEMS

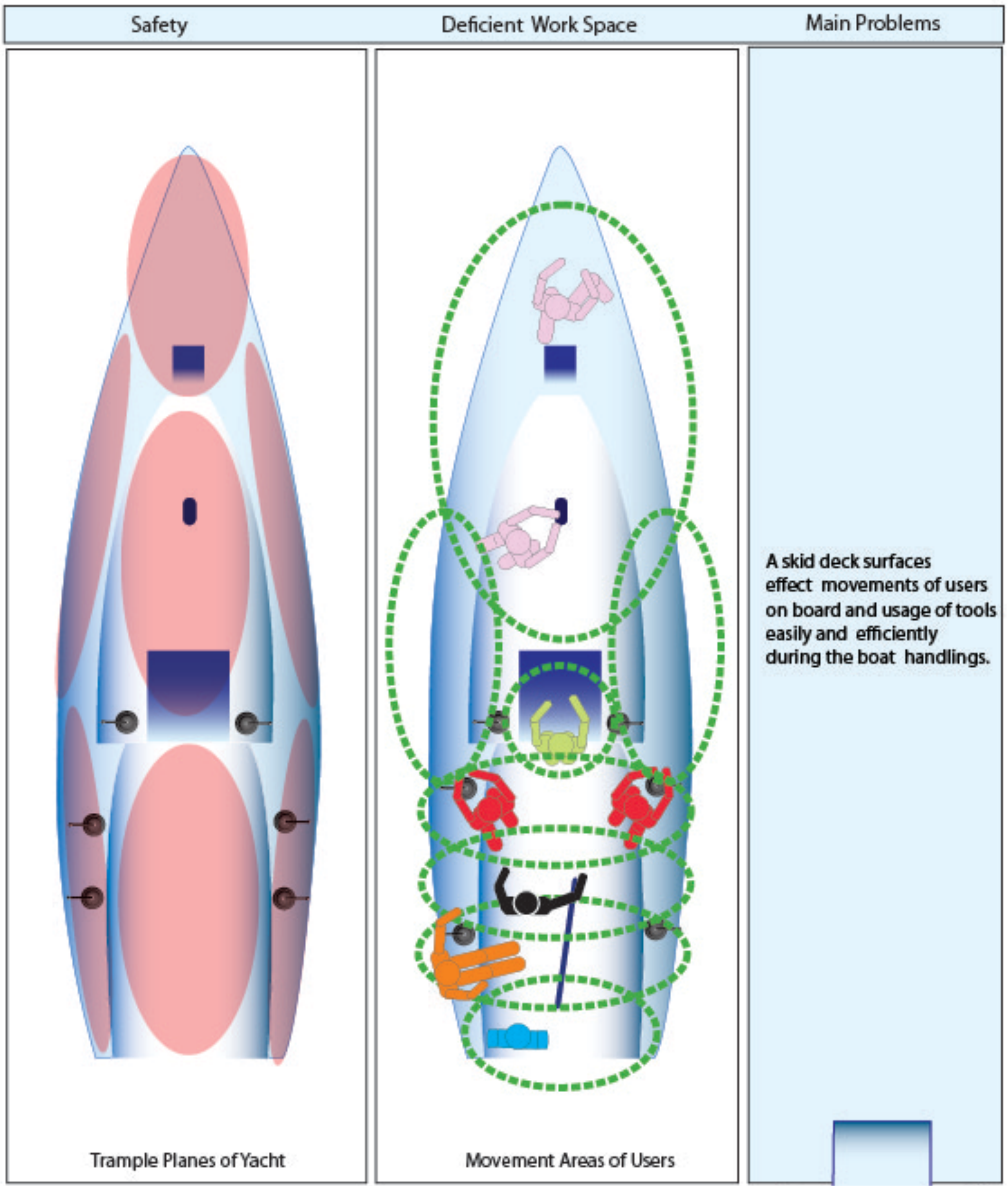
USERS	SPACE ORGANIZATION	DESIGN OF LOCATION	SAFETY	DESIGN OF TOOL
TACTICIAN		Location of Navigation Tools	Slippy Deck Surfaces	
HELMSMAN		Helms Location Missing Foot stops	Slippy Deck Surfaces	Tiller's Design
MAINSAIL TRIMMER	Winch Position (Deficient Work Space)	Winch Position Traveller Location Missing Foot stops	Slippy Deck Surfaces	
GENOA TRIMMER	Winch Position (Deficient Work Space)	Winch Position Missing Foot stops	Slippy Deck Surfaces	
PITMAN	Winch Position (Deficient Work Space)	Winch Position Missing Foot stops	Slippy Deck Surfaces	
BOWMAN			Missing Foot Stops Slippy Deck Surfaces	Usage of Spinnaker Pole
MASTMAN			Missing Foot Stops Slippy Deck Surfaces	Usage of Spinnaker Pole
PIANO	Deficient Work Space (intersection between users)	Winch Position Missing Foot Stops	Slippy Deck Surfaces	
SPINNAKER TRIMMER	Deficient Work Space (intersection between users)	Winch Position Missing Foot Stops	Slippy Deck Surfaces	

: *Table of Main Problems*

Regarding the all problems, further careful considerations could be developed to better clarify some problems observed in the field. Owing to the task and user's problem table was possible to define guidelines to favor and guide design choices on users, stations, and riggings, referring to the users role. According to those schemes, all problems have been clarified and general "Main Problems" table were done.

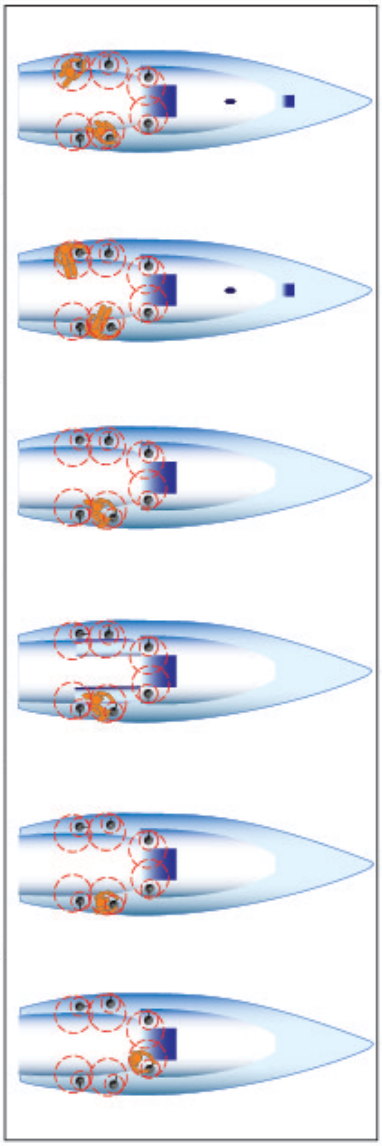
Problem \ User	Tactician	Helmsman	Mainsail Trimmer	Genoa Trimmer	Spinnaker Trimmer	Pitman	Mastman	Bowman	Number of Answer	Number of User	Percentage
User	**4**	**14**	**12**	**19**	**16**	**15**	**9**	**14**	**103**	**103**	**100%**
Skid Deck Surface	**1**	**5**	**6**	**12**	**9**	**8**	**8**	**13**	**62**	**103**	60%
Missing Foot-stops	**2**	**9**	**7**	**10**	**8**	**2**	**7**	**11**	**57**	**103**	55%
Deficient Workspace	**3**	**8**	**10**	**13**	**12**	**8**	-	-	**54**	**78**	69%
Location of Navigation Tools	**3**	**8**	**2**	**1**	-	-	-	-	**14**	**49**	29%
Winch Position	-	-	**7**	**11**	**9**	**8**	-	-	**35**	**62**	57%
Traveler Position	-	**1**	**3**	-	-	-	-	-	**4**	**26**	15%
Helm's Position	**1**	**4**	**4**	-	-	-	-	-	**9**	**30**	30%
Design of Tiller	-	**7**	**5**	-	-	-	-	-	**12**	**26**	46%
Design of Winch	-	-	**7**	**9**	**8**	**8**	-	-	**32**	**62**	**51%**
Design of Winch Handle	-		**7**	**11**	**6**	**12**			**36**	**62**	**57%**
Design of Spinnaker Pole	-	-	-	-	-	-	**2**	**4**	**6**	**23**	26%

This result table has shown some findings. While most of the user care about safety issues they mentioned antiskid deck surfaces and foot-stops that is located both side of the deck.



Also a very high percentage of users have problems about design of winches, winch handles and tillers. They mentioned that these tools can be more effective and easy their location design, in addition to that they mentioned that they need to foot-stop or supporting plane for staying stable and keeping their body direction during the angled movements..

Design Of Tools	Design Of Tools	Main Problems
		Designs and choices of winches and winch handles effect to use sails in an efficient way during the boat handlings.

Functionality and Design of Space	Winch Positions	Main Problems
		Hight of the placement effects to use it in a comfortable way during the boat handlings Distance between each winches zeffects to use it in an efficient way during the boat handlings The placement in the back of the seat doesn't allow to use it in a comfortable way during the boat handlings The placement that is near of the cabin door need effective space and hight to use it in a comfortable way during the boat handlings

Most of them complain deficient workspace, especially users of racer-cruisers. Intersection between users is another problems for narrow cockpit typology. As seen in below (*Figure*)

Consequently, it was possible to define some guidelines to favor and guide design choices on work areas and riggings, referring to the users role when using their tools.

CHAPTER 5

CONCLUSION

It's important to realize that best practices can be deliberate and are based upon principles that have been proven. This thesis study discusses most important of these principles before the practical study. Then, it aimed to understand the practices of users' on board by making a practical study on a specific domain in three main steps according to user-centered design method. In each step, unique and customized approaches that are specific to individual case had been used. Existing user centered design methods had been combined in a creative way to be able to find new interactions between methods that might take us to the new insights and methods.

In "data collecting phase", practices data were collected for each racing yacht domain by observing the sailing activities and users' task data were collected by using methods like capturing of sailing activity with photography and video record, informal interviews, field notes and ethnographic observation. Lots of practices data was collected as a guest user in different races with different teams and yachts. That's why observation library of this study already had good collection of notes and observations from the past.

In "data modeling phase", an alternative data model had been tried to construct and the "Hierarchical Task Analysis" had been used as a base for modeling the organized work system data. For that purpose, work analysis for each user with their tools had been developed. This data connective method is a sort of combination of different models. It is simply a framework that allows the designer to document, collect, communicate and understand the all design related information quickly and easily.

In analysis phase, only method I have used was the approach that I have developed in my thesis study. Work analysis maps became this study's pathfinder during analysis period. This map had been used as a roadmap for every single task and its problem. This study became a useful application, which is a combination of "Hierarchical Task Analysis" (HTA) and "Work Analysis" in the field of "User-Centered

Design”. Many task patterns had been developed related to the deck area in basic maneuvers (tacking, jibing etc.) in races.

Work pattern sections point out the requirements of design suggestions for user-friendly sailing yachts. Every single design requirement and remark is the result of the holistic view of all task patterns that considers design developments. This is the real potency of the model. It gives the designer very wide scope of understanding practices with interactions and interrelations with each other. Force of the model is the unique opportunity of defining relations from task pattern sections to other task pattern sections and from patterns to design ideas. This flexible occasion lets the designer, imagine the “on board scenarios” with design ideas with better understanding.

Since the framework is quite flexible, eventually it could be transformed into a design guideline that consists of task patterns and the map. The guideline like representation of the practice patterns would be much real and more communicative for the designers. Creating solutions with this type of guideline might be much convenient with this kind of visual representation. Additionally, model could work much better and find many opportunities in a design phase.

5.1. Findings and Suggestions

According to the results of research, there are 4 main critical problem category were determined.

- *Functionality of workspace for each task and user: Design of workspace*

- *Usage of tools: Design of tools*
- *General space organizations*
- *Safety on board.*

Some solutions were improved considering either users' experiences, demands and suggestions or technical requirements, design and ergonomic criteria. These are explained in the following sections.

5.1.1. Functionality of Workspace: Design of Workspace

Category of "Functionality of workspace for each task and user" has 3 main sub-category. These are related to placements of tools that have to provide to use tools in a comfortable and efficient way. They should place ergonomically on board and should be used more effective by users who should be able to reach them easily.

1. Positions of tools
2. Angle of visibility of user
3. Direction (Position) of user

Positions of Tools

For this study, 60% of trimmers (mainsail trimmers, headsail trimmers, spinnaker trimmers and pitman) have problem about their "positions of tools", in other words; "*positions of winches".*

They mentioned that;

- Distance between each winches effect to use them in an efficient way
- The placement in the back of the seat does not allow to use it in an easy and comfortable way
- Height of placement effects to use it in a comfortable way

- The placement that is near the cabin door needs more effective space and height to use winches in an easy way.

Solutions of the these problems could be the following way;

- An area of usage for each winch can be measured for different boat positions and optimal measurement can be determined in order to make cockpit more effective and usable.
- It may be preferable to place the winch inside the cockpit in order to make it more accessible, avoiding the user knocking against the jutting elements of the cockpit.
- It may be preferable to place the winches in front of the trimmers according to their true bending height, sitting and standing positions.
- It may be preferable to design pitman's work area higher or it may be preferable to design height of winches lower according to ergonomics criteria which have measurements of true bending positions for using them in an easy and effective way.

Angle of Visibility

Second problem of trimmers is about their "angle of visibility". Their tasks require to them to continuously and slightly adjust the sails efficiency. During the boat handling they looking up to the sails and at the same time down to the winch. So, the trimmers need more effective work area, which provide to see sails and use winch in same time. 45% of trimmers are complaining about it.

Solution of the these problem could be the following way;

- It may be preferable to design the trimmer's body leans on his/her back with true angle so that he/she can contemporary take a glance both to the sail and to the winch.

Body Direction (Position)

Third problem of users is about their "body direction (position)" during the boat handling. They need to align their bodies to the boat direction because of the efficient usage of sails. As mentioned before, users should look up to sails and they use their tools during the boat handling but in addition to that, they should check environs of their boat, other boats, wind and other environmental conditions at the same time. That's why they need to align their body direction to the boat and route direction. Their sitting or standing position should be perfect as far as possible. They should be able to use their body and keep their positions in a comfortable and an efficient way during their work period. 58% of trimmers are complaining about this problem.

Solution of the these problem could be the following way;

- It may be preferable to design a wide room in the abaft area of the winch for easily changing their direction.
- It may be preferable to design special foot-stops or supporting plane for each user. Their positions that are sitting, lying or simply standing, need different supporting element for keeping their true body direction.

5.1.2. Usage of Tools: Design of Tools

In analysis process, "***Usage of tools***" was determined as second important category of problems. During the collecting data period, users mentioned that their other important problem is about "***design of their tools***". All users have some problems about their tools, but only design problems were considered and classified. Especially;

- Trimmers (who are using winches/winch Handles),
- Helmsman (who are using tiller),

have important problems about their tools.

Designs of winches and winch handles

"Designs of winches and winch handles" directly effect to use sails in an efficient way. Effective usage of sails is enabled with effective usage of ropes on the winches. 48% of trimmers are complaining about their tools. Winches are working with human-power and especially in windy days, users need more power that they have. Keeping their power stable and using tools with maximum performance are only possible with the best ergonomic and user-friendly design. Different types of users are using these tools and they have different physical specialties and physical power. That's why design of winches should provide users to use same product for the same performance.

Solution of the these problem could be the following way;

- It may be preferable to design winches adjustable according to different physical powers. One of the usable solution is using gearshift or power transmission mechanism.
- It may be preferable to design of winch handles more comfortable, easy to use, ergonomic and adjustable.

Design of tiller

Second important point is "Design of tiller". In some yachts, especially in racer-cruisers, which have sitting unit in cockpit area, do not have enough space for using tiller efficiently. It blocks movements of other users because of its design. During the boat handling and the maneuvers, helmsman and main sail trimmer are jumping over it but its design does not allow to jumping over it easily. 65% of helmsmen who are using tiller are complaining about their tools. Not only racer-cruiser but also racer yachts have similar problem, so design of tiller should renew. Users who are helmsman, mainsail trimmer and tactician mentioned that the tiller should design considering their movements in cockpit.

Solution of the these problem could be the following way;

- It may be preferable to design the tiller lower according to height of jump It has to be suitable for jumping over it easily for other users who work at the backside of the tiller (mainsail trimmer and tactician).
- It may be preferable to design the tiller foldable and adjustable according to helmsman's position and general space planning. It should be suitable for general space organization for avoiding intersection.

5.1.3. General Space Organizations

Third category of users' problem is "***General space organization***" which is related to distances between each tools and intersections of work areas. 75% of users, who answer surveys, mentioned that intersections of work areas block their body movement and slow down their performances. If they use closer tools at the same time during the hard maneuvers, boat speed is getting slower. It is not preferable situation for races.

Solution of the these problem could be the following way;

- It may be preferable to determine minimum (measured) work area (Diameter of work area) for each user and minimum (measured) distances between tools in order to make cockpit more effective and usable. Diameter of user's work area and measurements of distances of tools can be overlapped and than space planning can be made according to these measurements.

5.1.4. Safety On Board

The fourth category of user problem is about "**Safety on board**". Most of users mentioned that "skid deck surface" as a main problem. It effects their movements on deck and usage of tools easily and efficiently during the boat handlings. Additionally, users feel insecure because of the fear of falling. Especially, bowman and mastman are in danger of falling into the sea because of the "wet and skid" curved surface. Big part of deck surface especially trample planes cover with antiskid materials but some slopped surfaces and joints cannot cover with it, because of the insufficient production techniques or cost.

Solution of the these problem could be the following way;

- Some parts of deck surface needs more protection with antiskid materials, supporting plane or foot stops which should design according to needs of users one by one. They will affect users dynamic activity (walking and working) positively and they feel in secure. Some surfaces, which cannot cover with antiskid surface materials or need more protection, should support with food-stops and supporting planes.

5.2. Conclusion

At the end of the research, main characteristics of sailing yacht design according to user-centered design approach have been shaped. This design guide has given the idea of how it makes difference to care about the user practice while designing sailing yachts. It is a flexible framework, which allows data set easily growing and evolving. Additionally during different phases of this research, there awakened several new questions related to the issues mentioned in this thesis. These questions can be considered as suggestions for prospective studies.

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APPENDIXES

Appendix 1.

Appendix 2.