

## A design approach to activate innovation in the marine industry

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### ABSTRACT

The global Marine Industry is projected to grow in accordance with the rising interest in water-based leisure activities by up to 11% and to reach a market value of US\$ 74.7 billion by 2022. A recent review of market research has indicated that boat manufacturers must be able to react quickly to changing consumer preferences and engage in continuous research and development. The traditional process of boat design prioritised an engineering approach, involves incremental development and a slow evolution. It is suggested that a design approach is the key to bring innovation into the marine industry and to maintain the competitiveness in the world market.

This paper aims to evaluate the capability of design methods to drive innovation in the marine industry. Four yacht projects developed at Politecnico di Milano and Izmir University of Economics programs have been chosen to represent best practices. Within the scope of this study, the projects are categorized into three groups: the change of typology, the evolution of construction technology and a new service system. The projects move from an initial research phase based on selected methods of data collection such as interviews, ethnographic observations and questionnaires. Then, the later stages of problem solving, development, prototyping and proposals are led through a multidisciplinary design approach which includes scenario creation, technology-push innovation and service-design. As a conclusion, it is argued that the design approach in product, process and service development delivers positive outcomes for the Marine Industry.

**Keywords:** design innovation, marine industry, boat design, boat construction techniques, service system design

### INTRODUCTION

Marine Industry is projected to reach US\$ 74.7 billion by 2022, which means a growth by up to 11%. It is known that the market widely benefits from the upward trends of marine tourism like water-based sports and leisure activities (1) (2) (3). Nevertheless, the global yachting industry is still recovering the negative effects of global economic crisis. In particular, the demand for small and medium crafts is shrinking and shifting. On the other hand, customers are generally looking for new on-water experiences with fewer days spent on-board (4). Besides, new ways of living on the water based on boat sharing and interactive service systems are expected to have a positive effect on the marine market. Public administrations of big cities like Paris, London and Boston are starting to explore new leisure activities on inland waters and sharing systems for marine transportation as new services for the inhabitants and tourists. The floating capsule hotel in Omura Bay, Japan, and the self-driving

Seine Taxi “Seabubble”, presented in Paris on October 2016 are some examples of this approach.

To maintain the leading position in a global growing system, boat manufactures must be prepared to react quickly to the change in consumer preferences and to involve into research and development processes. A recent review of market research indicates that design and innovation in manufacturing are the keys to be competitive and attractive in the world marine market (5). In this context, traditional process of boat design dealt with an engineering approach and a slow incremental development could be re-valued by a design approach. Briefly, design methods and tools could support the overall process of being innovative. The purpose of this paper is to investigate the possible yacht design strategies and to evaluate the capability of these to activate innovation processes in the marine industry. This is exemplified by the case studies of product, process and service design.

In the following chapters, theoretical framework of the study is outlined and the research method is explained first. Then, four projects chosen as best practices are introduced in a categorization of three groups: the change of typology, the evolution of construction technology and a new service system. Additionally, design strategy of the projects including the methods and tools is presented and discussed based on the findings. Finally, the capability of design to deliver positive outcomes for the Marine Industry is exhibited as a concluding remark.

## 2. Theoretical Framework

Yacht design is an applied sector of industrial design characterized by a particular complexity. Nowadays, in the contemporary design field, yacht designers need to coordinate highly diversified and interacting multidisciplinary areas of competence. Scientific fields of engineering, design, architecture, ergonomics and materials, with their respective specialized disciplinary articulations, are involved in a boat project. In addition to this, a marine product must have characteristics halfway between a passenger compartment and a living space that “moves even when it is still” (6). Because of this, every project has to manage the diversified system of limitations imposed by the user and by the overall efficiency of the system-boat.

A multidisciplinary design approach, together with the system of design methods and tools, offers to the sector a useful contribution to the management of yacht design processes. According to several research, most problems in the maritime industry projects and processes are wicked or ill-defined problems. There is no meaningfully correct or false solution in these challenges. In the nature of the design approach, “learning what the problem is” is the problem (7) and trying to solve the problems refers to the activities of problem understanding and problem definition. These activities, dealt with design tools and methods, aim to understand what the problems really are (8) (9).

In this framework, the nature of problem research is shifted from “how things are” to “how things ought to be”(10). According to that, the design approach to wicked or ill-defined problems comes up with radical and innovative solutions, unlike with the traditional problem formulation followed by a rational, logical, and systematic design process of optimization as in engineering. The strength of a designer approach is its reasoning, methods and tools especially developed for the purpose of exploring several and diverse sets of alternative solutions. A continuous process of generating new design visions for future user experiences may improve a company’s innovation strategy and hereby foster the development of new products or services.

### 2.1. User-Centered and Technology-Push Innovation Approach for Yacht Design

In recent decades, designers have increasingly moved closer to the potential users in order to better understand what they need. The UCD “User-centered design” (11) is a broad term to describe design processes in which end-users influence how a design takes shape. A careful users observation in creating breakthrough products opens up new scenarios that might lead

to commercial innovation ideas (12). The UCD approach with its theoretical and applied scope allows the human actions to be placed at the centre of yacht design which reflects on the main levels of the requirements of the nautical product (13). In particular, it affects the stability on board, the usability and the safety of both the boat-system and the equipment and the feeling of interacting with the product and environment. The UCD research in yachting fields could offer a strategic approach and necessary instruments to identify and verify innovative solutions on boat and equipment requirements.

On the other hand, the radical change in technology or the radical change in using existing technologies could provide new meaning assigned to the product and its uses (14). A technology-push innovation approach become central in the contemporary design field, strongly influenced by connected, computational and open sourced manufacturing. Digital manufacturing is already proving its potential to create value in the design phase (15) and it's expected to have a significant role in the yachting industry too. Technology-push innovation approach may generate a new wave of personalization and customization and brings innovation in how products are developed, made and delivered to retailers and consumers.

### **3. Research Methods**

The empirical part of this study consists of an extensive analysis of research-through-design (16) activities developed during undergraduate and graduate programs of Politecnico di Milano and Izmir University of Economics. Product, process and service design projects have been chosen as best practices and categorized into three groups: the change of typology (UCD approach), the evolution of construction technology (Technology-push approach) and a new service system (UCD + Technology-push approaches).

Each selected project moves from an initial research phase based on the methods of data collection such as interviews, ethnographic observations and questionnaires. Then, the later stages of problem solving, development, prototyping and proposals are led through a multidisciplinary design strategy. Findings are articulated in order to bring yacht design tools and methods out and to evaluate their capability to activate innovation processes in the marine industry.

#### **3.1. Best Practices: Design the Strategy, not only the Product**

The projects below selected as best practices were developed during the curricular workshop and thesis in interior design and design engineering programs at Politecnico di Milano and Izmir University of Economics. Students involved in the activities had no previous experience in yacht design fields and were stimulated to develop a proper yacht design strategy based on design tools and methods.

#### **3.2. Mahi Project as the Case of Typology Change**

Mahi is a project focus on a new solution to the problems of seiner type professional fishing boat by proposing a revised operation system in the fishing strategy. The project analyses in deep the current fishing practice and proposes an innovative system based on the user-centered design approach. The project propose to change the boat hull type and the main fishing equipment to answer to the problems encountered in the existing operation at sea.

##### **3.2.1. Definition of the Problem**

It is known that there is a variety of fishing boat types such as seiner, trawler, line vessel and artisan vessel among which the most common one is the seiner type in Turkey. Compared to the others, this is the most number of crew required type as well (17). For this reason, the seiner type of fishing boat is selected as the case. Needed data for the analysis was collected mainly by the observation of fishing operation and interviews with boat owners and crew. According to the interviews, it was clearly understood that the priority of owner is to have bigger storage areas, so, more fish at once and increasing the profit to be able to compete in the

market. This demand results new fishing boat hulls to be designed very large with more storage capacity but bulky with low performance. Hull shape needs more powerful engines and this causes more oil consumption, more air pollution and more noise and vibration effecting the sea life negatively. It also causes the crew areas to be designed inefficiently, so, the crew's performance gets low and problems emerge related to work safety and economic efficiency.

On the other hand, observation helped to clarify the problems encountered in fishing operation. Firstly, it should be mentioned that fish is surrounded by a seine or net and it is lifted up on the deck by a crane in seiner type fishing boats. Thus, the operation starts with letting the seine into the sea. While the seine is left to the sea with the assistance of a tender, main vessel keeps its location, so the tender can pull the seine and dispose it to the sea. Then it goes on with collecting the seine back to the main vessel. After taking the fish into the seine, main vessel begins to pull the other end of rope in order to create an enclosed space. Next step is narrowing the seine space and taking the fish onto the deck. So, the whole seine is lifted up to the deck by a crane or the fish is taken from the seine space if there is a pump. This is the hardest step of fishing. The tender pulls the main vessel to the opposite direction of the seine to prevent it from being unbalanced and dragged onto the seine or capsized at worst (Fig. 1). Once the seining operation is completed, the fish equal or bigger than the permitted size is stored. This process needs a teamwork of many people to store the fish in a variable sizes of wooden boxes in a cold room on the lower deck (18).

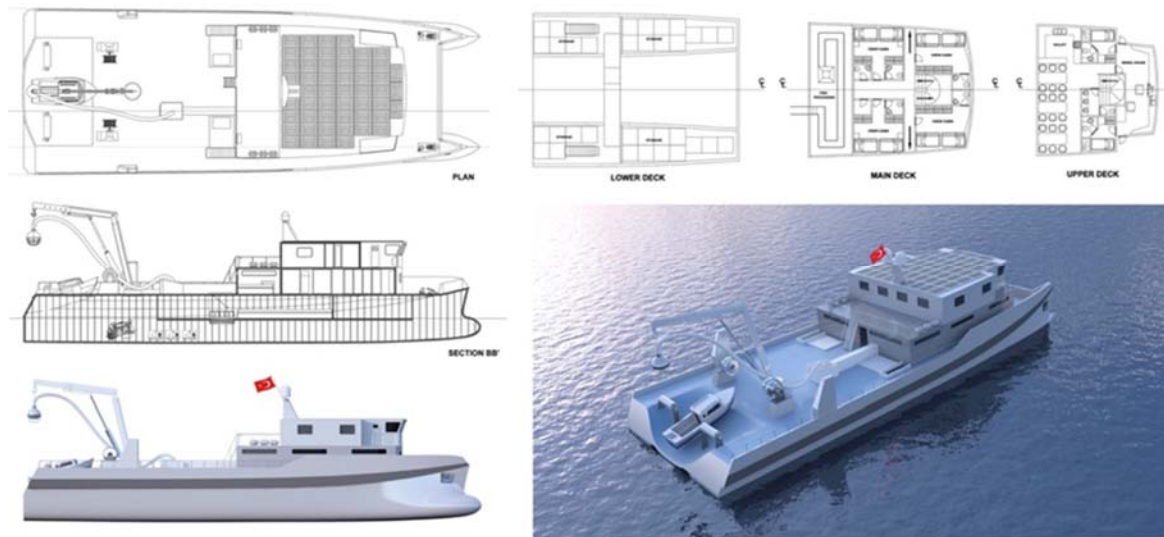


**Fig. 1: Phases of Seiner Fishing Operation: Letting, Collecting and Taking the Fish onto the Deck. Source: Denizden Tabaga, June 2014.**

Briefly, problems listed above can be categorized into three groups, so can be evaluated in a new design. The first is related to the boat owner's needs that are bigger storage areas, and less running costs. The second is related to the crew's: sufficient spaces for work efficiency and safety in operation means the stability of boat. Finally the third is related to the environment which are reducing the impact and using renewable energy.

### 3.2.2. Project Proposal

A functional seiner type fishing boat design with using existing construction techniques and materials was the goal to have an applicable solution. However, the way to follow in design in this case was to change the typology of boat to remove the problems. Otherwise, no problem could have been eliminated by temporary solutions. Therefore, mono hull type is removed and catamaran type, which offers an efficiency in propulsion, a larger deck and operation area, was chosen. Catamaran type has more advantageous than mono hulls in terms of stability which means safer in navigation and operation especially in wavy sea conditions. Tender, substitute seines and other equipment can be located easier on a larger deck area, so the operation area may become more functional and crew friendly (Fig. 2).



**Fig. 2: Deck Plans, Section, Elevation and Perspective View of Mahi Project.**  
**Source: Term Project Report, 2014.**

An automation system is developed for the operation area to minimize the human based risk factors and decrease the running cost. The system has a fish pump towards the stern and a fish transportation unit. Within this new system, letting, disposing and narrowing the seine, all are executed at the stern, which is large enough in the catamaran type, not at the board sides. The fish is taken to up not by the winch but by the pump to prevent from instability. Transportation unit is a moving way which has a filter leaves the less sized fish back to the sea and it extends down to the lower deck where the fish is stored by the track bands into the boxes in cold rooms. In short the system is constituted with four zones, collection, elimination, processing and storage zones. Since the large deck allows to design more comfortable crew areas, superstructure of the boat is completely reserved for the cabins, dining hall, rest hall and wheel house. To support the electricity supply by renewable energy systems, the top of the superstructure is covered by solar panels (19).

### **3.3. Strips project: parametric system for the design and construction of customized and self-made recreational crafts**

The project is part of the cultural debate on the democratization of production techniques, setting the goal to investigate how these methods can be declined towards the boats, starting from design, through the production till to the decommissioning phase. Taking the opportunity offered by the power of parametric modeling, the idea is to allow a user to "manipulate", within fixed limits, the project by making changes without necessarily having all the skills required for designing and producing a boat.

To reach this goal in the production phase it is unthinkable to refer to the large numbers of the industrial technologies, but rather to allow the user/designer to have a direct contact with the production. A possibility is therefore the self-production, which allows to delegate to the end-user, through a guided process, also the realization phase.

To meet these requirements, the starting point is offered by modern self-production techniques, with particular reference to the stitch & glue construction with marine plywood which allows to start from the cutting of flat panels, simplifying the construction of small boats, while preserving the main features typical in the wood constructions and avoiding several difficulties connected with the traditional construction techniques as for example the strip-planking.





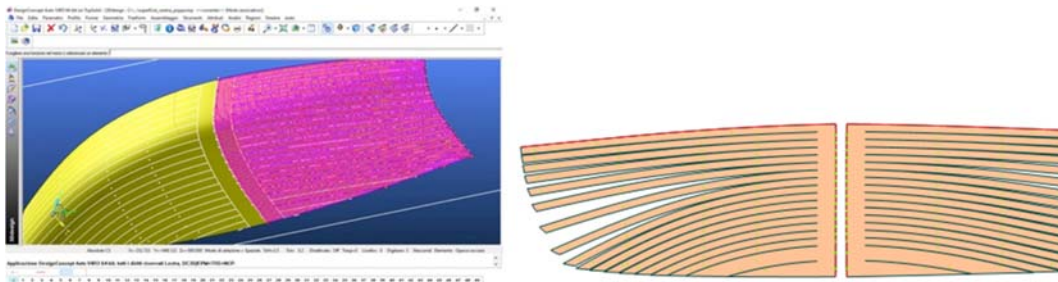
**Fig. 1: Render of the first prototyping boat and preliminary tests for the processing of plywood flat panels**

With the help of digital fabrication technologies, in the specific machinery for the execution of CNC cuts, it's possible to begin directly with the digital files to derive cutting geometries although it is very complex. Shaping the plywood panels is possible to obtain the all sides of boat form composed of individual panels, which are very close to the form of boats in planking, overcoming the limits of the construction with panels which are mainly the presence of edges.



**Fig. 2: Model study carried out starting from cardboard sheets**

To obtain this, it is necessary to start from the three-dimensional geometry of the hull and proceed with the flattening of it by exploiting specific software, with the possibility to obtain the result through a parametric and automatic operation.



**Fig. 3: Change in surface geometries and development plan with Software 3D Design Concept**

Furthermore, to make accessible and sustainable life-long stages of the product, it is necessary to facilitate maintenance, transportation, storage and lastly its sale. It is suitable to underline that a correct disposal should be planned in advance for any product especially with

the reference to nautical products in which the irreversibility of FRP content has accentuated the problem of the end of life. The requirement to refer to a reversibility of the process directs toward the principles of disassembly of the components and then drying assembly systems. It is therefore expected that all the junctions of the internal components are made with mechanical joints and with dry procedures.

With such expedients the entire product is assembled in a totally reversible way. The components are repairable and/or replaceable, easily transportable and, consequently, properly decommissioning.

### **3.4. New City Water Services: Nap-Nap and Pic-Mi for Milano Darsena**

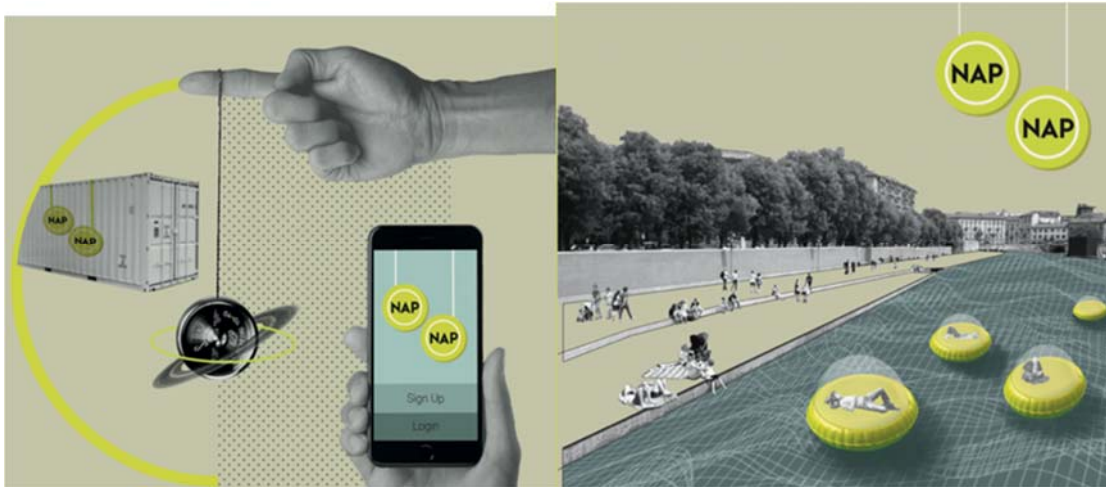
The inland water system, Navigli and Darsena, is an important sign in the territory of Milan. Until 1950 it played a strategic role in for irrigation, trade, transport of goods and passengers and it become today a centre of attraction with its shopping and entertainment opportunities for inhabitants and tourists.

Nap-Nap and Pic-Mi are two new services to “live the city water experience” both located in Darsena, Porta Genova region of Milan, the antique harbour where the two canals, Naviglio Grande and Naviglio Pavese meet. The selected projects present a multidisciplinary approach to the design problem definition and combine digital and physical systems to create a innovative service for public benefit.

#### **3.4.1. Nap-Nap Project**

The lack of sleeping has a negative effect on daily facilities of human. And probably everybody experiences napping about 20 minutes a day which increases body energy and concentration, reduces anxiety and stress, so healthy. It is not only for the kids but today many companies allow the employees to have napping also for more productivity. Apart from this idea, Nap-Nap project is created to offer a new service to the public to have a break in the busy life of Milan. This new service system covers both, individuals for napping in isolated spaces named as capsules and groups of people for gathering on inclined decks by the purpose of making them feel better and get relaxed.

Nap-nap is a modular system with floating polypropylene cubes and composed of two elements can be mounted on site. First one is the dock as a walkway and the second is napping parts of which capsules are moored and decks are attached to the first. As the land services, there is a container for maintenance including a cupboard for cleaning equipment, a room for the responsible person and toilets for Nap-nap users. Container walls are used as info boards. The whole system can easily be transported, since the length of modules is less than 2.50 meters. Therefore, it has a possibility of exportation to other cities with canals or rivers as well as handling to other places of the city (Fig. 3).



**Fig. 3: Layout, Plan and Section of a Module, Service System and Model Photos of Nap-nap Project**

Source: Graduation Project Submission, 2017.

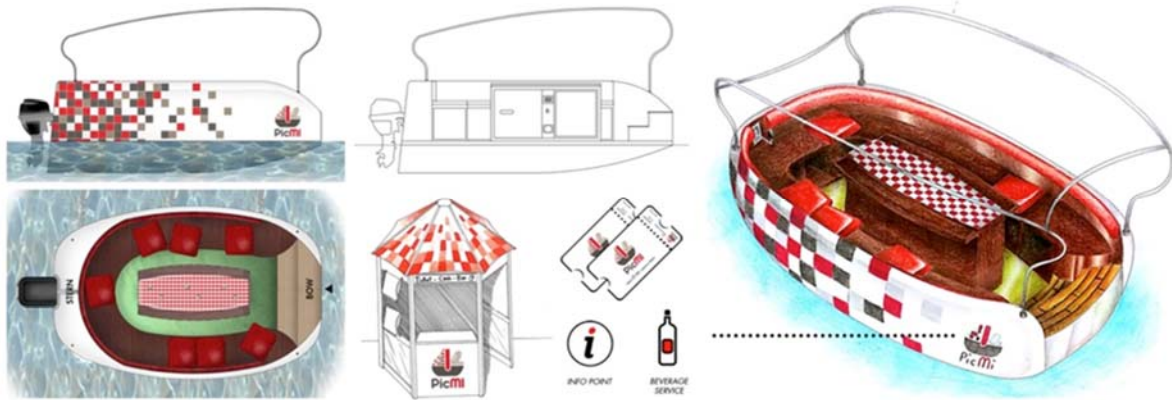
Nap-nap works with an application on cell phones. After subscribing to the system, users can see the closest service point, choose one of the available capsules and set the desired ambiance in the space. Shoes are left into the box on the dock, then user gets on the capsule and finally it is released to the water. Capsules are spherical shells of fiberglass and foam material, with fibre optic textile upholstered inside, that illuminates the space. Colour of the light, scenting and listening music are all to create an ideal atmosphere. Capsules are controlled by an electrical winch, released to a certain distance, slightly oscillated like a cradle on the water, then at the end of experience time, they are taken back to the dock.

### 3.4.2. Pic-Mi Project

As a popular recreational activity, people would like to go to picnic mainly at the outside of city and in the weekends. However, in-city parks also become full of families and friend groups, but after work in the week days. People do enjoy spending time for a couple of hours, they chat, eat and drink on a seating bench or on the grass. Pic-Me shifts this activity up to a higher level by proposing a picnic boat with a new service system for the tourists and inhabitants of the city. It offers an opportunity to sense the soft atmosphere of Darsena and experience the light glares of water surface during a short time lunch break means a day-time picnic in the week. Moreover, since some people bring their lunch in a box from home to the office, if not, they can buy some food in a market, then get on Pic-Me and share the food with other people whom they meet as the first time. This system, combining on-water picnic activity with food sharing idea, is a way of creating humane relations as well.

The picnic boat for six people is designed to function all year long from 09.00 am. to 06.00 pm., so the system includes earlier and later lunch options. Applying the same pattern and similar colours of a usual table cloth refers to the domestic taste of picnic activity which is unified with music broadcasting and comfortable seating benches. Red coloured pillows, green painted floor and walnut veneered furniture are the elements of creating a calm and relaxing environment. Besides, a cupboard for the backpacks of users, a mini fridge and a container to store the glasses are included in design. Plugs, USB ports and free Wi-Fi connection are considered to share this lunch experience with others. Low speed boats are navigated by users with their easy driving system and powered by electricity engines, so, a recharge unit on the land is provided. A kiosk, which works as an info point, ticketing and beverage service, is the place land services can be taken. Nearby the kiosk, there is a luminous totem showing the position of each boat with a number on its top (Fig. 4).





**Fig. 4: Plan, Section, Elevation, Perspective View and the System of Pic-Mi Project**

Source: Workshop Project Submission, 2017.

#### 4. FINDINGS AND CONCLUSION REMARKS

The presented best practices highlight a multidisciplinary design strategy based on user-centered design and technology push innovation approaches. These, combined with the system of design methods and tools, offer a useful contribution to the yacht design process, especially in the concept and scenario building phases. The case studies try to solve wicked or ill-defined problems in which the main issues are “understanding the problem” and “problem definition”. As defined in the theoretical framework, the research-through-design projects presented above shift the nature of research in “how things ought to be” resulting in radicals approaches and innovative projects which is not existed in traditional solutions.

With the well-structured research and analysis and with the originality of ideas proposed, all the projects introduced have a potential and capability to activate the innovation in yacht industry. Mahi presents a pioneering project based on the user-centered approach changing the existing fishing strategy. While the typology of hull and the main equipment proposed are not new for the yachting sector they are used with a complete different meaning. Strips project develops an innovative construction technique strongly influenced by connected, computational and open sourced manufacturing. Through a technology push innovation approach, this research project brings innovation in how boats are designed and developed in a low-volume production system. Finally, Nap-Nap and Pic-Mi explore the new possibility of services to experience the city-waters with both user-centered and technology-push approach. The results are digital and physical spaces for the public environment designed to be connected and interactive.

The strength of the presented approaches is their strategy developed to explore alternative solutions based on the users experience. This process of generating new design visions may improve a company’s innovation and hereby foster the development of new products or services for the marine sector. While the projects presented as best practices are not in production yet, the design concepts and prototypes have been shown to yachting firms and raised the interest of the stakeholders. Mahi project was presented in Izmir Boat Show and had an interest of investment to produce this type of new fishing boat by the shipyards. Strips project created a long-term collaboration between the Politecnico di Milano University and industrial partners and makers, and Nap-Nap and Pic-Mi projects will be presented to the municipality of Milan as a prototyping service during the next Milano Design Week.

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