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MILDS - Maintenance, Infotainment, Learning Digital Services

Executive summary

Sanlorenzo Yacht S.p.A., a luxury yacht manufacturer known for its craftsmanship, is embracing digital innovation by developing a superyacht Digital Twin (DT) to meet evolving customer demands and maintain a competitive edge in the yachting industry. In this context, the MILDS project aims to integrate Digital Twin technology throughout the entire superyacht lifecycle, from design and production to post-delivery, with a focus on reducing environmental impact and extending the yacht lifecycle.

The MILDS project encompasses two primary solutions. The first solution involves integrating data-driven maintenance and energy efficiency services into the DT. Data-driven maintenance utilizes historical data and supplier information to optimize maintenance policies, reducing unscheduled repairs by 8% and enabling continuous monitoring of onboard systems. Energy efficiency enhancements involve optimizing fuel consumption through smart routing based on real-time weather and sea conditions and implementing domotics solutions for intelligent management of hôtellerie systems (such as lighting and HVAC systems). Both solutions offer significant benefits to both Sanlorenzo and yacht owners, reducing operational costs. The project's cost-benefit analysis demonstrates the potential profitability of the investment in those functionalities, with a positive Net Present Value (NPV) from Sanlorenzo's perspective.

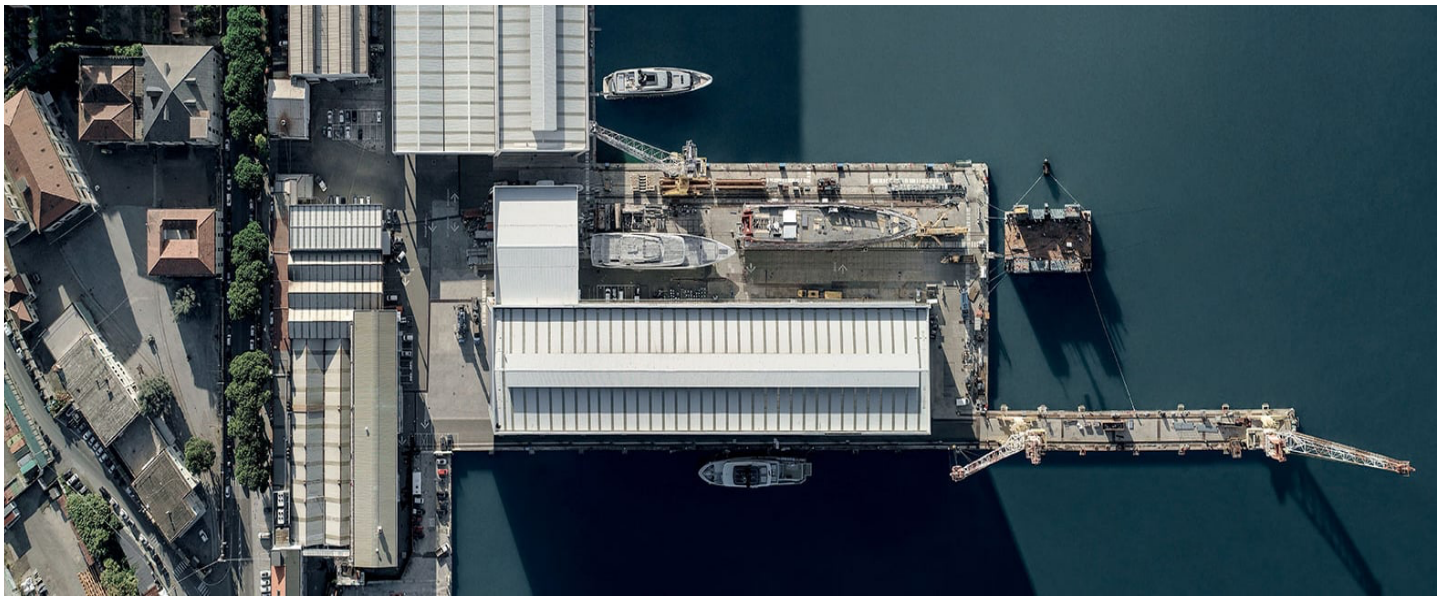
The second solution addresses the need to enhance the current technological infrastructure, transitioning from a Digital Model (DM) to a full-fledged Digital Twin. This entails developing user interfaces and modules illustrated through Unified Modeling Languages (UML) diagrams. The goal is to create a dynamic, real-time, and automated DT capable of offering a wide range of innovative functionalities to satisfy numerous of stakeholders throughout the yacht's lifecycle. Even if the implementation of these solutions presents some challenges and may require overcoming resistance to innovation, the potential benefits for both Sanlorenzo and its customers are significant. The developments are not only expected to enhance the company's competitiveness but also offer yacht owners improved efficiency, reduced costs, and a more environmentally friendly yachting experience.

In summary, Sanlorenzo's MILDS project represents a significant step forward in leveraging Digital Twin technology to revolutionize the superyacht industry. By integrating data-driven maintenance, energy efficiency services, and a comprehensive DT infrastructure, the company aims to meet the demands of the emerging user requirements, while delivering exceptional value to its customers.

Key Words

Digital Twin, Energy efficiency, Optimized maintenance, Modules.

Example of Sanlorenzo's yacht



Sanlorenzo's shipyard in La Spezia

Project description written by the Principal AcademicTutor

With emerging technologies and cutting-edge materials, the yachting industry is rapidly evolving. This market, as well as the broader luxury landscape, is nowadays under transformation by the shifting wealth demographic. While shipyards and companies are answering to an extremely growing of new yacht requests, designers are moving the borders of the traditional yacht design to meet the needs of future owners. On the other hand, the growing number of construction and launch models demand a more efficient yacht manufacturing and its supply chain along the whole lifecycle. The project MILDS was born from a strategic plan of the world-leading shipbuilding company Sanlorenzo, aiming at merging the company's traditional craftsmanship and design soul with digital solutions to enable industrial competitiveness and sustainability. The project MILDS, here developed in collaboration with Alta Scuola Politecnica, stands for "Maintenance, Infotainment, Learning Digital Services" and aims at analyzing and developing the concept of superyacht Digital Twin in all the lifecycle phases of the product. MILDS ambition is notably high, considering the ecosystem of people, processes, and services associated with superyacht design, construction, and operations. In a superyacht Digital Twin panorama, this ecosystem must be fully integrated in a cloud platform able not only to encompass all the data coming and feeding the different life-cycle steps – from ideation and production to post-delivery and maintenance services – but also to show insights in a meaningful way to different stakeholders.

The Digital Twin, functioning as a virtual representation of a physical system, has already found applications in various industries, including the maritime sector, particularly manufacturing and operations. However, within the yacht industry, Sanlorenzo stands out as a pioneer in adopting DT technology in all the superyacht life cycle. The company has devised a four-year roadmap for implementing this solution, defining clear objectives, incorporating Cadmatic eShare for 3D design, and utilizing information management software. At this stage, the platform envisaged in the roadmap will be considered a Digital Model of the product to comprehend what aspects deserve additional enhancements. In particular, the existing modules function predominantly in silos, not leveraging the full potential of integrated, dynamic updates. This results in a system that, while rich in stored data, lacks the dynamism of real-time adaptability and evolution. Thanks to the opportunity of research developed together with the group of students and professors of Politecnico di Milano and Politecnico di Torino, the superyacht Digital Twin made a further step ahead to embody the essence of phygital assets continuously synchronizing and simulating its behavior at the core of MILDS project. The research result is twofold: a proposal of a Maintenance and Energy efficiency pack to be added to the current superyacht Digital Twin and a Dynamic Digital Twin proposal with UML diagram and development roadmap.

Team description by skill

The MILDS team is composed of six members: two management engineers, one industrial production engineer, two computer science engineers, and one aeronautical engineer. The team's diverse composition, featuring four distinct engineering backgrounds, enriches our collective technical knowledge.

Indeed, the multidisciplinary approach of the project not only challenges everyone's expertise but also fosters collaborative growth at the team level.
Marco was the Team controller and managed both the budget and the communication with the tutors. His aeronautical knowledge was crucial to helping the team understand all the power systems onboard the superyacht.
Sofia and **Luca**, as management engineering students, embraced the roles of project managers in the planning and execution of project development, starting from the analysis of DT literature and Sanlorenzo's strategic choices and roadmap. Within the solution, they took care of the Energy Efficiency Solution and the Cost and Benefit analysis.
Iulian, as an industrial production engineer, took care of understanding the current implementation of the DT within the superyacht's production process and developed the Maintenance solution.
Simone and **Antonio**, as computer science engineers, developed the second solution presented by the MILDS team, proposing further development to the technology currently developed by Sanlorenzo.

Goal

MILDS team joined Sanlorenzo's ambitious project of developing a superyacht Digital Twin, with the objective of exploring and recommending specific new functionalities to completely rethink the superyacht product along the whole lifecycle. The company was already working on production process-related functionalities, relying on Cadmatic eShare software to support the construction, but any application for the post-delivery remained unexplored. The MILDS team was therefore asked to propose new applications of the DT technology from which the company could benefit from.

In addition to this initial objective, which was required by Sanlorenzo, the MILDS team parallelly understood the need to improve the actual technology the company was relying on, to achieve a dynamic, interconnected, and real-time DT technology. Consequently, it became necessary to propose enhancements that would transform the existing Digital Model technology into a full-fledged Digital Twin technology, capable of actively supporting all stages of a superyacht's lifecycle.

The project could be summarized with two main macro-goals:

1. The proposal of two new functionalities, which is aligned with Sanlorenzo's needs and expectations on the project: data-driven maintenance and energy efficiency solutions. The proposal is complemented by a cost-benefit analysis to provide support for the company to decide whether to validate the investment decision.
2. A second goal, independently proposed by the team: given the technical limitations of the current Digital Model, the group aims to provide the company a first reference to orient the DM development toward a Digital Twin infrastructure.

CADMATIC eShare software

Understanding theproblem

Initially, the project focused on understanding the needs of the firm and its stakeholders regarding the Digital Twin project and assessing the state of DT technology in the maritime industry. The naval industry was found to be relatively new to the concept of DT and understanding the problem faced by Sanlorenzo revolved around understanding its business model, the relationship with the stakeholders and their relative needs, as well as having a holistic overview of the superyachts' production process and onboard technology and systems. In this phase, the interaction of the teams with Sanlorenzo was crucial, as well as the visits to the shipyard and the construction sites.
At the same time, it was necessary to understand what type of DT technology the company was developing, the relative expectations, and which was its roadmap and time objectives in terms of Digital Twin implementation on the superyachts. This process was quite long and iterative since the complete understanding of the software and hardware that were already implemented and in the process of implementation required several meetings with technicians and experts. Similarly, meetings with Sanlorenzo's engineers were crucial to comprehending the functioning of both the onboard energy and hôtellerie systems, and the existing criticalities of the maintenance process.

Additionally, the comparison between Sanlorenzo's objective with the literature review about the DT maritime application and meetings with professionals in the DT field, allowed the team to understand that there was a need to renew and enhance their Digital Twin practices. The company has so far implemented what is referred to in literature as the Digital Model, which serves as a preliminary step to a full-fledged Digital Twin. The transition from a Digital Model to a Digital Twin appears to be therefore essential for Sanlorenzo to provide a complete and dynamic representation of their superyachts. The overall process of understanding the problem was undoubtedly complex since the objectives and expectations of the MILDS project were initially broad and difficult to focus. This occurred because of the company's stringent privacy policy, the novelty of the Digital Twin, application in the naval and yacht industry, and the time-consuming process of aligning the MILDS team's vision and the company's viewpoint regarding DT capabilities.

Exploring the opportunities

Embarking on a project focused on Digital Twin technology requires a comprehensive exploration of its various implications thus the exploration phase can be divided into two parts. The first half of the project was dedicated to the understating of Sanlorenzo's business model and culture, its construction process, and the different onboard systems. Given the unicity of the industry and the absence of a direct expert in this field among the team of students, a lot of effort and time was dedicated to grasping superyachts' systems technicalities and defining the user requirements along with the state of the art.
Exploring opportunities throughout the project's duration relied on four key pillars:

1. *On-Site Visits:* Team visits to Sanlorenzo's shipyards provided firsthand insight into the potential of Digital Twin technology. This experience reinforced the significance of their recommendations for enhancing Sanlorenzo's performance.

The MILDS team visiting Sanlorenzo shipyard

2. *Support Meetings:* Regular meetings with external experts and academic tutors offered guidance and strategic inputs. These professionals played a pivotal role in refining the team's strategy, validating concepts, and adapting recommendations for Sanlorenzo.
3. *Literature Review:* A comprehensive review of scientific papers and research articles related to Digital Twin technologies, both within and outside the maritime industry, formed the team's strong theoretical foundation. This review encompassed diverse topics, from energy consumption to real-time analytics and maintenance policies.
4. *Engagement with Specialized Companies:* Collaborative sessions with other companies implementing Digital Twin solutions in similar industries facilitated the exchange of innovative ideas, best practices, and emerging technologies in the Digital Twin realm.

Generating a solution

The team evaluated Sanlorenzo's existing platforms and tools, recognizing that the company was at the Digital Model stage and needed advancement for a fully operational Digital Twin. Additionally, the scope of DT functionalities needed expansion to cover more phases of the superyacht's lifecycle. With this understanding, the project explored two tracks: improving energy efficiency through smart routing and domotics applications, as well as transitioning from time-based to condition-based maintenance, which offered significant cost savings. The cost-benefit analysis supported these approaches, aligning with Sanlorenzo's goals of extending product lifecycles and reducing environmental impact.

IT students provided strategic guidelines for structuring the Digital Twin as a modular, scalable, and integrated software solution. This involved interpreting user requirements through UML use case diagrams and using UML activity diagrams to illustrate dynamic system behavior, crucial for the Digital Twin's success. In conclusion, the collaboration between ASP and Sanlorenzo has paved the way for innovative analysis in the naval industry, which is relatively new to Digital Twin technology. In a broad perspective, all the involved stakeholders will be positively affected by the result of the MILDS project, especially Sanlorenzo which, thanks to this collaboration, can benefit from first-mover advantages, gaining a substantial competitive edge in its market.

Representation of the solution

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