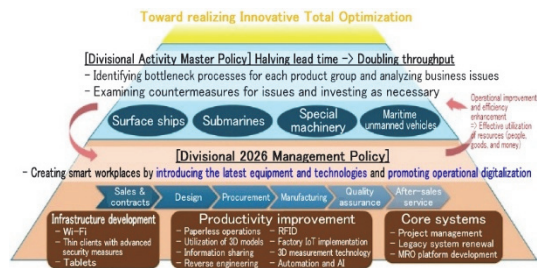


Driving Digital Transformation in Naval Ship & Maritime Systems Division



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The Naval Ship & Maritime Systems Division of Mitsubishi Heavy Industries, Ltd. is promoting end-to-end digitalization from design to manufacturing to adapt to changes in the business environment. To boost overall productivity and achieve labor savings, the division is advancing paperless operations by leveraging digitized forms and tablets, while also promoting cross-site know-how sharing. In the future, advanced technologies such as AI will be incorporated to further advance the digitalization of the engineering chain and supply chain.

1. Introduction

To address the need for "contribution to new national security," the business environment surrounding Mitsubishi Heavy Industries, Ltd. Naval Ship & Maritime Systems Division is undergoing significant changes. Consequently, the introduction of advanced equipment and technologies, alongside the digitalization of operations, is essential to reduce development, design, and manufacturing lead times, and achieve labor savings and manpower reduction. The Naval Ship & Maritime Systems Division produces a diverse range of equipment, including surface ships, submarines, special machinery, and maritime unmanned vehicles, across multiple sites at Nagasaki Shipyard & Machinery Works, Kobe Shipyard & Machinery Works, Yokohama Dockyard & Machinery Works, and Mitsubishi Heavy Industries Maritime Systems Co., Ltd. (Tamano). While promoting digitalization to improve production efficiency at each site, horizontal sharing is conducted between these sites to generate synergy effects across the entire division.

2. Utilization of digital technology

2.1 Challenges at construction sites

At naval ship construction sites, increased production, shorter manufacturing lead times, and the development of new equipment are required, leading to an increase in workload and diversification of operations in design and manufacturing. Meanwhile, amid the decline in the working population due to the recent declining birthrate, it is difficult to secure designers and site workers. To respond to these demands with the current personnel, improvement of work methods and efficiency enhancement are urgent matters. Furthermore, with experienced personnel retiring, improvements in work methods and efficiency enhancement that do not rely on individual worker skills are required.

2.2 Improvement of work methods and efficiency enhancement utilizing digital technology

Design for submarines and surface ships has conventionally been conducted using 3D CAD. However, design information was previously transmitted to manufacturing sites by converting 3D model data created in CAD into 2D drawings on paper media. Consequently, a massive amount of time was required to create 2D drawings, and site workers at manufacturing sites needed the ability to read and interpret 2D drawings.

By utilizing digital technology to directly use 3D data created in design at manufacturing sites, this initiative is designed to reduce 2D drawing creation work and improve work methods at manufacturing sites are being made.

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The utilization status of digital technology at manufacturing sites is shown below.

1) Efficiency enhancement of site work in submarine construction

1-1) Provision of 3D models to outsourced manufacturers

The creation of production drawings for outsourced manufacturers has been eliminated; instead, only 3D models are provided to request the manufacturing of auxiliary machinery foundations.

In the past, when outsourcing auxiliary machinery foundations, production drawings in 2D were created from 3D models and all necessary notes were added to the drawings. However, the created drawings were complex, resulting in many minor errors at outsourced manufacturers. Manufacturing errors often could not be identified until trial fitting was performed after the items were received, causing waiting times due to returns to and rework at the manufacturers. Therefore, the operational workflow was changed to provide 3D models with embedded notes to outsourced manufacturers. If necessary, these manufacturers create easy-to-work-with 2D drawings on their own to manufacture the auxiliary machinery foundations. This eliminated the creation of approximately 500 drawings that require experienced drafting workers. Furthermore, because orders are placed using 3D models, outsourced manufacturers can perform inspection work using AR devices. As a result, correctly manufactured items are delivered, eliminating the need for verification through trial fitting and enabling installation without waiting time.

1-2) Efficiency enhancement of marking work

Conventionally, site workers identified component installation positions based on 2D drawings, manually measured component dimensions and installation locations, and performed marking work. By projecting 3D model data with AR devices, site workers can now directly mark out components without measuring component dimensions and installation positions. This has achieved a significant reduction in time for marking work, simplification of operations, and a reduction in careless mistakes by eliminating the need for drawing interpretation (**Figure 1**).

1-3) Efficiency enhancement of inspection work

Site workers previously confirmed the shape of actual objects and measured dimensions each time while referring to 2D drawings. However, by overlaying 3D models onto actual objects via AR devices, reference to drawings and measurement have become unnecessary, enabling instantaneous inspection (**Figure 2**).

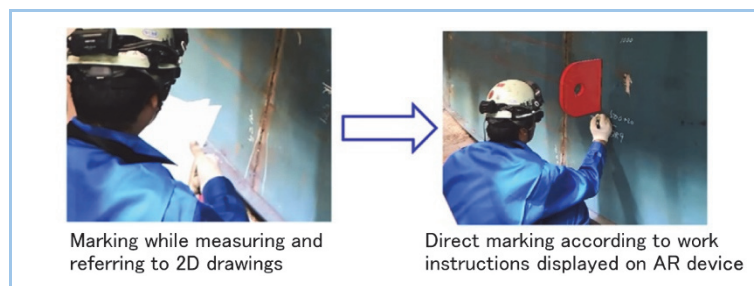


Figure 1 Efficiency enhancement of marking work utilizing AR technology

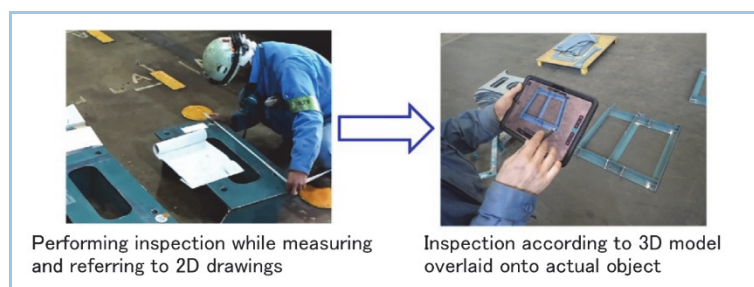


Figure 2 Efficiency enhancement of inspection work utilizing AR technology

2) Efficiency enhancement of site work in surface ship construction: Efficiency enhancement of keel block arrangement

In the manufacturing and repair of ships at Nagasaki Shipyard & Machinery Works and Yokohama Dockyard & Machinery Works, during dry dock operations, keel blocks to support the hull are arranged on the dock floor. In arranging the keel blocks, marking work is performed on the dock floor based on the keel block arrangement plan, which requires drawing the arrangement of hundreds or more keel blocks. This marking work required a massive amount of time and labor. Furthermore, constructed ships have a wide variety of hull forms, making it necessary to change the installation keel blocks each time. AR devices have been utilized to superimpose and display 3D data on the dock floor at the site in order to reduce the marking work time for keel block arrangement positions (**Figure 3**).

Model data for keel block arrangement at Nagasaki Shipyard & Machinery Works and Yokohama Dockyard & Machinery Works is created by engineers at Kobe Shipyard & Machinery Works based on necessary information such as the arrangement and dimensions of keel blocks, and marking work for keel block arrangement is performed using AR devices at each dock. By promoting cross-site collaboration and horizontal deployment of digital technologies within the division, synergy effects are generated across the entire division.

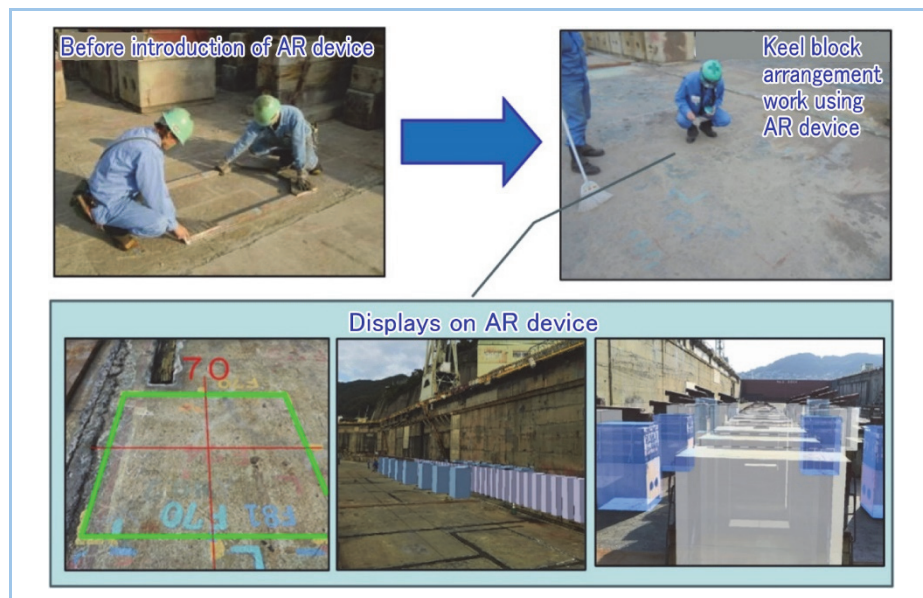


Figure 3 Efficiency enhancement of keel block arrangement utilizing AR device

2.3 Efforts toward paperless operations

Key to leveraging digital technology is the promotion of digital data utilization, which means breaking away from information transmission via analog data, namely paper media (achieving paperless operations). Although the reduction of 2D drawings through the utilization of 3D model data between design and manufacturing is progressing, many paper forms still remain. Furthermore, incidental tasks such as issuance, printing, and distribution occur for each form, and the digitalization of forms also contributes to reducing these associated tasks. At each site within the division, steady efforts toward paperless operations are being made.

In ship repair at Yokohama Dockyard & Machinery Works, efforts are being made to improve operational efficiency through the digitization of forms using document management and editing software. By electronically managing and operating procurement forms including requirement specifications, as well as internal application procedures and construction-related forms, this software accelerates review and approval processes while simplifying information sharing.

Additionally, in special machinery manufacturing at Nagasaki Shipyard & Machinery Works Isahaya Plant, efforts are being made to eliminate the distribution of paper forms to sites by using commercially available software to display instructions on tablets at manufacturing sites, and to automatically aggregate data by enabling input and entry at the sites.

3. Conclusion

Amid the current international situation surrounding Japan and the decline in the working population due to the domestic declining birthrate, efficiency enhancement, labor savings, and productivity improvement utilizing digital technology are essential. Furthermore, an innovative transformation of the defense industry base utilizing advanced technologies such as AI is required. Based on promoting the utilization of 3D model data at manufacturing sites and achieving the complete digitalization of information through paperless operations, the digitalization of the entire engineering chain and supply chain will be promoted to achieve further digital transformation.