Submarine & naval platform design and engineering
80 years engineering experience

“Good men learn from experience. Wise men learn from the experience of others.”
Otto von Bismarck
Introducing our company

Established in 1935, Nevesbu is a Naval Architecture and Marine Engineering company based in the Netherlands. Nevesbu offers design and engineering services to the maritime, naval and offshore industries worldwide. Our technical experience, in-house knowledge and ability to think ‘outside the box’ provide added value to our clients. We are fully equipped to manage and execute design processes with an aim towards exceeding the expectations of our clients.

We focus on three main markets:
• Engineering for Submarines & Naval Vessels,
• Engineering for Offshore Projects, and
• Engineering for Special Ships & Projects, whereby we provide added value through application of the know-how and skills attained from working in first two markets.

Nevesbu offers its clients the benefit of its experience using a structured engineering approach which encompasses design, organisation and communication and is supported by expert Naval Architecture & Marine Engineering. We aim to exceed the expectations of our clients, which is an approach that has led to many long-lasting relationships. Our enthusiastic professionals are driven and highly motivated engineers, who are abreast of the latest developments in their respective fields.
History

Let’s go back in time to where it all began in the mid thirties. The age old dilemma of inadequate and excess capacity for companies was evident at this time for foreign navies. The need to tighten the belt meant downsizing, which inadvertently led to difficulty in landing large projects when they came onto the market. However, having a larger staff along with an insufficient workload could have meant the end was near. Facing this dilemma, representatives of yards met to discuss the possibility of collaboration. Besides the obvious advantage of combining strengths for the Dutch naval shipbuilding market, an important motivation for working together was landing contracts with foreign naval clients and therefore promoting the export of naval vessels. This collaboration led to Nevesbu’s foundation. Where did we go from here?

Shortly after its establishment in 1935, Nevesbu’s first export contract became a reality. Two, 1000-ton submarines, the Sep and Orzel, were designed for the Polish navy. Thereafter came the Design 1047 battlecruisers, for which Nevesbu completed the preliminary design; a design that was later incorporated into one of two design studies. In the 1940s, the Second World War caused a disturbance in the flow of Nevesbu’s history.

After the war, things picked up quickly and Nevesbu got involved with the innovative, three cylinder submarines. The concept was devised in the war by Nevesbu’s director at the time for the transport of troops by submarine into the Mediterranean via the Strait of Gibraltar. The most unique feature on this boat was that it contained not one but three pressure hulls within its streamlined outer shell. The advantage was that each hull, which was necessary to keep the crew and supplies dry, had a relatively small diameter enabling it to withstand water pressure at great depths.

Subsequently, the Swordfish class was designed for the Dutch navy and the Hai Lung class for Taiwan. With steady growth, Nevesbu increased its pace designing a number of combatants including the Karel Doorman Frigate, KRI Fatuhilah Corvette and the S-frigates. Before the end of the 1970s, work commenced on the Walrus submarines.

Towards the end of the century, two notable naval auxiliary ships were designed, the Auxiliary Oil Replenishing ship, Hr. Ms. Amsterdam and the LPD Rotterdam.

This decade also included two hydrographic survey vessels, the M.S. Zirfaea and the Arca. Some of Nevesbu’s latest design work includes the SD Victoria and the complete design of MV Sigrid, a special vessel for the carriage of nuclear cargo.

In the early 1990s, Nevesbu made her inroads into offshore design. The first conversion of a tanker into a Floating Production Storage and Offloading vessel (FPSO) led to participation in many other such projects. Since then, Nevesbu has worked with all major Offshore Operators in the Netherlands as well as some abroad. A major, recent project was our involvement in the conversion of the former Bluewater FPSO Uisge Gorm into the present EnQuest Producer for its redeployment for production in the Alma-Galia Field in the UK sector of the North Sea.

Our in-house knowledge and years of experience are assets that we want to pass on and expand over the next generations to ensure all of our engineers are highly qualified for your project.
Innovative Naval & Marine engineering since 1935
Our services for new-build submarines & naval platforms

Naval platforms are versatile vessels used for various tasks. These vessels are outfitted with various pieces of equipment to suit the needs of the end-user and make the intended tasks possible. The design of such vessels with unique capabilities requires specialist know-how and an integrated design approach. Founded in 1935, Nevesbu has a proven track record in designing naval vessels. We understand that the complexity in respect to the vessel’s purpose has a direct relation to the total new building costs as well as total life cycle costs. As a knowledge center, Nevesbu can take care of the total design and engineering. We assist our clients in all project phases, from the early design stage up to support during production and throughout the life cycle. Our services include Concept Studies, System Integration and Design & Documentation.

Concept Studies
We offer support in defining the design of new naval platforms. We assist in the election of requirements and wishes, and translate these into concept design solutions to evaluate performance, benefits and operational costs. Nevesbu clarifies the relationship between requirements and design consequences to gain insight into the design-driving requirements.

System Integration
Nevesbu acts as a platform system integrator for both new-build and refit projects, bringing together new and existing systems into one platform, and ensuring that all subsystems function as a whole. We monitor all vital ship systems, such as available electrical power, heat load, ship weight as well as stability and strength. Furthermore we provide technical support on site.

Nevesbu supports its customers with design and documentation of naval platforms or parts thereof based on know-how and experience. We provide design and analysis of mechanical equipment and transport and handling systems. We also design mounting and integration of weapons and command systems provided by a third party. Nevesbu establishes procedures for design reviews, tests, installations, alignment et cetera, as well as requirement management. Additionally we provide detailed design and engineering for both new-build and refit projects.

Nevesbu brings added value to projects with a practical and structured design process. We manage meeting of pre-set requirements and, more-over, to achieve and maintain the target mission philosophy of the project.
Tool development to improve the submarine design process

It is well-known that the design of new naval platforms is a complex and time-consuming task. To improve and simplify the submarine design process, Nevesbu continually develops its working processes and tools. Among the latest developments are two work packages: SUBmarine Supporting Design Tool (SUBSIDE) and the Volumetric Estimation Tool.

**SUBSIDE**

Due to the great complexity of modern submarines, the process of selecting a design philosophy requires iterative developments and comparison of multiple design strategies to assess technical and performance characteristics, cost implications and risks. To break down this process, Nevesbu has designed a tool which has been incorporated into the naval architectural software package (NAPA), developed by Napa Group. This tool assesses the performance of submarines in the early stages of the concept design as well as in the later stages of the design process.

The Submarine Supporting Design Tool is used for modelling submarines, balancing and evaluating their stability. Some of the main capabilities developed within the tool include modelling of the pressure hull, parametric modelling of the outer hull (including appendages), main internal structure for tankage, bulkheads and main decks, contribution to buoyancy, weight distribution and balance, size and location of typical tanks in submarines like MBT (Main Ballast Tanks) and Trim and Compensation Tanks, hydrostatics, transition analysis, stability check, operational conditions checked, and equilibrium polygon.

**Volumetric Estimation Tool**

Establishing a viable starting point for the displacement and principal dimensions is an imperative step to take in the early stages of submarine design. Nevesbu has developed a tool that is capable of achieving decent accuracy and provides the designer with in-depth information on the estimated values. It has proven itself a useful tool for defining a viable starting point for the displacement and principal dimensions of a future design.

To overcome the challenges of early design stage estimation using a single estimation method, the fundamental differences between volume estimation and principal dimension estimation must be recognized. This requires using separate estimation procedures for volume and principal dimension estimation which will later be harmonized in order to produce one, consistent solution. The volume estimation is made possible by distinguishing a trend in the data which can be considered valid, despite the inaccuracy of the reference data itself. This is done using the Theil-Sen regression method. A trend line can be created from this regression by calibrating the trend found by using the Theil-Sen method to the value of known submarine designs. The advantage of using this method is that it becomes possible to give the obtained values meaning, as the implicit design choices of the design used for calibration are carried over to the estimated values.

The estimation of principal dimensions requires a different approach. Principal dimensions are determined by the dimensions of critical objects inside the pressure hull. Modelling of individual critical items is required, as the geometric properties of the submarine cannot be directly scaled within the desired degree of accuracy. The critical items are chosen based on a selection of common critical items across a range of submarine designs. By parameterizing the dimensions of the critical items, the maximum required pressure hull diameter can be determined. When the diameter is known, the volume estimation is integrated into the result to produce the other geometric properties of the submarine, such as length overall, length of the pressure hull, and prismatic coefficient.
Our services for Life Extension Programmes

To ensure overall operational availability, an upgrade is sometimes necessary. The objective of a naval platform Life Extension Programme (LEP) is to prolong its service life and to increase its operability in the current operational environment. Performance and safety modifications need to be made to accomplish this. The LEP integrates all the work needed to upgrade existing systems. Our history record consists of a wide range of experience in Life Extension Programmes of various naval platforms. We can take care of the complete design and engineering and assist our clients in all project phases.

Our services include Concept Studies, System Integration and Design & Documentation. In addition to engineering and design, we also offer assistance on-site during the construction phase and implementation.

Nevesbu acts as a platform system integrator (PSI) for upkeep and Life Extension Programmes. As the platform engineering partner, Nevesbu carries out the engineering necessary to allow embedding of all modifications (including new systems) on board the platforms. Nevesbu ensures that all systems are able to operate as an integrated whole, and makes an inventory of systems to be decommissioned. Further steps in the process include, among others, designing the new arrangement, allocating space for new hardware, and as an architect giving all new and existing equipment a place in the ship or submarine. Furthermore, Nevesbu provides technical support and advice.

With a multidisciplinary approach and expert team, Nevesbu is capable of developing multiple platform configurations. For example, maintaining the capability to withstand high water pressures and shock (e.g. from explosions) in submarines while satisfying other requirements in areas like electromagnetic separation and radiated noise, or drawing a transport plan to find out how all components (structural elements as well as equipment) can be brought on board. It is a complex puzzle to find room for all systems and to ensure that they work according to plan. With Nevesbu as a partner, this can be accomplished.

Due to the specific kind of knowledge required for naval platforms, we aim to bring together knowledge and expertise in the field of naval platforms and achieve synergy through cooperation with other parties. Combining these strengths gives our clients added value.
An example of a project executed by Nevesbu: Life Extension Programme for the Walrus class submarines

The four Walrus class submarines of the Royal Netherlands Navy went into service back in 1990. The submarines were originally designed for a service life of 25 years, with an upkeep planned for halfway through their life cycle. To ensure overall operational availability, in 2007 the Dutch government agreed to an upgrade of the four submarines and the Navy Command decided to recruit extra personnel. The objective of the Walrus class submarines Life Extension Programme (LEP) is to prolong their service life to at least 2025 and to increase their operability in coastal waters. To meet the new technical standards and requirements, the command center of the Walrus class submarines have to be completely stripped and provided with new equipment, cable ducts, piping and technology. The LEP integrates all the work needed for this. A puzzle which asks for efficient use of the available space and effective implementation of state-of-the-art engineering.

Platform system integrator
As the platform system integrator, Nevesbu was tasked with carrying out the engineering necessary to allow embedding of all modifications (including the new systems) on-board the submarines. Nevesbu ensured that all systems are able to operate as an integrated whole, and was responsible for making an inventory of systems for decommissioning. Further steps in the process included designing the new arrangement, allocating space for new hardware, and as an architect give all new and existing equipment a place in the submarine. Nevesbu was further responsible for designing the foundations for equipment, cable ducts, piping and furniture. The scope of the work also included designing connections for piping, electrical systems, controls and cooling systems, and monitor essential aspects like the power distribution, the heat load, and the vessel’s weight, volume, stability and strength. Furthermore, we provided technical support and advice.

Design philosophy
To adhere to the Walrus class design philosophy, Nevesbu’s designs are based on the new-build requirements and design rules. The systems are integrally designed to produce a single design that functions harmoniously. Nevesbu started with high level designs and worked its way down to the detailed level in order to comply to the general design philosophy. The engineering part of the maintenance programme has been divided into two phases. Nevesbu kicked off with a conceptual phase that zoomed in on the changes with the largest impact during the detailed design. The consequences for the LEP platform were worked out in detail.

DUCK
Due to the specific kind of knowledge required for the Walrus class submarines, the programme manager at the Defence Material Organisation (DMO) of the Ministry of Defence enlisted the assistance of the Dutch Underwater Knowledge Centre (DUKC). DUKC is a working party dedicated to maintaining submarine know-how in the Dutch industry. It initiated a collaborative venture to support the conceptual and platform engineering activities in the LEP. The aim is to bring together knowledge and expertise in the field of submarines, and to achieve synergy through cooperation. A number of basic principles were defined for the maintenance engineering work.

An example of a project executed by Nevesbu:
Life Extension Programme for the Walrus class submarines

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**Conceptual phase**

During the conceptual phase, the consequences of integrating new systems were assessed, to produce an initial design of the required modifications and space reservations, and to translate the design requirements into procedures. The aim was to quantify and reduce technical risks, identify interfaces and questions (also for suppliers), validate the choice of suppliers, and act as a SMART Buyer in the procurement process. This has been accomplished by monitoring ergonomic aspects and ensuring a comfortable living and working environment on board of the submarines. Other work included monitoring the heat balance (cooling capacity), the available power, and the seaworthiness of the vessel. Factors like the available space, the electrical power and the cooling capacity cannot be changed. This makes it essential to keep the entire modification within the constraints of the current submarine design.

To obtain a good baseline for the platform engineering, the existing documentation was examined on-board and the differences were highlighted. A three-dimensional model was produced of areas where complex changes are expected, based on the relevant two-dimensional drawings and diagrams. As part of the tender evaluation process a number of new systems, such as the optronic mast and the SHF satellite communication system, the integration consequences for the platform were analysed and compared.

The information obtained from the RFQ was used to produce a draft integration plan. The modifications were analysed and the plan was evaluated from an engineering point of view. This made it possible to produce a ranking, with quantification for all tenderers of the layout consequences (clashes with existing systems and routing), construction, platform systems (hull penetrations, heat load, hydraulics, et cetera), weight and volume.

Thanks to this work we were able to draw up modification recommendations for all potential suppliers. With this advice, suppliers had an opportunity to optimise their design and reduce its impact on the platform. Using the revised plan from the supplier, we again conducted a series of analysis. The ranking of the platform consequences served as input for the ultimate selection of suppliers. Examining all consequences for the submarine in the RFQ phase made it possible to establish clear confines for suppliers, and thus greatly mitigate the risks for the overall maintenance programme.

**Analysis of design requirements**

The original requirements for the Walrus class submarines were converted into concrete design solutions and verification procedures for the activities conducted as part of the LEP. This practical translation of the original requirements ensures adherence to the original design philosophy, so that all new elements will satisfy the original requirements.

**Detailing phase**

The detail design was worked out in the detailing phase. This started by defining the demolition work, the equipment, foundations, cables and pipes to be removed. This disassembly plan was followed by the design of the new layout and furnishings of the submarine. The new layout was used to determine the locations of all components, to design the foundations, cable ducts and piping, and to decide on the structural modifications. The design were then validated.
Submarines must meet stringent requirements. Among other things, a submarine must be capable of withstanding high water pressures and shocks (e.g. from explosions), and satisfy all other requirements in areas like electromagnetic separation and radiated noise. A transport plan also has to be drawn up to find out how all components (structural elements as well as equipment) can be brought on-board. Space on-board a submarine is at a premium. So it is a complex puzzle to find room for all systems and to ensure that they work according to plan. At the end of this phase, the design is translated into a manufacturing documentation package.

During the LEP, numerous changes are made to the submarine’s systems. New weapons, sensors and communications systems are brought on board. Systems are modernised and obsolete systems are removed. Changes had to be made to the connections between all of these ‘subsystems’.

All of these systems are still under development, so design and configuration management is extremely important. It involves questions like: Which information has or has not been incorporated into a particular part of the design? The relevant information is saved in the configuration management system. Nevesbu is also involved in the design reviews of all suppliers so as to monitor the platform interfaces. The relation between the platform and the suppliers’ engineering interests is monitored by platform engineering units. It is important for DMO, supplier and platform engineer to agree and monitor interfaces between the different systems and the platform.

The concept phase started in 2008 and finished in 2011. In 2011 Nevesbu started the detailing phase and completed the engineering by the end of 2012. Work on the LEP went underway in early 2013 at the navy dock yard in Den Helder, the Netherlands. On Monday, 13 May 2013, the Life Extension Programme for Walrus class submarines officially started.
An example of a project executed by Nevesbu: Life Extension Programme for the Malaysian corvettes KD Kasturi and KD Lekir

It took more than four years of hard work to extend the service life of the corvettes that were delivered to the Malaysian Navy back in 1984. Nevesbu made an important contribution to this project and acted as the platform system integrator. The objective of this ‘Service Life Extension Programme’ was to upgrade the weaponry and ship platform systems to enhance the corvettes’ combat strength against surface ships and submarines and to improve the living conditions of the crew for the next 15 years.

The Boustead Naval Shipyard in Malaysia engaged Nevesbu as the platform system integrator for the refit of the two corvettes because of the company’s specific knowledge and experience. The ships — KD Kasturi and KD Lekir — are almost 100 metres long. They were built in 1983 and 1984, respectively, at the HDW yard in Germany. With a maximum crew of 124 members and a top speed of 28 knots (51 km/h), Malaysia deploys the ships along its coast to combat pirates, smugglers and illegal immigrants.

Systems are regularly added to ships and on-board layouts can change over time. Changes like this are not always recorded on drawings and diagrams. To get a good picture of the prevailing situation despite the missing details, Nevesbu starts conversion projects by conducting our own inspection and recording the current situation by means of drawings, photos and videos. This project was no exception. Nevesbu first took stock of the basic details in the yard and then moved on to the design.

In 2014 the final tests on board the second corvette, KD Lekir, were completed. A good time to look back on a complex project that presented numerous challenges. Nevesbu was able to start the Service Life Extension Programme in November 2009 after officially being contracted by Boustead Naval Shipyard of Lumut. But the company had actually been working on the acquisition of this contract since April 2006. Nevesbu tackled KD Kasturi first. The vessel had been in the naval shipyard in Malaysia for a while. An initial on-board inspection revealed that a lot of equipment had already been removed.

This made it necessary for us to conduct a survey aboard KD Lekir to ascertain where the equipment had been positioned. Nevesbu discovered that the existing drawings had not been updated after earlier on-board modifications.

All cables, airconditioning systems, sonar systems, radars, torpedo tubes and guns are either being modified or replaced on KD Kasturi and KD Lekir. Nevesbu defined the demolition work, produced the plans for the new layouts (thereby ensuring that all sensors, weapons and other systems were interconnected and geared together) and designed the foundations and all the connections with the ship, such as the cables, pipes and controls. Nevesbu also worked intensively on monitoring the stability and energy balance of the two vessels. Our designs had to make allowance for the characteristics of all the components to be installed on board. Aspects we had to keep in mind include the operability and maintainability of hardware, the distances in connection with signal loss over excessively long cables, and the furnishing of the area where the equipment had to be installed. In addition, we ensured the right weight distribution so that the ship remains stable. Naval vessels must also meet some specific additional requirements. Equipment must be fitted with shock absorbers, for example, because the ships must be able to withstand depth charges. Cables must not be sensitive to interference and must be kept at a certain distance from each other to avoid mutual interference. Nevesbu also entirely reconstructed the operating system of the four main engines and rendered on-site technical assistance at the shipyard during the day-to-day work on board. Altogether this resulted in a large amount of design and engineering work that kept a team of 24 engineers very busy in Alblasserdam.
Difficult measurements

Another challenge was performance of the static alignment measurements. Thales had been engaged by the shipyard to overhaul their own systems and also to ensure that all existing and new sensors and weapons on board were installed at the right place and were able to ‘talk’ to each other. The combat management system is the brain of all of the sensors and weapons. The system analyses all data observed by the sensors, and weapons can be controlled to be ready for action. To set this completely integrated system properly, Thales wanted to know, down to the very last millimetre, where all sensors and weapons were located relative to a certain reference point on board.

To determine this accurately, a measurement team of Iv-Infra (a sister organisation of Nevesbu) used a ‘Total Station’ measurement device (tachymeter) made by Leica. From a predefined point, a grid of measurement points was superimposed over the entire ship, so to speak, so as to enable accurate determination of the position of all sensors and weapons. It was certainly a difficult measurement project involving a lot of arithmetic. The measurements were subsequently calculated back to the ship’s centre of gravity and Thales set to work using that data. The measurement team spent a week in Malaysia for this project, performing measurements over a period of three days. It was by no means easy, because work was still in full swing on and in the ship when daytime outdoor temperatures rose far above 30°C. Due to the temperature and the number of people on board, the measurements were performed mostly in the morning until approximately 1:00 pm and in the evening after 4:00 pm.

Concluding inclination test

The final measurement was the inclination test for KD Lekir. Nevesbu needed to perform the inclination test to obtain proof of stability. This was one of the requirements imposed by the classification society, in this case Germanischer Lloyd. The details were entered into a stability booklet. To properly determine stability, Nevesbu first had to find out where the centre of gravity was. It proved difficult. To do it Nevesbu used a clinometer, a device capable of accurately measuring the ship’s angle of inclination. By moving around weights on board the vessel and repeatedly measuring the angle of inclination, Nevesbu was able to determine the centre of gravity. The measurements were performed aboard KD Lekir in the evening and during the night together with a large team of people from the naval shipyard. Around 50 people were involved in all.

The Service Life Extension Programme was a complex project with inevitable challenges, not least in terms of working with other cultures. So Nevesbu learned a lot from the project. But the Nevesbu’s experiences in Malaysia were so positive that the company is keen to do more work there.

The Malaysian Navy has presented a film proudly showing the capabilities of the first renovated corvette. The second corvette has also undergone trials at sea and returned to service in autumn 2014.
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