UDT 2019 – SMX31 : THINKING TOMORROW'S SUBMARINE TO FACE OPERATIONAL CHALLENGES IN A CONSTRAINED ENVIRONMENT

Abstract — R&D is the pathway to submarines capable of fulfilling future missions with specific operational constraints. In fact, R&D only makes sense when driven by operational needs. This is what we intent with SMX31, a concept which scrutinizes the needs over 3 decades from now and connects with emerging technologies and architectures.
This paper explores this forecasting regarding operational needs and environmental shifts. It presents in a second chapter ways to improve stealth (shape and hydrodynamics, materials…), operational capabilities (Sensors including drones, Special forces, weapons), and to bring assistance in conducting highly demanding missions (trends and technologies). To conclude, this leads to discussing architectural options and R&D.

1 Introduction

Before three decades, the surface of oceans will be permanently scrutinized; it is already the case in the dense environments. In fact, civilian activities continuously expand with maritime traffic. Could a submarine possibly operate free and safe in such an environment, in the vicinity of submarine networks and commercial routes? How to prepare for cyber threats? How to perform powerful surgical strikes or deliver Special Forces when access is denied, in a fast-changing theatre? How to effectively gather and share intelligence with a Naval Force?

SMX31 is a submarine project which embodies answers to these questions. Thought to be extremely stealth, autonomous and resilient to any threat, she highlights tomorrow's capabilities and indicates where to focus architectural breaks and technological developments, among which the following examples will be discussed with in mind, once again: "in the next thirty years, could a submarine possibly operate free and safe in a constrained environment?".

2 Conducting ghost operations

2.1 Stealth

Submarine strategies rely on stealth under and above the surface. Shapes, architecture, materials and active signatures monitoring are of paramount importance in designing SMX31 as she highlights trends in tomorrow's shapes while taking into account future threats.

2.1.1 Shaped to face threats

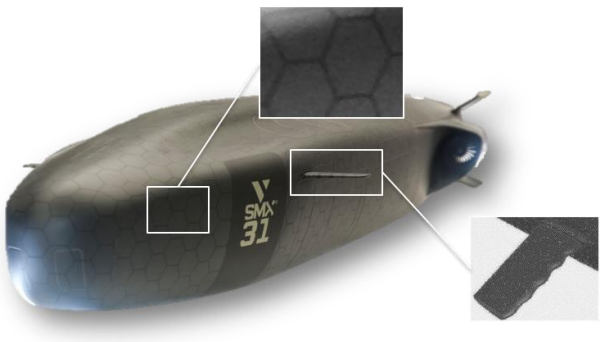
Target echo strength of current submarines is mostly due to the sail and particularly to the masts. It is considered that for future submarines, anechoic coverage and integration of all sorts of appendixes is the key to a non-responsive design against active sonars threats. This explains why there is no such sail on SMX31 as on today's submarines, which does not mean that the functions carried by the foresaid have disappeared: surface navigation, masts integration, hydrodynamic aspects are all dealt with, with the help of technologies which were unavailable when today's submarines where designed.

Figure 1 Side view of SMX31 designed for a very low target echo

Figure 2 Side views of today's typical submarines

2.1.2 Skin material

Shapes and integration of appendixes are not sufficient to cope with future threats; it is well known that anechoic and multifunction materials will play a major role.



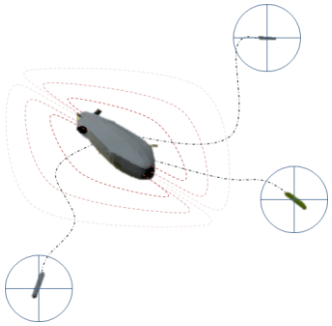
As a matter of facts, by covering SMX31 in almost its whole, signature against active acoustic threats is

tremendously reduced, with very high probabilities of remaining undetected versus active sonars, especially in constrained environments.

In addition, diffraction and absorption tiles with active response (in addition to passive protection) and signatures monitoring ensure SMX31 is definitely undetectable

1 - Environment is assessed thanks to all sensors including remote sensors

2 – Signatures are captured on the skin of the submarine and thanks to remote sensors



3 – the overall signature is calculated in all directions, specific layers can be displayed on the tactical situation for analysis by the officer

4 – the tactical situation shows areas where positioning SMX31 would have positive impact on signatures (advising the crew on where to hide) while active multifunction tiles modulate their response to better monitor the signatures regarding the environment.

2.2 Know better, further, before others

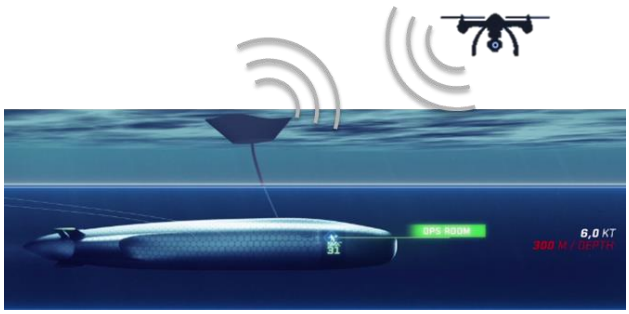
Drones integration shall provide operational advantage with informational superiority, summarized in SMX31's motto "know better, further, before others". Launch and recovery, maintenance, control, data link and integration into tactical situations are some of the challenges addressed by Naval Group's R&D.

2.2.1 Remote UUVs

So-called Remote UUVs are actually light torpedoe-shaped ROVs with stand-alone capabilities. The role of these Remote UUVs is to act as sensors in order to cover a very large area, monitoring SMX31's signatures, and participating in combat situations as a first barrier in access denial operations. These UUVs are wire-linked to SMX31, offering a permanent multi-directional environment assessment, for safe navigation and finding the most favourable positions.

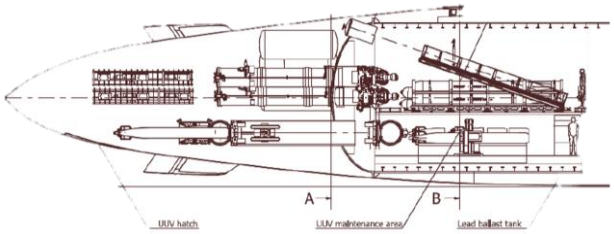
2.2.2 Remote UAV

Safety and discretion are made compatible with surface intelligence thanks to an UAV buoy. This drives R&D on several aspects: deployment of a surface buoy, launch and recovery of an UAV from a surface buoy, data link and remote control from the control room.



2.2.3 Long-range UUVs

Long range UUVs are integrated as versatile tools for intelligence and resilience on a distant theatre. Specificity of SMX31 is her ability to launch and recover these UUVs with practically no operational constraint (speed, depth, …). Launch and recovery is not only a stand-alone system but is fully integrated in the architecture of SMX31 to enable easy and almost transparent operations for the crew. For these reasons, the whole aft part of the submarine is dedicated to UUVs (and weapons) when it is usually dedicated to propulsion.



In a more general way, connectivity ensures that SMX31 is a submerged advanced control station to operate various effectors including pre-deployed weapons if necessary.

3 The best use of sciences and technologies

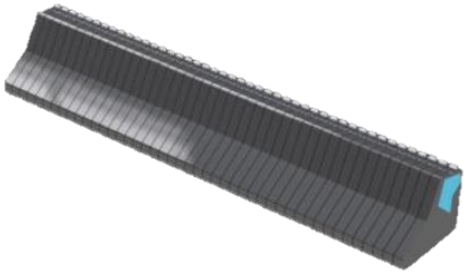
R&D has to be, at the same time, pulled by operational (and industrial) needs and pushed by sciences and technologies.

3.1 SMX31 - The Electric

Energy is at the heart of any SSK Submariner's planning. If we think about conducting Baltic sea operations, the commanding officer will ideally dives as soon as possible… and will never has to get back to the surface

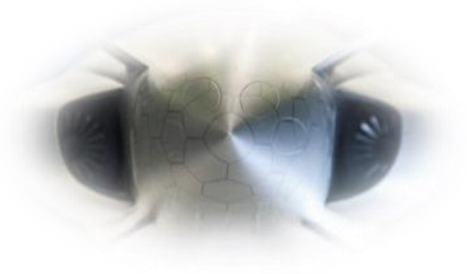
before 6 weeks. Ensuring endurance and mobility is a permanent challenge, and integrating emerging technologies require very attentive analysis not to only follow the market, but to propose the best operational value and prepare further steps.

SMX31 is capable of different energy & propulsion architectures. If we remain with the example of a Baltic mission, indiscretion ratio has to be null. Tomorrow's batteries will allow a 40-days mission at 5 knots on such a submarine.



The future of electric submarines relies on the capability of a 0% indiscretion rate for the whole patrol duration and on the fact that energy is mainly –if not only- transferred by electrical wires and no more fluids (thus actuators, system architectures, electrical protections are impacted).

SMX31 is fitted by twin rim-driven tunnelled propellers (reverse of tidal turbines), granting modularity to the design and valuing the aft section for operational functions (drones, sensors, weapons).



3.2 A man in the loop, integrated with systems

The whole design is meant to allow conducting complex operations in a constrained environment... with a crew of about 15 people (mainly officers).

To achieve this goal, complete integration of systems is compulsory; if the crew has to keep full control, with the help of a smart and adaptive automation. Adaptive in many aspects such as operational situation (silence, eco, combat…), capability to switch by itself from one to the other, and bringing the right level of information at the right time to the crew. Enlightening the future requires heavy investments in cognitive sciences, Man-Machine interfaces of the future, and data science.

3.3 Architectural aspects and benefits

Sovereignty may involve cooperation but with special attention to independence. This is a challenge for industries too. Time to deliver robust and highly capable platforms, while taking into account new economic models with transfer of technologies, and taking the best benefits of technologies is a tough topic.

Considering these new paradigms, architecture has to adapt. Modularity is one of the themes for developing smart architectures, responding to industrial challenges and allowing for high upgradability in order to improve through-life value. In addition, crew evolutions are another driver to design a comfortable, easy to control platform. Space is to be dedicated to operational functions, when technical functions are to become almost transparent to the user.

This is how, with SMX31, we explore the future of science, technologies, and architectures to provide the best industrial answer to an operational need : conducting highly complex missions in very constrained environments.