The Australian government's decision to spend A$50 billion to double its submarine fleet to 12 was based on a number of considerations about what the new submarines would be required to do.

In military parlance, the value of submarines can be discussed in terms of the missions they can carry out and the military effects they can create, such as:

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Sea denial – the threat of attack by submarines can deny an adversary the use of a strategic area of the sea. An example is the exclusion zone that British submarines enforced around the Falklands Islands in the war with Argentina in 1982.

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Maritime strike – the ability to attack and destroy enemy forces and capabilities.

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Intelligence collection – which can take several forms, such as the gathering of technical information about the capabilities and operational practices of enemy forces, or information that indicates the current or future intentions of an adversary.

The missions

Submarines carry out various kinds of missions , including:

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Anti-surface warfare – attacking ships, either merchant shipping carrying supplies or naval ships. This has always been the primary role of most submarines.

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Anti-submarine warfare – submarines can be employed to track and possibly attack other submarines, contributing to anti-submarine operations, which are likely to involve surface ships and maritime aircraft as well. Anti-submarine warfare demands a higher level of capability and proficiency than anti-surface warfare and not all submarines are capable of carrying out this role.

Estimating the capability offered by submarines of a particular design is done through a combination of systems performance analysis and operations analysis.

Systems performance analysis models the submarine and its subsystems to estimate measures such as range, endurance, speed, stealth and sensor detection range. Operations analysis models what the submarine is can do to estimate its mission effectiveness.

The utility of submarines largely derives from stealth, uncertainty, persistent presence and firepower. In plain terms, a submarine can hang around, unseen, in places where other forces might not be able to go and inflict damage when required.

Sustained presence involves requirements for the endurance, the length of time that the presence of the submarine must be sustained, and the number of operational areas that need to be covered.

The design

There are a multitude of interconnected drivers in the design of a submarine. These drivers can be modelled starting with high-level requirements for sustained presence and the missions to be undertaken.

The drivers result in a design involving the synthesis and integration of many complex systems and subsystems. To provide a context for this, a Collins class submarine has about 500,000 parts to be assembled. This is about five times as many parts as a large commercial airliner and about three times as many as a frigate.

Nevertheless, the important characteristics of submarines can be understood in terms of a few basic building blocks. These are the hull and the manoeuvring control systems, the propulsion system, power and energy, stealth, habitability and the combat system.

Generally the back half of a submarine is devoted to propulsion systems, which for a diesel-electric submarine means the diesel generators, the main electric motor and the electrical power conversion and control equipment.

The front half contains the control room where the sensor information is processed and the submarine is commanded, the crew’s living quarters and the weapon stowage.

Tanks containing fuel and fresh water are distributed around the submarine. The batteries are located along the bottom of the hull where they also act as ballast.

Diesel-electric submarines store electrical energy in a large set of batteries, which are recharged using a diesel generator. While fully submerged, traditional diesel-electric submarines use a battery-powered electric motor to turn the propeller.

Because there are few moving parts with electric drive, a diesel-electric submarine can be extremely quiet when running on batteries.

Submerged

The length of time a diesel-electric submarine can stay fully submerged is limited by the amount of energy that can be stored in the battery. The submerged endurance of a diesel-electric submarine while running on its battery depends on its speed for two reasons.

First, the hydrodynamic resistance to moving through water increases steeply as speed increases.

Second, the total amount of energy that can be extracted from a lead-acid battery reduces the faster it is discharged. This means that while a submarine might be able to stay submerged for a few days if it travels slowly, it could exhaust its battery in an hour or two travelling at maximum speed.

Understanding the power requirements of submarines and their interplay with stealth is a key determinant in the design of a submarine. There are two major components that affect the need for power.

One is the power required for propulsion, mentioned above. There is also the power required for the crew (including atmosphere control, victuals and garbage management), for data processing associated with the sensor and combat systems, the platform subsystems and delivery of weapons and countermeasures.

This second component is virtually independent of speed and is sometimes called the “hotel load”.

Silent running

The ability of a submarine to operate successfully hinges on its stealth. Stealth underpins survivability and mission success in high-threat environments.

Once a submarine is detected, its mission may be compromised and it is liable to be tracked and destroyed. The ability to remain underwater is paramount to submarine stealth and survivability.

The primary way to detect a submerged submarine is sonar (detection of underwater sound), leading to an ongoing endeavour to make submarines increasingly quieter and harder to detect.

There are two types of anti-submarine sonars: active and passive.

Passive sonar detects the noise radiated by the submarine. This is the most likely way a submerged submarine will be initially detected. The greatest attention must be given during design, and also in maintenance, to eliminating or controlling sources of noise on the submarine.

Active sonar transmits a pulse of sound and detects echoes from the submarine. This transmission can be intercepted by the submarine on its own sonar system, which alerts it to the presence of the threat. This gives it some information about the type, location and movement of the threat.

A submarine can generally detect active sonar at a greater range than the threat sonar can detect the submarine. This is because the sound only has to travel one way to get to the submarine, but has to be reflected and travel back to the threat sonar, losing more signal strength in the two-way round trip.

The control of noise includes addressing sources internal to the submarine as well as the noise generated by the flow of water over the hull and propeller.

Why 12 submarines?

A key measure of submarine capability is the level of presence that the fleet as a whole can sustain in operational areas. The level of presence depends on the availability of submarines for operations.

Every submarine goes through a cycle of availability and periods of maintenance. Once or twice during the life of a submarine it will be docked for a deep maintenance period lasting a year or more.

During deep maintenance, the pressure hull may be opened to allow access to major machinery to be repaired or upgraded. Major capability upgrades requiring new masts or sonar arrays may be carried out during deep maintenance.

In addition to the deep maintenance periods, there may be mid-cycle docking for extended, but lesser, maintenance lasting several months.

When a submarine emerges from a major maintenance period, it needs to spend some time working up at sea. During this time, its systems are tested and the crew complete drills and training before deploying on operations.

It is an inescapable fact that for any submarine fleet about half of the boats will be unavailable for operations at any time. The smaller the fleet, the more susceptible it is to fluctuations in availability.

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Read more http://theconversation.com/what-do-we-want-from-australias-new-submarines-58588