UNDER CURRENTS

THE MARITIME CORPORATE DEFENCE JOURNAL

Underwater Warfare

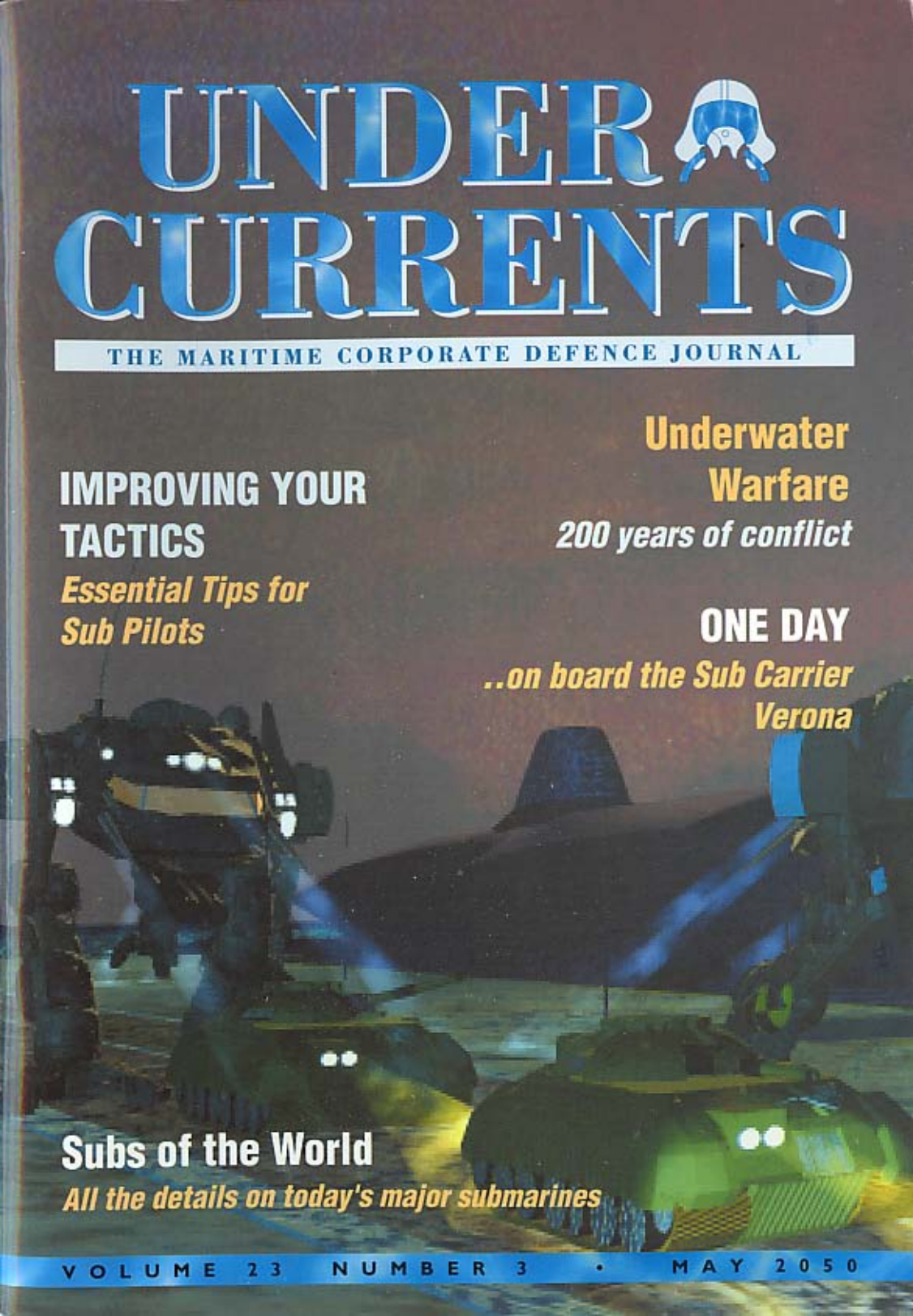
200 years of conflict

IMPROVING YOUR TACTICS

Essential Tips for Sub Pilots

ONE DAY

..on board the Sub Carrier Verona



Subs of the World

All the details on today's major submarines

VOLUME 23 NUMBER 3 • MAY 2050

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by
Thalion

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THE MARITIME CORPORATE DEFENCE JOURNAL

Contents

Unwelcome Intervention

As we predicted last issue, the Indonesian government intervened to 'limit' the underwater conflict between Richteur International and O'Sullivan plc. Company property suffered extensive damage, as is always the case when government forces get involved. The end result is that O'Sullivan, who were already experiencing financial difficulties, have been forced out of business.

Why can't the government forces keep their noses out of our affairs? Ours are private conflicts, usually involving no collateral damage or civilian casualties. The feeling among the staff here at UnderCurrents is that government forces get involved in corporate conflicts to justify their existence to the public - making us out to be the bad guys, while their propaganda machines turn them into heroes.

Let us not forget the lessons of the 20th century; every war in which government forces were involved resulted in heavy civilian casualties and almost total destruction of what they were meant to be defending!

If any government officials are reading, take this advice - leave corporate defence to the professionals.

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Pacific Coastal Mining Rights:-

An Anderson owned 'Tornado' fighter sub

SUB WAR LOOMS

As we went to press, the war of words between the American Anderson Corporation and Japanese Industrial Giant Hideyoshi was taking a new turn.

Almost 20 years ago, Hideyoshi agreed by treaty not to mine within 50 miles of the US West Coast. Over the last year, Hideyoshi have been establishing mines closer to the West Coast of the USA and the latest mine, the Ohka facility, is just within the 50 mile limit. Hideyoshi officials state that this is due to 'adverse conditions when operating far out at sea', but Anderson officials insist that Hideyoshi is 'way out of line' in their mining operations. An armed conflict seems inevitable. Anderson and Hideyoshi have substantial fighter sub forces of their own, but both have approached mercenary sub fighter organisations, openly offering large sums of money for the hottest sub pilots.

ARCTIC CONFLICT DRAWS CLOSER

In early March, Deeping-Drew Inc acquired the prospecting rights to the sought-after Sector 27 in the Arctic Quadrant Px223. This pitched them right next to the Nicholson Extraction Corp, who have been mining Sector 26 for the last six months. Ignoring warnings issued by DD, Nicholson vehicles have frequently entered Sector 27 and raids by DD fighter subs have claimed two Nicholson 'Floor Crawler' prospecting vehicles. DD are moving three Enterprise class sub carriers into the region, and it seems that this situation will be resolved with a corporate war very soon.

New Freelance Sub Fighter Organisation Founded

As the Tokyo Sub Expo '50 opens, so too does a new Japan-based mercenary sub fighter organisation.

The Sword and Shield Society has been set up to cater for 'elite sub pilots who excel at their craft and wish to work for only the most reputable and wealthy employers'. The Society has a strict rule of presenting members with only the most demanding contracts.

BSS DISCOVER NEW LUDINUM 90 SEAM

Our sources inform us that a fresh seam of Ludinum 90 has been discovered by the Berger-Smith-Scott Corp 'somewhere in the South Atlantic'. This rumour has sent BSS stocks soaring in markets across the world but has yet to be confirmed by Undersea Mining Federation auditors. "Jimbo" Ramsay, BSS Chief Executive, has refused to comment.

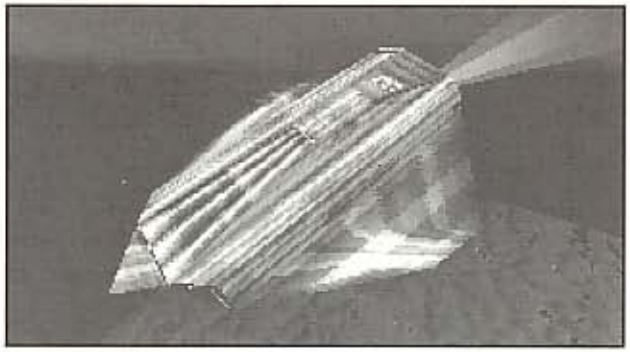
"Jimbo" Ramsay

New Sub Carrier Revealed

Tyler Underwater Shipyards have revealed their new sub carrier for 2051, at the Tokyo Sub Expo '50. The craft, known as the Constellation class, is capable of carrying and servicing 12 fighter subs and has more leisure facilities than your local mega complex. It retails at a cool $2825 million. Any takers?

MOD2 STANDARD LIGHTNING AVAILABLE

The other big news of the show is the latest version of the popular American Lightning class light-weight fighter sub. As we know, when Ferrara produced the excellent Mk96 torpedo, it would only function correctly when fired from the Ferrara Aquila class fighter sub. This boosted sales of the Aquila, but did not help most of us; the Lightning was already being used by over 80% of freelance fighters.



SubAm have now modified the design of the Lightning's torp tubes, so she can fire the Mk96 without any problems. The mod2 Lightning remains at the same price ($38 million) as the mod1, anyone still operating the mod1 can have it upgraded by SubAm to mod2 standard for just $7700.

German U-boat Discovery: FURTHER REVELATIONS

Espamarine SA have refused to comment on the latest rumours surrounding the 110-year old German U-boat discovered last month in the Eastern Atlantic quadrant Nm527. We know that the sub was fleeing to Brazil when it was caught by a British anti-sub plane and sunk, but the story does not end there. Our sources have discovered that the U-boat Captain carried with him, stored in airtight containers, some of the finest works of art owned by Germany. Presumably these were to be sold in Brazil.

It is planned that the sub will be raised and preserved as a centrepiece in the lobby of the Atlantic Mining Corporation head-quarters at Atlantic Tower, New York. What will happen to the priceless artefacts in the sub is yet to be recovered. Espamarine deep recovery vehicles are known to be moving into position right now.

Improving Your Tactics

So you've just spent your last million on the latest in fighter sub technology and you're there - 2000 feet down at 80 knots with the underwater world displayed in glorious 3-D all around you. Your briefed target approaches; a transport - should be an easy kill. You go active, lock a torpedo on and BOOM; you're hit by a rear quarter attack you didn't even see coming. You didn't check your most vulnerable zone - behind you, in your 'baffles'.

BY
Chris *'Tiger'* Johnson

During my last 5 years as a mercenary pilot, it amazed me that so few mercs knew any tactics at all. There were a handful who could pull off a few good tricks under pressure, but I only met two pilots who I thought were really good.

Now that I'm retiring as a merc pilot, it's a good time to put down on paper the rules that I've been following since my first under-water engagements.

All sub tactics are based around stealth. You will be more effective if you manage to keep the element of surprise. The section of this article on Avoiding Detection gives you details on how to achieve this.

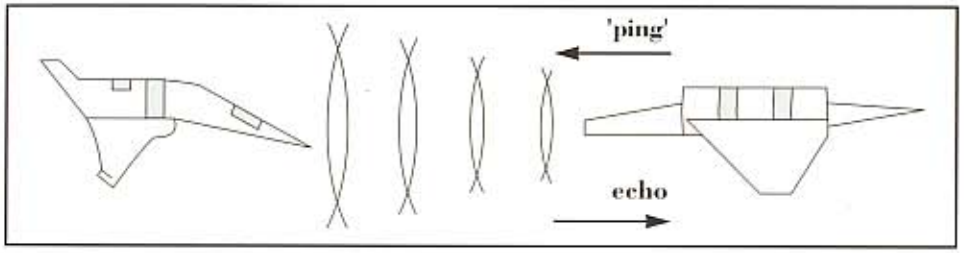
When it comes to sub versus sub fights, there's two tactics; attack and defence. You've got to know when to switch between attack and defence and you shouldn't press home a poorly planned attack; you'll end up dead. ➡

Attack Tactics

Using Active Sonar

Active Sonar sends out a high-pitched 'ping' noise and listens to the echo. The data from this sound profile is projected onto the inside of the submarine's cockpit, enclosing the pilot within a 3-D image of the surrounding underwater world.

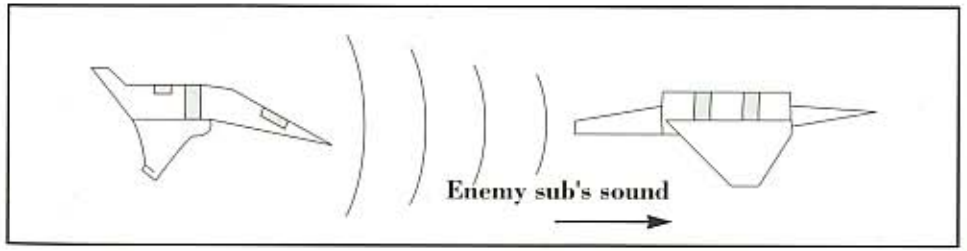
If you are in a high-threat environment, you should avoid using active sonar; it broadcasts your presence to the enemy and may be used to pinpoint your sub.



Using Passive Sonar

Passive sonar is simply an underwater microphone, listening out for the sound of impellers or even the sound of turbulent water around the hull of a moving submarine.

Passive sonar is less effective than active sonar, but does not give away your position to the enemy. My personal preference is to stick with passive sonar 90% of the time, only 'going active' when I am sure that I am safe from attack.



Attack Tactics

Exploiting the Terrain

To set up an ambush, use underwater rock or ice formations to hide from active sonar. Lie still and use your passive sonar to detect the enemy. Attack while stationary and watch the result of your attack - don't move unless you are fired on: you'll give yourself away and you may miss the chance to carry out a follow-up attack.

Firing Weapons

It is important to select an appropriate weapon system and fire at an optimum time. Don't waste torpedoes on short-range shots when rockets would be better.

Hidden Enemies

Enemies who are hiding from passive sonar by lying 'dead in the water' may be scared into moving by firing a homing torpedo 'blindly' in their general direction. Avoid 'going active' yourself; this will almost certainly result in the enemy launching a torpedo at you.

Manoeuvring

A good firing position is one which strikes a balance between escaping enemy detection and being close enough to minimise the chances of the enemy avoiding your torpedo. If the enemy has no towed sonar array, then it is always best to attack from behind.

If your opponent detects you, a close-range manoeuvring battle could take place. I have always tried to avoid these, since they are usually very hard work and any slight mistake will leave you dead. One of my colleagues described sub vs. sub dogfights as being like a 'knife fight in a telephone box'.

If you get into a manoeuvring battle, try to get into your opponent's 'six-o-clock' (immediately behind) and match speed and manoeuvres exactly. Don't forget to keep your wits about you; another sub could easily move into your 'six' while you are pursuing your target.

Defensive Tactics

Defensive tactics are last resort measures which are carried out to prevent your sub from being destroyed.

Returning Fire

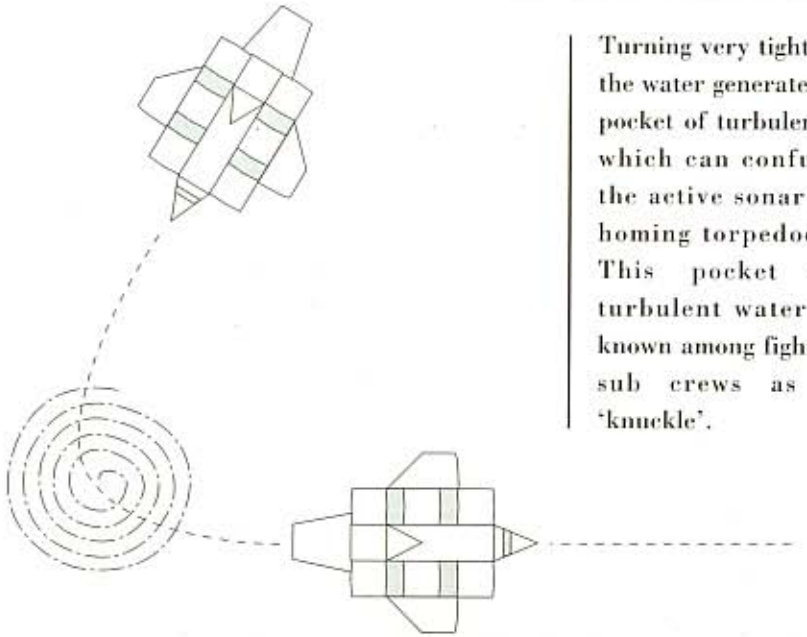
Firing a homing torpedo down the bearing of a running enemy torpedo will often find a target. Even if it does not, it will delay the enemy sub's follow-up attack while they attempt to outmanoeuvre your torpedo.

Using Your Strengths

If you are piloting a deep sea sub, dive out of the enemy's range; you can turn around and shoot him from below. If you are piloting a really fast fighter, turn around and speed off in the opposite direction to the enemy.

Every sub has unique features which you could use to your advantage; it's up to you to exploit them.

Creating a Knuckle



Turning very tight in the water generates a pocket of turbulence which can confuse the active sonar of homing torpedoes. This pocket of turbulent water is known among fighter sub crews as a 'knuckle'.

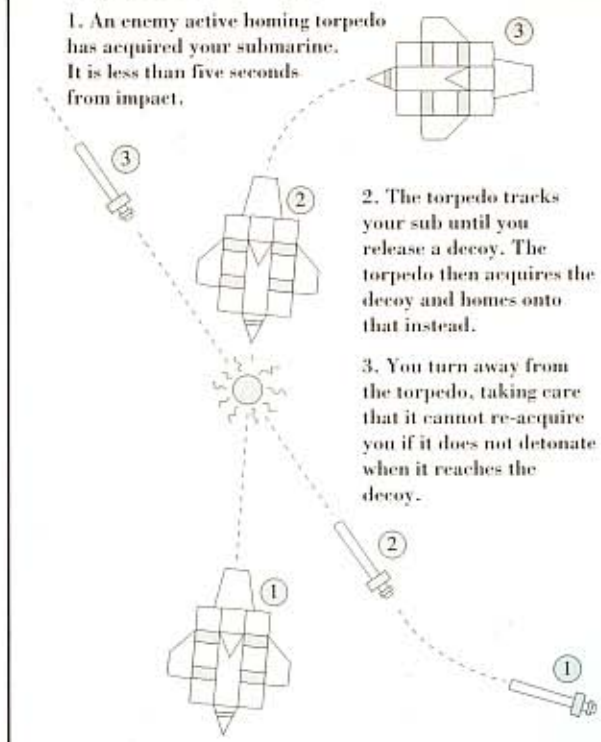
Defensive Tactics

Defensive tactics are last resort measures which are carried out to prevent your sub from being destroyed.

High Speed Evasive Manoeuvres

After creating a 'knuckle' or dropping a decoy or noisemaker, you should turn away from the torpedo.

Torpedo evasion technique



Using Decoys and Noisemakers

These should only be used as a last resort countermeasure and are most effective if released approximately 1 to 2 seconds before torpedo impact.

Avoiding Detection

Avoiding detection is more important than any other consideration. If the enemy see you before you see them, the chances are that you will lose the fight.

Using Thermal Layers

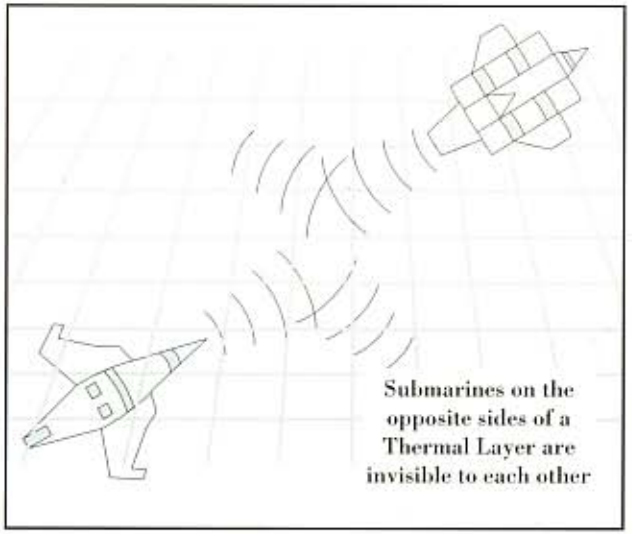
Thermal layers are the boundaries which are set up by ocean currents between the sunlight-heated surface water and the cooler deep water.

When sonar first came into use, submarine crews discovered that if they dived deep enough, ship-based sonar suddenly reached a point where it could not detect them at all. The submarine had disappeared from sonar beneath a thermal layer. Because sound travels slower in dense cold water, the sonar signal was being reflected back up to the lower density warm water. Submarines have been using the ocean's thermal layers to hide from sonar ever since.

Thermal layers are displayed on your fighter sub's 3-D cockpit display as a grid of either red or green. A red grid denotes a thermal layer from lower to higher temperature water, a green grid is a thermal layer from higher to lower temperature water.

If you position your sub so that there is a thermal layer between you and the enemy, neither sub will be able to see each other. This is an excellent defensive tactic.

In general, it is best to stay close to the thermal layers at all times and stealthily attack the enemy before they get the chance to return fire.



Submarines on the opposite sides of a Thermal Layer are invisible to each other

Avoiding Detection

Avoiding detection is more important than any other consideration. If the enemy see you before you see them, the chances are that you will lose the fight.

Lying 'Dead in the Water'

This must only be carried out if the enemy is uncertain of your exact position. Remaining motionless reduces your passive sonar emissions to zero, forcing the enemy to 'go active' and give away their position to you. This allows you to lock and launch a torpedo at them.

Reducing Cavitation Noise

Cavitation noise is the sound made by air bubbles forming as a result of water boiling at the tips of a sub's propeller/impeller blades. It can reveal your submarine's position to the enemy even if they are using only passive sonar.

The propulsion units of modern fighter subs are designed to minimise cavitation, but will still cavitate when running at shallow depths and high RPM. Old subs are most susceptible to cavitation due to their high RPM 'open' props.

To suppress your cavitation noise you must either reduce your speed or dive to the higher pressure deep water.

Summary

You don't need to remember every detail of the tactics outlined above, but a broad understanding of them could give you the edge which leads to victory in battles.

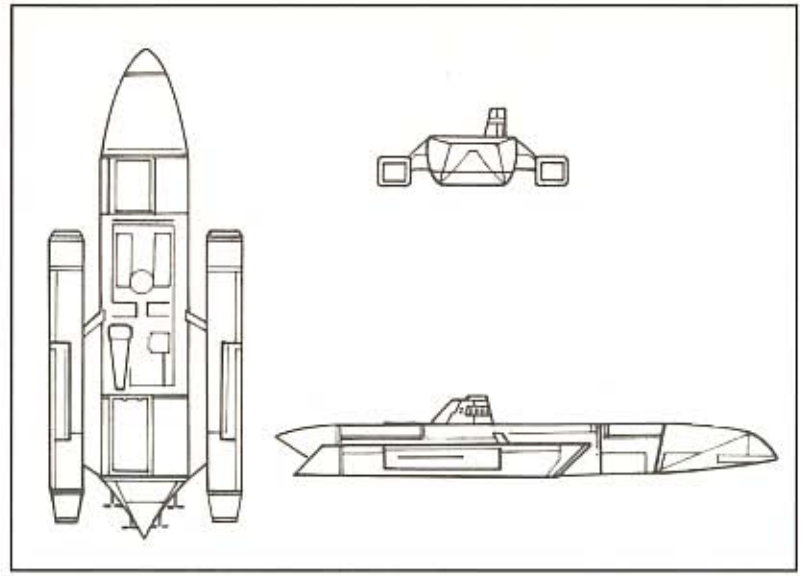
Even if you gain nothing else from this article, remember this:- your 'six-o-clock' is your most vulnerable zone. I killed more fighter subs by shooting them in the back than any other way. If you want to survive out there, you've got to remember to 'check six'.

Subs *of* the WORLD

Since our first Sub review of May 2041, we have established ourselves as the leader in gathering information on modern sub-surface weapon systems. All the entries in this review are both in production and freely available throughout the world. Subs which are only available to governments or large corporations are not included.

Last year saw several new systems come into service including one completely new weapon: the PBRS (Particle Beam Rocket System). Submarine technology has not advanced significantly, however, with only one major new type coming onto the world market over the last two years. The emphasis these days seems to be on upgrading and improving existing equipment rather than developing completely new submarines.

Enterprise Class
-Sub Carrier-



PRICE
$2360 million

IN-SERVICE DATE
2039

DISPLACEMENT
60,000 tons (unloaded)

LENGTH
742 ft

PROPULSION
Fusion nuclear powered with conventional screw drive

MAX. SPEED
35 kts

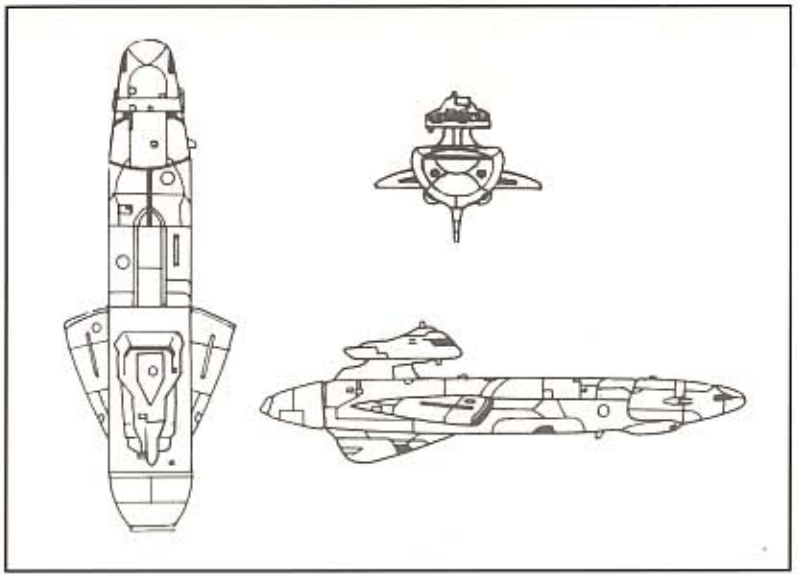
MAX. DIVING DEPTH
4500 ft

ARMAMENT
10 fighter subs
20 cruise missiles
4 torpedo tubes

DEFENCE & SENSOR SYSTEMS
Noisemakers Decoys
Active and passive sonar
Sidescan sonar Surface radar
Surface RWR
QV-82 airborne drones
Mk96 underwater drones

Tsunami Class

-Sub Carrier-



PRICE
$2170 million

IN-SERVICE DATE
2042

DISPLACEMENT
55,000 tons (unloaded)

LENGTH
649 ft

PROPULSION
Fusion Nuclear powered with electro-magnetic/ducted impeller drive

MAX. SPEED
37 kts

MAX. DIVING DEPTH
4300 ft

ARMAMENT
8 fighter subs
10 cruise missiles
6 torpedo tubes

DEFENCE & SENSOR SYSTEMS
Noisemakers Decoys
Active and passive sonar
Sidescan sonar
Surface radar Surface RWR
QV-82 airborne drones
Mk96 underwater drones

Tornado Class

-Heavy Fighter Sub-

PRICE
$62 million

IN-SERVICE DATE
2050

DISPLACEMENT
220 tons

LENGTH
86 ft

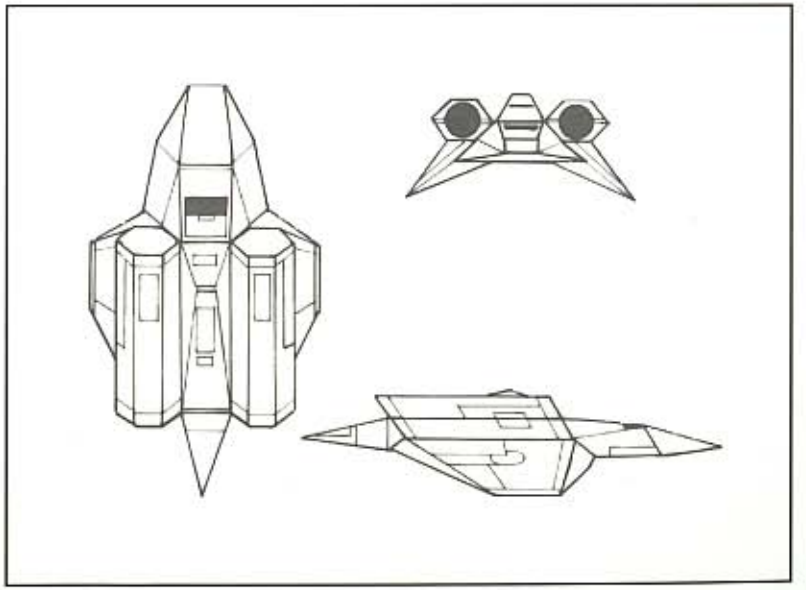
PROPULSION
Fusion nuclear powered with electromagnetic/ducted impeller drive

MAX. SPEED
80 kts

MAX. DIVING DEPTH
4600 ft

ARMAMENT
4 torpedo tubes
Particle Beam Rocket System
Mine-laying capability

DEFENCE & SENSOR SYSTEMS
Noisemakers Decoys
Active and passive sonar
Sidescan sonar



Lightning Class

-Light Fighter Sub-

PRICE

$38 million

IN-SERVICE DATE

2043

DISPLACEMENT

120 tons

LENGTH

65 ft

PROPULSION

Fusion nuclear powered with electromagnetic/ducted impeller drive

MAX. SPEED

100 kts

MAX. DIVING DEPTH

2000 ft

ARMAMENT

2 torpedo tubes

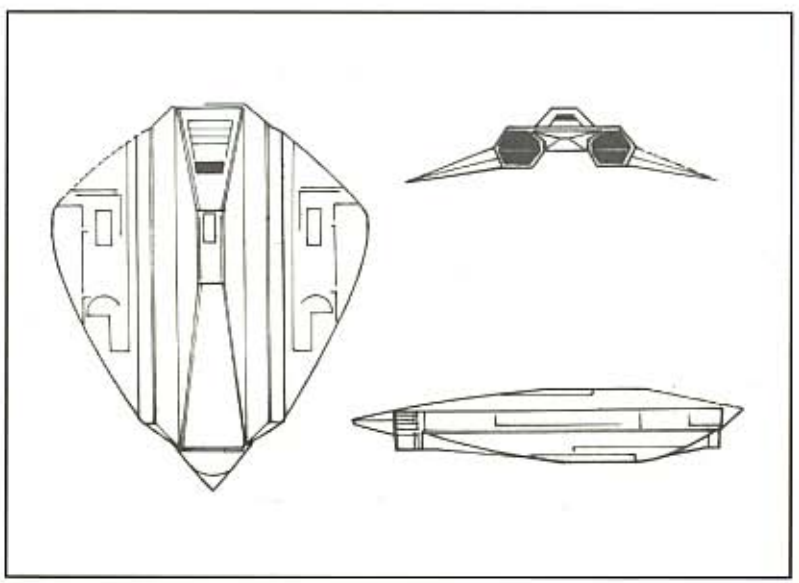
DEFENCE & SENSOR SYSTEMS

Noisemakers

Decoys

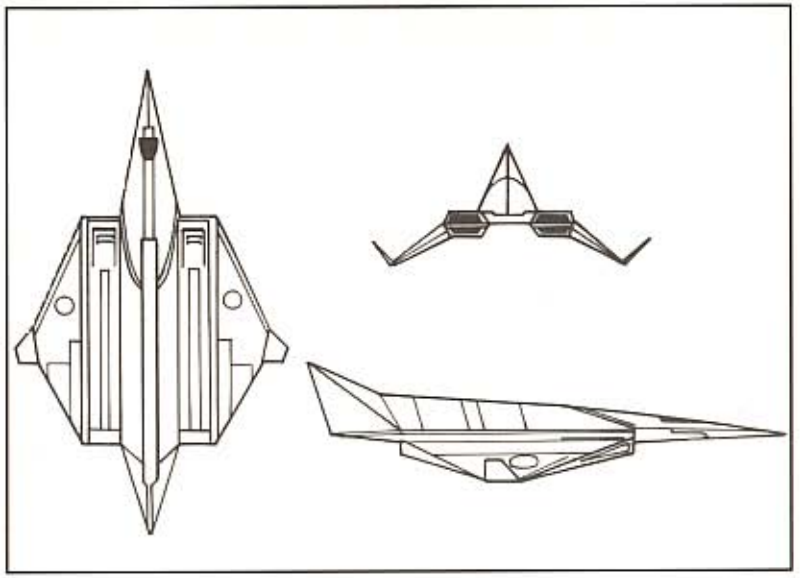
Active and passive sonar

Sidescan sonar



Typhoon Class

-Heavy Fighter Sub-



PRICE

$45 million

IN-SERVICE DATE

2048

DISPLACEMENT

210 tons

LENGTH

92 ft

PROPULSION

Fusion nuclear powered with electromagnetic/ducted impeller drive

MAX. SPEED

85 kts

MAX. DIVING DEPTH

4200 ft

ARMAMENT

4 torpedo tubes

Mine-laying capability

DEFENCE & SENSOR SYSTEMS

Noisemakers

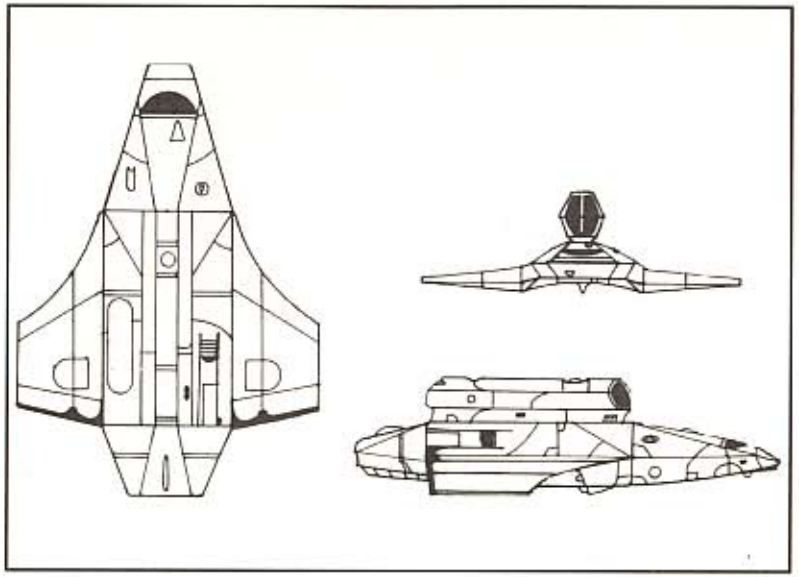
Decoys

Active and passive sonar

Sidescan sonar

Hurricane Class

-Light Fighter Sub-



PRICE

$36 million

IN-SERVICE DATE

2044

DISPLACEMENT

140 tons

LENGTH

69 ft

PROPULSION

Fusion nuclear powered with electromagnetic/ducted impeller drive

MAX. SPEED

90 kts

MAX. DIVING DEPTH

1800 ft

ARMAMENT

3 torpedo tubes

DEFENCE & SENSOR SYSTEMS

Noisemakers
Decoys
Active and passive sonar
Sidescan sonar

Trieste Class

-Ultra-Deep Sub-

PRICE

$230 million

IN-SERVICE DATE

2042

DISPLACEMENT

1,400 tons

LENGTH

251 ft

PROPULSION

Gas turbine/electric powered with ducted impeller drive

MAX. SPEED

30 kts

MAX. DIVING DEPTH

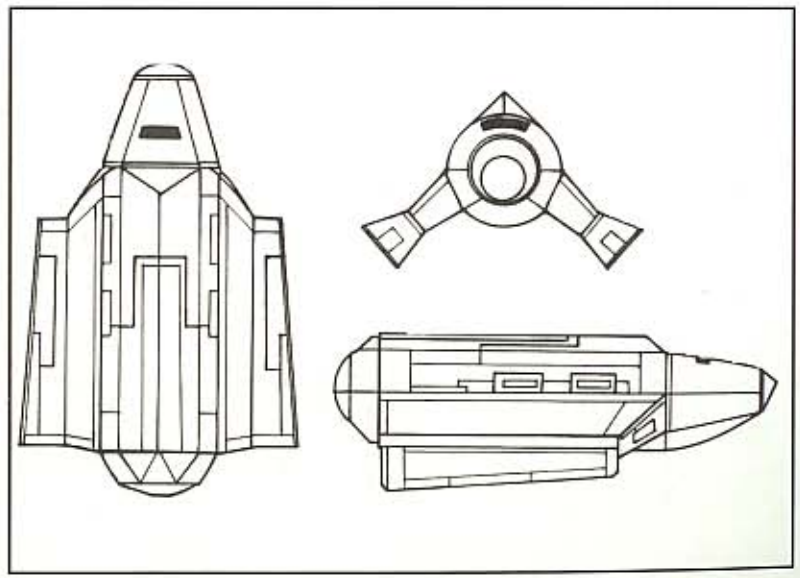
12500 ft

ARMAMENT

2 torpedo tubes

DEFENCE & SENSOR SYSTEMS

Noisemakers
Decoys
Active and passive sonar
Sidescan sonar



Whirlwind Class

-Ultra-Deep Sub-

PRICE
$198 million

IN-SERVICE DATE
2039

DISPLACEMENT
1,200 tons

LENGTH
287 ft

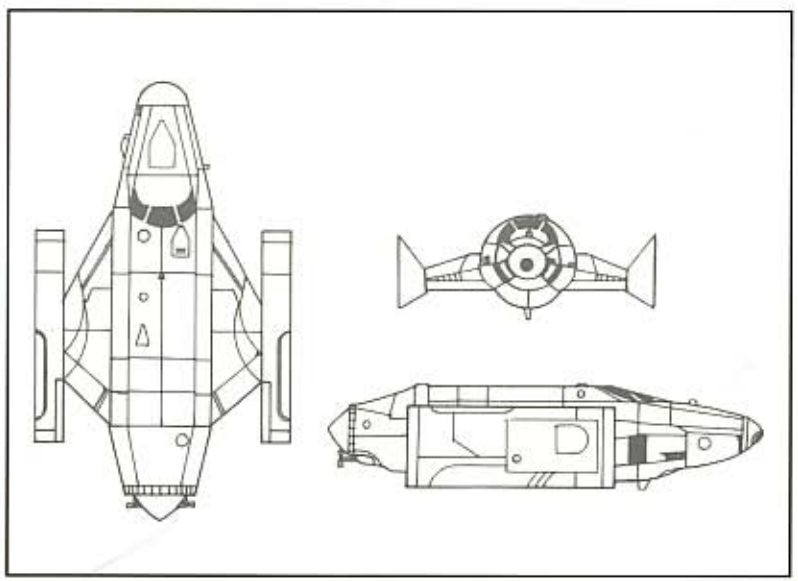
PROPULSION
Gas turbine/electric powered with conventional screw drive

MAX. SPEED
20 kts

MAX. DIVING DEPTH
11000 ft

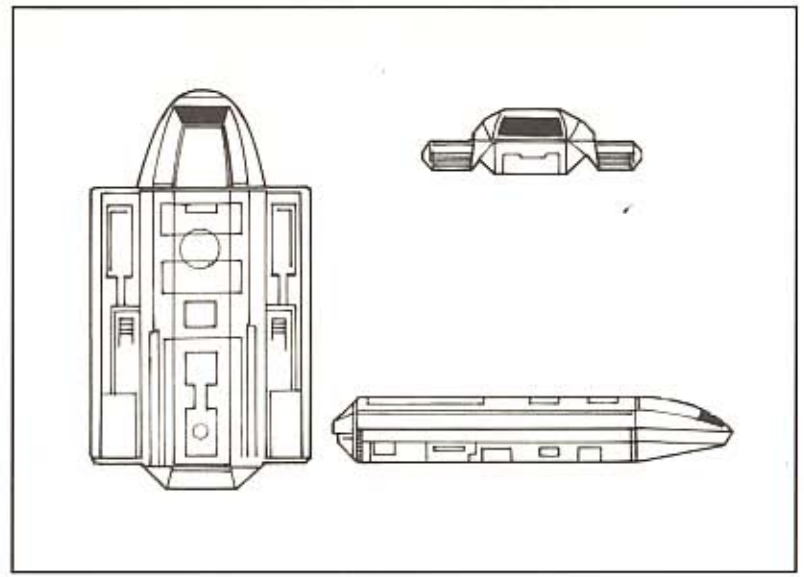
ARMAMENT
4 torpedo tubes

DEFENCE & SENSOR SYSTEMS
Noisemakers
Decoys
Active and passive sonar
Sidescan sonar



Powers Class

-Reconnaissance Sub-



PRICE
$31 million

IN-SERVICE DATE
2047

DISPLACEMENT
400 tons

LENGTH
160 ft

PROPULSION
Gas turbine/electric powered with ducted impeller drive

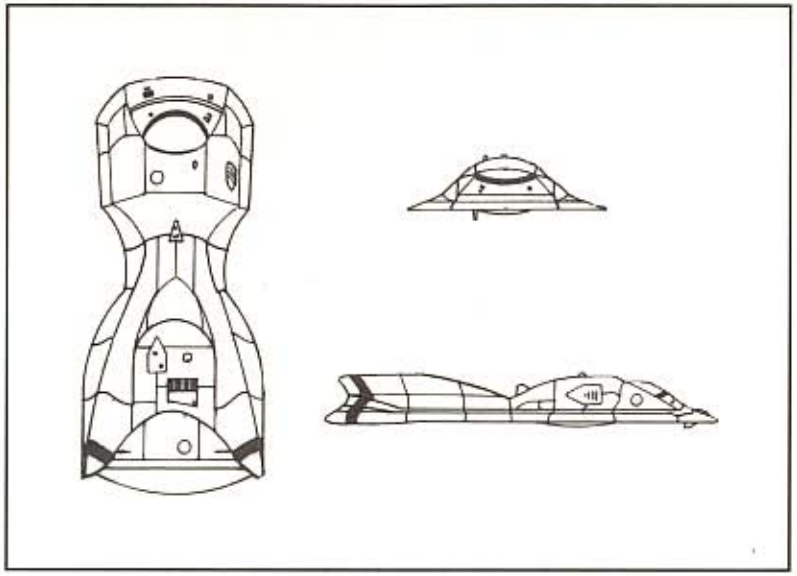
MAX. SPEED
40 kts

MAX. DIVING DEPTH
5500 ft

ARMAMENT
None

DEFENCE & SENSOR SYSTEMS
Noisemakers
Decoys
Active and passive sonar
Sidescan sonar
Surface radar
Surface RWR

Thunderbolt Class
-Reconnaissance Sub-



PRICE
$29 million

IN-SERVICE DATE
2045

DISPLACEMENT
330 tons

LENGTH
147 ft

PROPULSION
Gas turbine/electric powered with ducted impeller drive

MAX. SPEED
40 kts

MAX. DIVING DEPTH
5200 ft

ARMAMENT
None

DEFENCE & SENSOR SYSTEMS
Noisemakers
Decoys
Sidescan sonar
Active and passive sonar
Surface radar
Surface RWR
Mk96 underwater drones

Endurance Class
-Refueller Sub-

PRICE
$285 million

IN-SERVICE DATE
2040

DISPLACEMENT
12,000 tons

LENGTH
566 ft

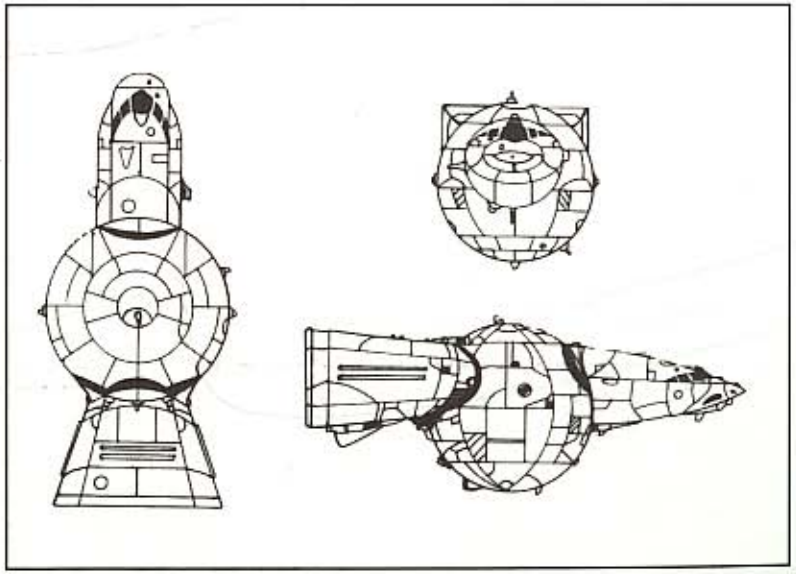
PROPULSION
Gas turbine/electric powered with conventional screw drive

MAX. SPEED
25 kts

MAX. DIVING DEPTH
1500 ft

ARMAMENT
None

DEFENCE & SENSOR SYSTEMS
Active and passive sonar



Type 17
-Refueller Sub-

PRICE
$341 million

IN-SERVICE DATE
2043

DISPLACEMENT
10,000 tons

LENGTH
510 ft

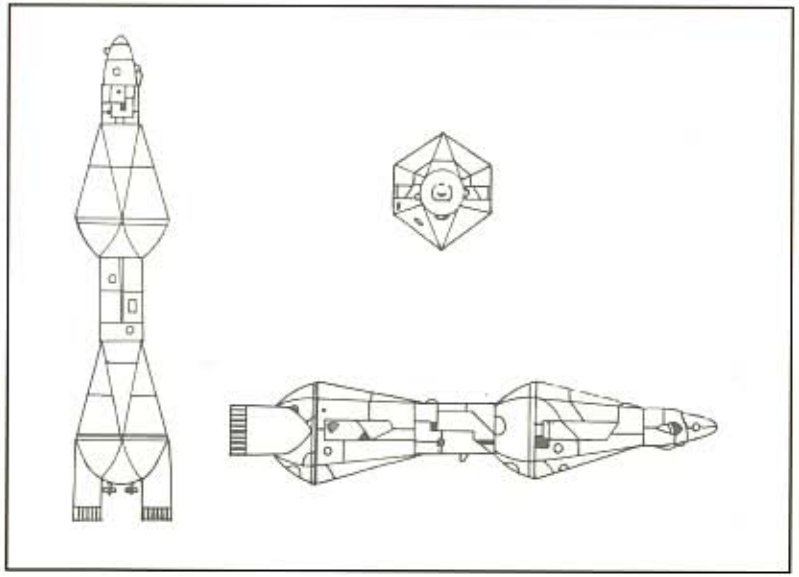
PROPULSION
Gas turbine/electric powered with conventional screw drive

MAX. SPEED
28 kts

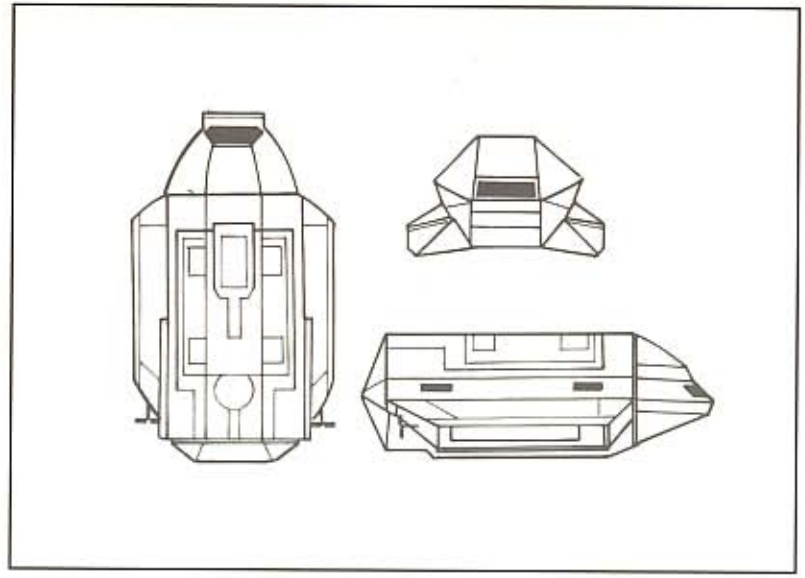
MAX. DIVING DEPTH
1200 ft

ARMAMENT
None

DEFENCE & SENSOR SYSTEMS
Active and passive sonar



Fury Class
-Troop Carrier Sub-



PRICE
$27 million

IN-SERVICE DATE
2046

DISPLACEMENT
150 tons

LENGTH
101 ft

PROPULSION
Gas turbine/electric powered with conventional screw drive

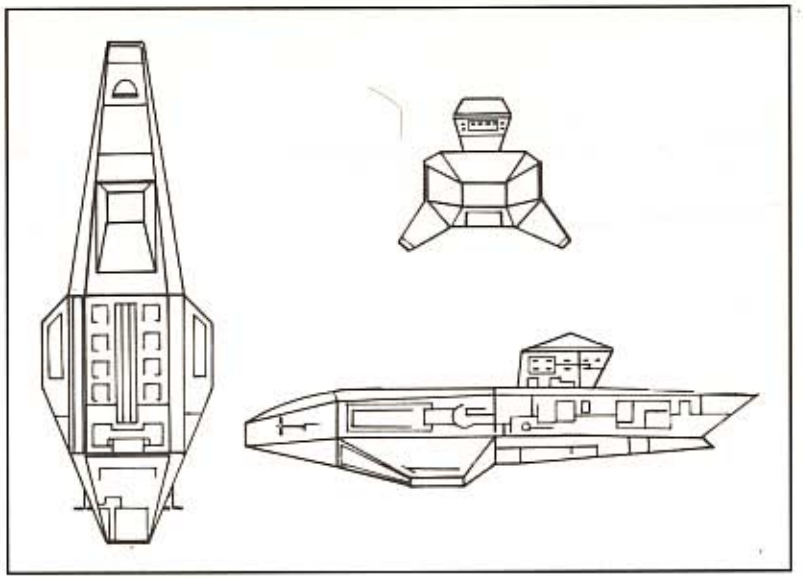
MAX. SPEED
25 kts

MAX. DIVING DEPTH
4500 ft

ARMAMENT
30 troops

DEFENCE & SENSOR SYSTEMS
Active and passive sonar

Jumbo Class
-Transport Sub-



PRICE
$314 million

IN-SERVICE DATE
2037

DISPLACEMENT
32,000 tons

LENGTH
652 ft

PROPULSION
Gas turbine/electric powered with conventional screw drive

MAX. SPEED
20 kts

MAX. DIVING DEPTH
3000 ft

ARMAMENT
None

DEFENCE & SENSOR SYSTEMS
Active and passive sonar

Type 25
-Transport Sub-

PRICE
$331 million

IN-SERVICE DATE
2044

DISPLACEMENT
38,000 tons

LENGTH
705 ft

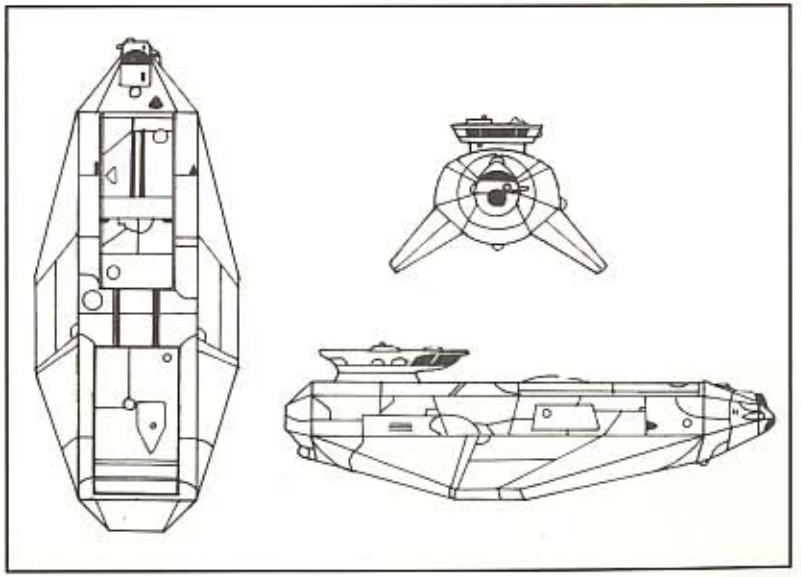
PROPULSION
Gas turbine/electric powered with conventional screw drive

MAX. SPEED
26 kts

MAX. DIVING DEPTH
2800 ft

ARMAMENT
None

DEFENCE & SENSOR SYSTEMS
Active and passive sonar



Revenge Class

-Heavy Missile Sub-

PRICE

$1549 million

IN-SERVICE DATE

2038

DISPLACEMENT

15,000 tons

LENGTH

574 ft

PROPULSION

Fusion nuclear powered with ducted impeller drive

MAX. SPEED

40 kts

MAX. DIVING DEPTH

3500 ft

ARMAMENT

6 torpedo tubes

24 ballistic missiles

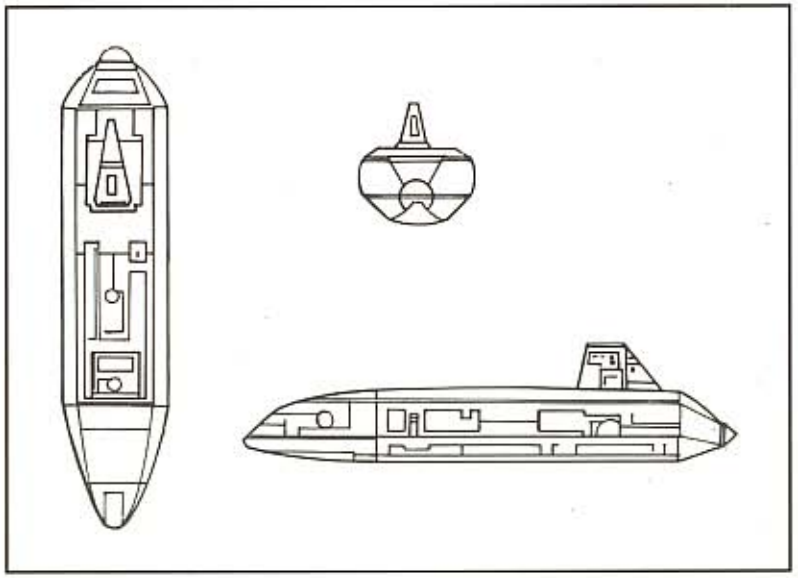
DEFENCE & SENSOR SYSTEMS

Noisemakers

Decoys

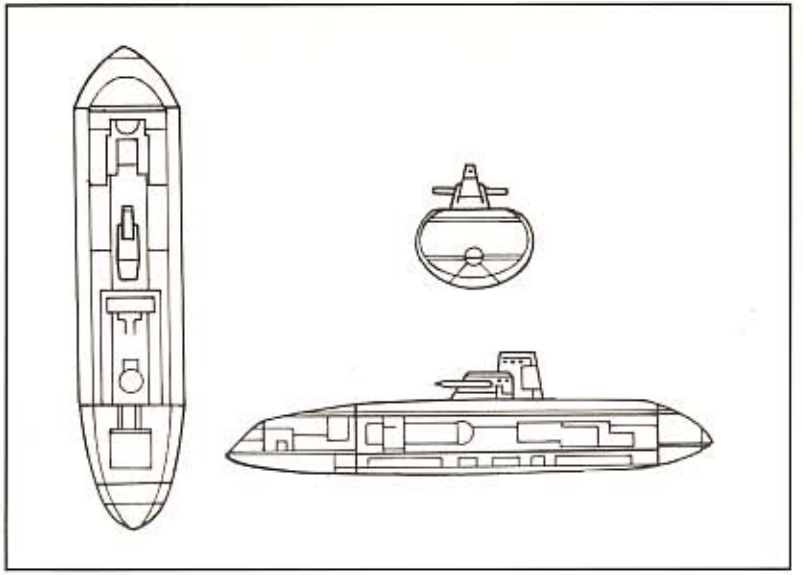
Active and passive sonar

Sidescan sonar



Tempest Class

-Heavy Missile Sub-



PRICE

$1384 million

IN-SERVICE DATE

2034

DISPLACEMENT

18,000 tons

LENGTH

610 ft

PROPULSION

Fusion nuclear powered with ducted impeller drive

MAX. SPEED

35 kts

MAX. DIVING DEPTH

3300 ft

ARMAMENT

4 torpedo tubes

28 ballistic missiles

DEFENCE & SENSOR SYSTEMS

Noisemakers

Decoys

Active and passive sonar

Sidescan sonar

Weapon Systems

Mk96 Torpedo

The Mk96 is the most widely used torpedo in the world and is capable of travelling in excess of 100 kts. The standard Mk96 is fitted with an active sonar seeker head but may be modified to accept passive sonar or thermal homing heads.

M704 Rocket

The M704 rocket is more effective than a torpedo at short range because, even though it is unguided, it is very fast. The M704 may be fired from standard diameter torpedo tubes.

Mk90 Anti-Torpedo Torpedo

The Mk90 is a small warhead torpedo which is very fast and manoeuvrable. It is optimised to destroy hostile torpedoes, but may be used to inflict minor damage on subs.

Mk97 Cluster-Rocket Torpedo

The Mk97 is a standard torpedo with an armour-piercing warhead which contains multiple short range rockets. This allows it to destroy even the thickest skinned submarines.

UGM-167 Cruise Missile

The UGM-167 has been in use for over 10 years and is still the world's principal long-range surface attack missile. It is launched from a submarine, surfaces, then deploys wings and cruises at high speed and low level to the target. It is suitable for use against any ship or land-based installation.

UIM-194 Surface-to-Air Missile

Helijets and helicopters equipped with dipping sonar can present a significant threat to submarines.

The UIM-194 allows an underwater sub to destroy any airborne threat.

Particle Beam Rocket System (PBRS)

The PBRS short range charged particle pulse/rocket weapon was developed to allow submarines to strike underwater targets with the accuracy and firepower of airborne weapons.

It functions by transmitting an extremely high energy pulse which vaporises a cylinder of water to the target. An armour-piercing rocket is then instantaneously fired at Mach 2 through this tube.

Sensor Systems

Active Sonar

Active sonar is a sound transmission and analysis device which uses sound echoes to visualise the underwater world.

Passive Sonar

Passive sonar is a sound analysis device which is used to track underwater objects from their noise signature.

Side-Scan Active Sonar

Side-scan active sonar is short-ranged active sonar which enables a submarine to sense nearby subsea terrain.

Periscope

Fibre-optic video periscopes have replaced optical periscopes in all but the oldest submarines. The risk of detection by enemy surface radar is greatly reduced with the fibre-optic periscope.

Satellite Imaging

Infra-red data on ocean currents, salinity, etc. gathered by satellites can sometimes detect submarines at shallow depths.

Magnetic Anomaly Detector (MAD)

MAD devices are used to locate older steel-hulled vessels by detecting the effect they have on the earth's magnetic field.

Surface Radar

Radar is a radio wave transmission and analysis device. It may be used to detect airborne enemies when you are submerged at periscope depth.

Surface Radar Warning Receiver (RWR)

A RWR is a radar analysis device. It may be used to detect enemy radar emissions when you are submerged at periscope depth.

QV-82 Airborne Drone

The QV-82 is a pilotless vertical take - off/ landing aircraft used for reconnaissance.

Mk96 Underwater Drone

The underwater drone version of the ubiquitous Mk96 torpedo is equipped with multiple reconnaissance sensors in place of the warhead.

Defence Systems

Noisemaker

The noisemaker is a small bubble-generating device which can temporarily blind a hostile active sonar homing torpedo.

Decoy

Decoys are larger than noisemakers, but are more effective since they actually imitate the sonar reflection of your sub, attracting enemy active sonar homing torpedoes.

Surface VHF Radio

Very High Frequency radio: used for long-range communication when the sub is surfaced.

ELF Radio

Extremely Low Frequency radio: used to receive long-range transmissions when the sub is submerged.

Communication Systems

Blue-Green Laser

Satellites may use this to relay messages if the submarine's position is known. Subs operating together underwater can also use this at close range to intercommunicate.

Acoustic Phone

This has been in use for over a century. It operates by transmitting audible sounds at close range, but is seldom used today due to the risk of enemy detection. ■

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UNDERWATER WARFARE

200 Years of Conflict

By Alan Crockett

INTRODUCTION

Over 25 years ago, on January 7 2025, the first Eagle class fighter submarine was launched at Groton, Connecticut. Until then, submarines had limited manoeuvrability and were blind to most of what was going on around them.

The Eagle was capable of stealthily approaching any enemy vessel, carrying out a deadly attack using the finest technology of the 21st century and escaping before the enemy could carry out a counter attack. 3-D graphical data was projected onto the inside of the cockpit, giving the pilot a unique view of the underwater world.

The shape of the Eagle was a clue to its capabilities, looking more like a jet fighter than a boat, the Eagle could out-manoeuvre any submarine in existence. Today's Tornado class may make the Eagle look outdated, but it should be remembered that before the Eagle, the fighter sub was just a dream in the minds of scientists and engineers.

Today, in the era of advanced fighter subs and 60,000 ton sub carriers, it is useful to look back at the history of the 'underwater boat'. ◗

The Pioneers

The first underwater vessels were open-ended barrels lowered from ships by a rope, these became known as 'diving bells'.

The principle of the diving bell is simple: an empty cup forced into a bowl of water upside down will not fill, air is trapped inside the cup. The diving bell was basically a huge cupful of air which could be breathed for a limited period of time by an underwater explorer. As early as 320 BC, Alexander the Great descended into the sea in a diving bell to observe underwater life. The diving bell is not a true submarine, however, because it can only travel up and down, like an elevator.

The first submarine was an underwater boat built in 1620 for the English King James I by Dutchman Cornelius van Drebbel. The submarine was made from grease-soaked leather stretched onto a wooden frame. Twelve oars protruded through watertight holes in the leather, and twelve oarsmen sat inside to provide propulsive power. But no matter how hard the oarsmen rowed, Drebbel's submarine could not dive and only managed to plunge down to about fifteen feet.

One and a half centuries later, David Bushness in the USA designed a submarine for attacking British ships. This tiny craft, named Turtle, had two man-powered propellers, one for going forwards or backwards and one for ascending or descending. On September 6th 1776, Turtle came very close to sinking the British man-of-war Eagle, but failed to attach an explosive device due to the tough, metal-sheathed hull of the Eagle. The Turtle continued trying to sink British ships, but was eventually destroyed.

Another American, Robert Fulton, designed a submarine in 1800 for Napoleon. This vessel was the first submarine to carry the name Nautilus. It had many of the features found on modern submarines including water ballast tanks (used to dive and surface) and a conning tower (for the captain to navigate the sub when on the surface). It generated considerable interest amongst the French military, especially when Fulton sank an old French schooner as a demonstration. Napoleon's admirals were not impressed however; they felt that the submarine was an ungentlemanly weapon and persuaded Napoleon to stick to using surface warships. One of Napoleon's officers wrote 'This type of warfare carries with it an objection: those who undertake it, and also those against whom it is launched, will all perish. And this cannot be called a gallant death.'

Fulton approached the British and American governments, but interest was limited due to the perception of the submarine as an 'underhand' weapon. He went on to design the first commercially successful paddle steamer, but never forgot his submarines. He spent all of his paddle steamer profits on building an 80 foot armoured submarine called Mute, but died before she could be launched.

During the American Civil War, the Confederate forces built an experimental submarine; the CSS Hunley. This little man-powered sub was capable of true underwater travel, but drowned several crews in training including Captain H.L. Hunley himself. Finally, the Confederate forces decided to take the Hunley into action and on February 17th 1864, the brand new Federal steam sloop USS Housatonic was attacked. The weapon used by the Hunley was a nose spar filled with 90 pounds of explosives. This was jabbed into the side of the Housatonic, a huge explosion followed and the enemy ship immediately started sinking. Unfortunately the Hunley and her crew were dragged down with the sinking Housatonic.

In 1888, the first submersible torpedo boat, Gymnote was launched in France. This vessel was powered by a combination of a petrol engine when on the surface and batteries when underwater. The French soon found that the petrol engine was not ideal for submarine operations because it gave off poisonous vapours and was inefficient in operation. In contrast, the batteries were ideal for submarine use; allowing the submarine to run underwater for extended periods of time. As well as an advanced propulsion system, Gymnote was armed with the latest in sub weapon technology; the torpedo. Designed by Robert Whitehead in 1868, the torpedo carried an explosive warhead on a steady course at a predetermined depth, making it deadly when used against surface ships.

In 1904, the French launched the Aigrette which was the first sub to be powered by a revolutionary new engine designed in Germany by Rudolf Diesel. The Diesel engine burnt oil without a spark, which meant that it did not give off the poisonous vapours of the petrol engine and was far more efficient. However the early Diesel engines were unreliable, and the French continued to use the steam engine in most of their early submarines. As the Diesel engine was improved it did gradually appear in service and was eventually used to power German submarines in 1912. ■

UNDERWATER WARFARE

World War I

At the outbreak of World War I, the submarine was still very much in its infancy.

The types of submarine operated by different countries varied widely and more than half of all the submarines in the world were still the inefficient, dangerous petrol-engined variety.

Without a doubt, the most formidable submarines of World War I were the German Unterseeboote (undersea boats), known to the Allies as 'U-boats'. It should be noted that submarines are known to sailors as 'boats' and never as 'ships'.

The first success for the U-boat came with the sinking of a British cruiser on the 5 September 1914. Shortly after this, on the 22 September, a single U-boat sank three armoured cruisers in less than a quarter of an hour. These events proved that the submarine was truly a force to be reckoned with. From now on, all cruisers were forced to operate with a destroyer escort to detect and deter U-boats. Allied ships were soon fitted with 'bulges': light casings filled with air and water compartments to absorb the impact of torpedoes.

U-boats started to make their presence felt by targeting Britain's food supply. The British fishing fleet was attacked in the North Sea, but it was in the Atlantic that the U-boats did most damage. The convoys carrying supplies from America to Britain soon started to suffer heavy losses. One of the most tragic events of World War I was the sinking of the British passenger liner Lusitania by a U-boat, resulting in the loss of 1,198 passengers and crew.

British submarines did not have as many targets as the U-boats, but still

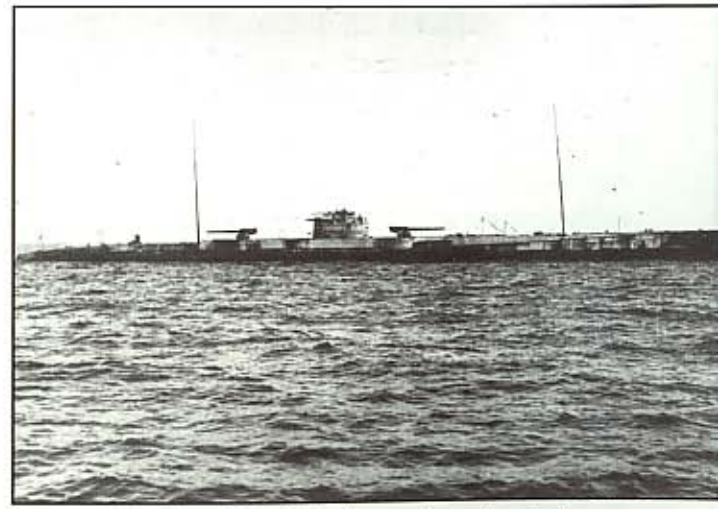
The crew of a World War I Royal Navy submarine preparing to dive.

managed to inflict heavy losses. Patrols in the North Sea sank German fishing vessels and U-boats were tracked down by British hunter-killer subs. During one raid in the Mediterranean, the ten year old British submarine B-11 penetrated five rows of mines and sank the Turkish battleship Messoudieh.

In 1916, Allied destroyers were fitted with the 'hydrophone', a device for finding the position of a U-boat from the noise made by its propellers. This device is still in use today, as 'passive sonar'. At the same time as receiving the hydrophone, Allied destroyers were issued with the first depth charges. A depth charge is basically a drum of explosive fitted with a hydrostatic valve to detonate it at a pre-set depth.

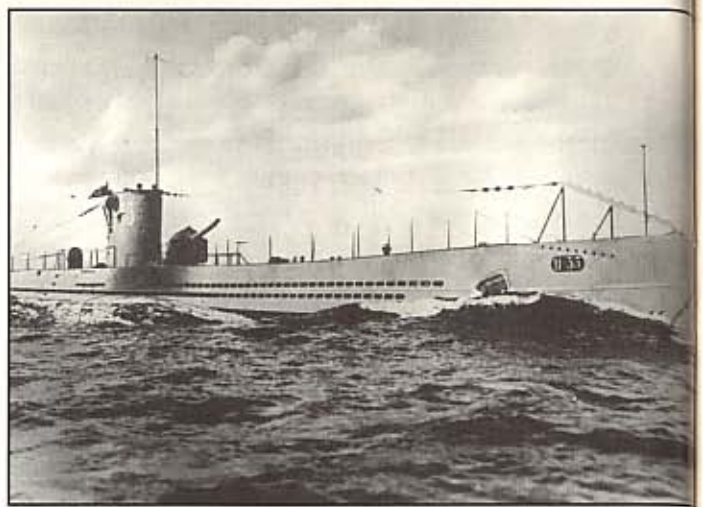
The conditions for the crews of World War I submarines were primitive when compared to the surface ships. The lack of proper ventilation led to a build-up of condensation which not only made food mouldy and bedding wet but also caused electrical system faults. The early diesel engines were dirty and unreliable and engine room crew would soon be covered in grime when working. The low power output from the batteries used in these subs meant that their underwater endurance was limited and they spent most of their time running under diesel power, on the surface.

Instead of concentrating on improving existing U-boats, Germany was working on several new designs at once; from huge 'U-cruisers' to small, quick-build 'UB-boats'. Although this led to technologically advanced subs, it also meant that less boats could be produced. The German navy was denied submarines when they most needed them. As the Allied armies advanced through Europe, the U-boats lost their bases on the French coast and their effectiveness dropped dramatically. ▸



A German Navy 'U-139' class U-Cruiser running under diesel power on the surface.

When Germany surrendered in 1918, U-boats had sunk more than 5,000 Allied ships. Although 199 U-boats had been lost, the German Navy still had 138 left. Even in these pioneering days of inefficient power sources and cramped conditions, the submarine had proved to be a formidable hunter. ■



'U-35', an early Type VII U-Boat, running on the surface.

Post-World War I

By the end of World War I, the submarine had acquired a bad reputation among the general public.

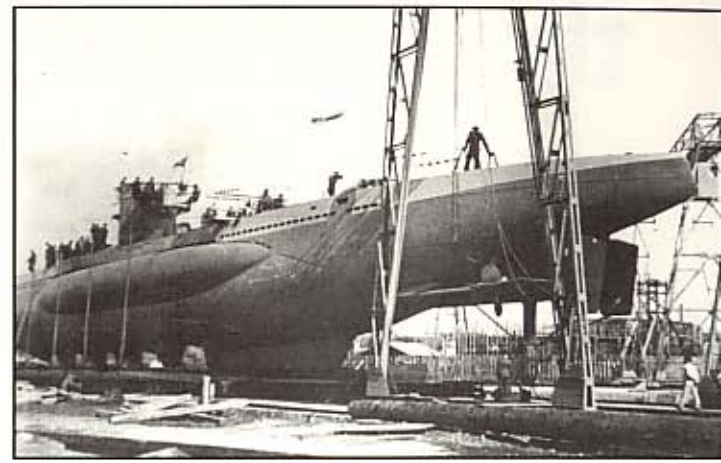
The sinking of merchant shipping was seen as morally wrong and popular sentiment was for banning submarines altogether.

In 1922, America, Britain and Japan signed the London Naval Treaty agreeing not to perform unrestricted submarine warfare on merchant ships. In the meantime, Germany was being forced to limit its armed forces to relatively low levels. German submarine research continued, however.

In 1935, the US launched the first of an advanced new type of submarine, the 'P' class. This boat had a lightweight diesel engine and a high-performance battery. This made the 'P' class faster and more manoeuvrable than other comparable submarines. An air conditioning system took care of the condensation problems which plagued earlier submarines and a Torpedo Data Computer (TDC) made torpedoes much more accurate.

In 1937, Germany launched a very powerful submarine; the type VII U-boat. The type VII had a submerged displacement of 871 tons, a maximum speed of 17 kts surfaced and 8 kts submerged and was armed with 14 torpedoes. The crew of 44 could stay at sea for 20 days, allowing the type VII to operate deep into the Atlantic from bases in France.

One of the main advances in post-World War I naval technology was SONAR (SOund Navigation And Ranging). This was a device which used sound to find the position of submarines, transmitting a loud 'ping' and listening for the echo. Sonar was deemed useful enough to be fitted to destroyers, but early models suffered by being short-ranged and easily confused. ■



A German Navy Type VII U-Boat in drydock.

World War II

By 1939, submarines were starting to evolve into very sophisticated fighting machines.

Most World War II submarines had a diesel engine for use on the surface, with an electric motor for use while submerged.

The batteries which powered the electric motor were charged from the diesel engine while the sub was on the surface. The batteries allowed the sub to travel for about an hour when submerged at maximum speed. Because of the inefficiency of early batteries, all World War II subs had a higher maximum speed when surfaced than when submerged.

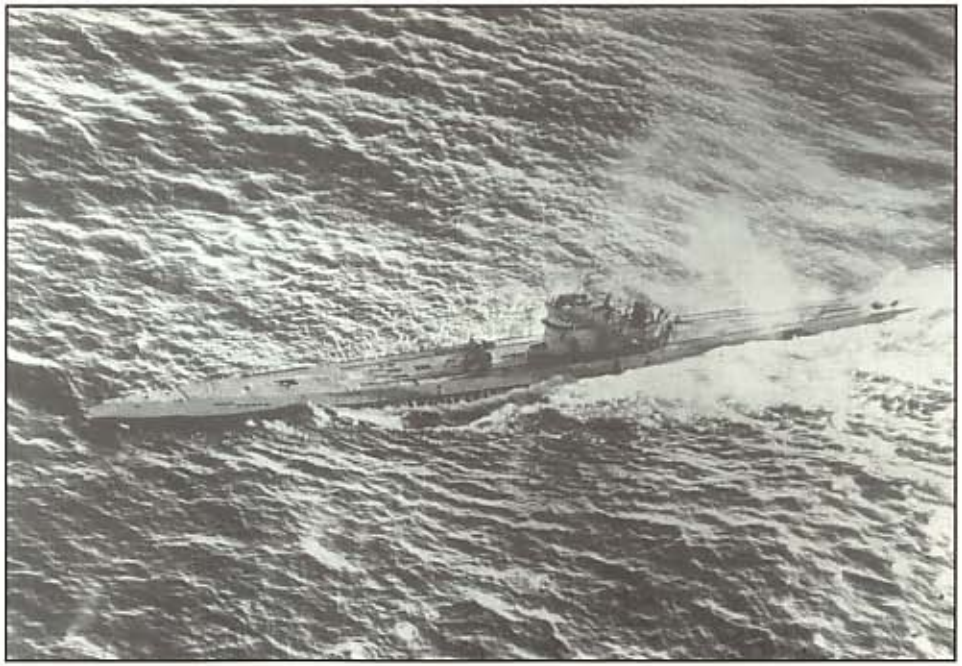
The maximum diving depth of most World War II subs was around 400 feet. In most conditions this would allow the submarine to dive below the cold water layer. Cold water, being denser, reflected the probing sonar waves of enemy sub hunters.

Early in the war, torpedoes were powered by a steam turbine. Unfortunately, the fuel burnt to produce this steam left a trail of bubbles in the wake of the torpedo, 'pointing' back to the firing submarine. Later in the war, electric torpedoes like the American Mk18 of 1944 put an end to this problem. ■

The War in the Atlantic

At the beginning of World War II the Germans had 56 submarines to Britain's 57. But while the German U-boats had thousands of freighters as targets, the British submarines could not attack German food supplies which arrived by rail, not sea.

Germany picked up where it had left off in 1918. The Atlantic was soon littered with the wreckage of Allied merchant ships, and the Allies started desperately searching for ways to counter the ever present German threat. Destroyer escorts offered some protection to the cruisers, but the first year of the Atlantic war belonged to the U-boat. Sonar was used on Allied destroyers, but was not very effective due to its limited range.



The Type IX U-Boat 'U-383' taken from an attacking RAF 'Sunderland' flying boat.

U-boats commanders perfected the tactic of operating several submarines together, in groups known as 'wolf packs'. These generally operated at night and by sharing information on the position of Allied ships the U-boats could engage many merchantmen as they passed by. As many as twenty U-boats could be in a single 'wolf pack'.

Learning from their earlier mistakes, the Germans concentrated resources on building one class of U-boat, the type VII. These subs saw extensive service initially in coastal waters, but as the pressure from Allied coastal escorts and air patrols increased they were forced to search for targets further into the Atlantic. Shore-based anti-sub aircraft from both Britain and the USA could not reach the mid-Atlantic and this region soon became known amongst Allied merchant crews as 'The Black Gap'.

The introduction of radar onto Allied destroyers in late 1940 was the first real step towards defeating the U-boats, allowing the Allies to catch them on the surface. When the U-boats dived to escape, the short-ranged Allied sonar could pinpoint the U-boat and an effective depth charge attack could be carried out.

To counter the Allied sonar, U-boats sometimes used Pillenwerfer, (pill thrower) which consisted of a perforated canister containing a chemical mixture. When Pillenwerfer was released, it would react with the water and generate a huge cloud of fine bubbles to confuse Allied sonar.

By 1941, the most experienced U-boat crews had been killed and the U-boats were ordered to change tactics. They were told to hit the destroyers first, and pick off the merchant shipping when this threat had been eliminated. The destroyers were not as easy to hit as the merchant ships, so Allied shipping losses immediately started to decline.

During World War II, British submarines joined forces with refugee submarines from all over Europe and ventured as far as Iceland and Norway in search of U-boats. Norwegian freighters carrying iron ore for Germany were raided by Allied subs but German dive bombers and mines hampered operations in these waters.

The most successful raids by British subs were in the Mediterranean Sea. German and Italian ships bound for Africa were at sea for just one or two days, and would travel in small convoys at high speed. Even with these odds stacked against them, British submarines accounted for 45% of all German ships lost in the Mediterranean.

A Royal Navy 'T' Class submarine. Fifty three of these submarines formed the backbone of the Royal Navy submarine fleet during World War II.

Throughout the war, midget submarines were used extensively by the British, Italians and Germans. "Midgets" were used to raid coastal shipping, and a notable success was the damaging of the huge German battleship Tirpitz at Asen Fjord in Norway by the British midget subs. A typical midget sub was the 15 tonne German Seehund class with 2 torpedoes, 2 crew, a maximum speed of 6 kts and a range of just 500 miles. In January 1945, several of these midget subs were operating very close to the British shore, just off Margate and in the Thames Estuary.

Meanwhile in the Atlantic, the shipyards of Britain, Canada and the USA were producing ships faster than the U-boats could sink them. The introduction of the centimetric wave radar on Allied corvettes in May 1941 gave the Allies the ability to detect the periscope of a U-boat from a great distance. Within a couple of years, Allied anti-sub aircraft were using radar to detect U-boats and were even carrying out attacks at night.

The U-boats started using a new weapon in 1943; the acoustic homing torpedo. This weapon accounted for several Allied ships, until the Allies realised what was happening and bought 'Kangol' petrol-driven hammers and fitted them to floats, towing them behind their ships. The stronger acoustic signal from the hammer attracted the torpedo and it detonated harmlessly, far away from its intended target.

German Navy 'Seehund' midget subs at their base in occupied Europe.

The Allies were still having problems with their sonar systems. They were finding that a slight disturbance in the sea would dramatically reduce the effectiveness of their sonar. This meant that, due to the waves to the side and rear of a destroyer, sonar was only effective when the destroyer was facing a U-boat. The Allies decided to put sonar onto buoys, floating still in the water, in 1944. This device would radio the position of submerged vessels back to Allied destroyers or anti-sub aircraft. Depth charges could then be placed with deadly accuracy. The sonar buoy came to be known as the 'sonobuoy' and is still in use today.

In 1944, Allied radar forced U-boats to start using a device called a Schnorkel. This allowed them to run their diesel engines while submerged at periscope depth. The Schnorkel was basically a pipe, similar to the 'Snorkel' used by divers, but with the addition of a valve to close off the pipe when it went under the water.

Towards the end of the war, U-boats were fitted with the formidable Schnee-Orgel 10-tube torpedo launcher, which sent a heavy battery of torpedoes at the target. This was highly effective when it was used, but the system did not come into widespread use before the end of the war.

The ultimate U-boat was the type XXI, which implemented all the lessons learned from early U-boats. The improvements included a streamlined hull, improved battery power output, a Schnorkel and a rapid-reloading system for the torpedoes.

U2511, the first type XXI U-boat, was launched in 1945, one week before the German surrender. It went on to evade several sub hunting vessels and made an undetected dummy attack on a British cruiser before surrendering. The history books were closed for the U-boat, but the type XXI heavily influenced the design of all future submarines. ■

The Type IXC U-Boat 'U505' being boarded by a party from the USS Guadalcanal. This submarine is now on public display in Chicago.

The Pacific War

The Japanese attack on Pearl Harbor, Hawaii on December 7 1941 marked the outbreak of the war in the Pacific. The submarine was to be one of the most important weapons of this war.

It was involved right at the start when the Japanese sent five midget submarines to Pearl Harbor, to attack any survivors of the air raid. Even though they managed to penetrate some harbour defences, all five midgets were destroyed and no more US ships were attacked.

The Japanese had more than just midget subs, however. The main Japanese submarines were known to the Allies as 'I-boats', and their design was heavily influenced by the German U-cruisers of World War I. The Japanese even built a submarine which displaced 5000 tons and could operate 3 seaplanes from its deck. Heavily armoured, it was not a practical vessel because it was slow to dive and clumsy to handle.

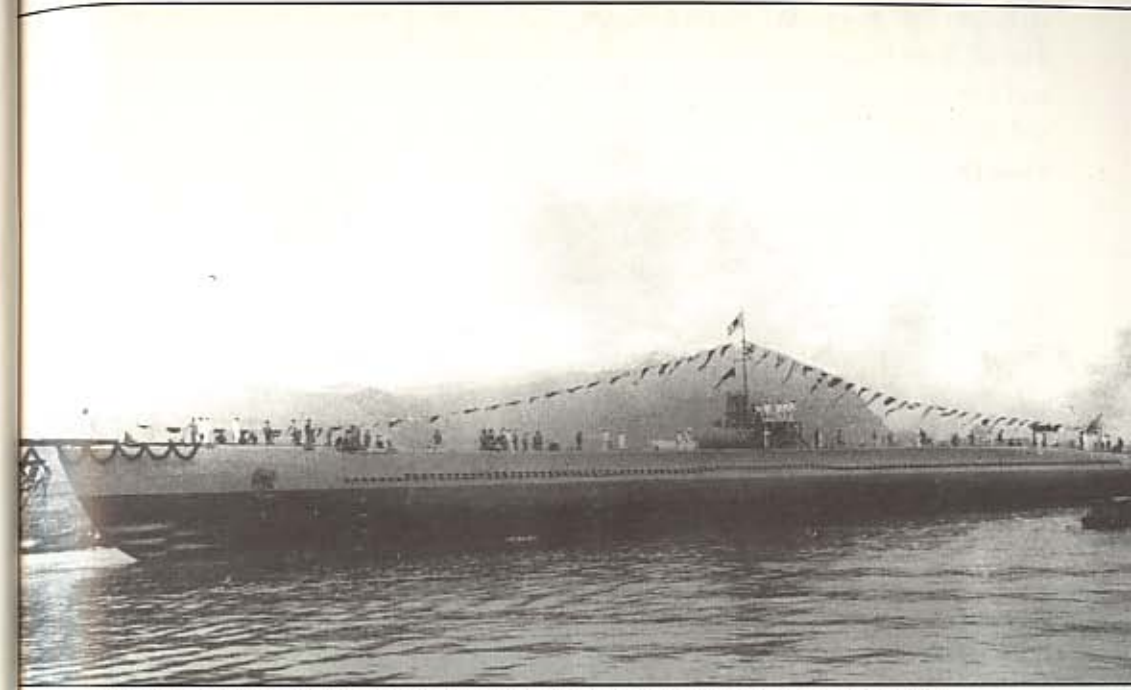
While Japanese submarines did manage to sink a number of US carriers they were not used as effectively as the British submarines in the Atlantic. The Japanese tended to use their subs defensively, keeping them close to surface vessels and never fully exploiting their offensive potential.

The Americans were learning from the Atlantic war, and US Navy submarines in the Pacific borrowed German tactics. US subs experimented with 'wolf packs' and eventually settled on using three boat 'wolf packs'. As well as simply attacking ships, American subs also shadowed the main Japanese battle fleets, reporting their movements to other US forces.

When US submarines attacked a Japanese convoy, they would target the larger cargo vessels first and dive to escape the inevitable depth charges which followed. This was the same tactic as that used by the U-boats during the first years of the Atlantic war. It was very effective against the Japanese supply lines.

In 1941 the first Gato class submarine was launched. The Gato class was the basis for all other US fleet subs built during World War II. This meant that American shipyards were able to concentrate on refining this design throughout the war. The Gato class subs were 50% bigger than their British equivalent, the 'T' class, because the US submarines had to be larger for long Pacific patrols.

The Gato class had a submerged displacement



The Japanese I-Boat 'I-17' during its launching ceremony at Yokosuka on the 19th July 1939.

of 2415 tons, a maximum speed of 20 kts surfaced and 10 kts submerged and was armed with 24 torpedoes. The crew of 80 could stay at sea for 60 days before the Gato needed to be refuelled.

November 1942 saw the introduction of surface radar into US Navy submarines. Radar supplemented the existing sonar and visual sighting techniques, allowing a sub to track enemy shipping from afar. The first radar fitted to US submarines had a maximum range of just over 9 miles, allowing it to be used well beyond visual range during day or night. The Japanese forces did not install radar until July 1944, but by then it was too late.

The Pacific war was not without problems for American submarines. The main problem was not with their excellent Gato class subs, but with their torpedoes. The US Navy had developed the steam powered Mk14 torpedo with a magnetic proximity detonator, designed to explode beneath a ship and break its keel. In service, however, the Mk14 was found to be highly unreliable.

Eventually, in 1943, it was found that torpedoes which were striking the sides of enemy vessels at angles were detonating, whilst those hitting

'straight on' were not. The US Navy investigated and found a design flaw with the contact exploder, which was actually being damaged when the torpedo hit the target vessel, preventing the torpedo from detonating. Once this design fault had been corrected, the Mk14 was found to be highly effective. The Mk14 was used throughout the rest of the war and was even used by many sub captains in preference to the electric (but slower) Mk18 of 1944.

In 1944, the US Navy in the Pacific was ordered to destroy Japan's war-making capability. Now, when US submarines sighted a convoy they targeted the destroyers first. As well as cargo vessels, US Navy subs began to sink some of the most powerful ships in the Japanese Navy, including the 30,000 ton aircraft carrier Shokaku, in June 1944.

Desperate at the failure of their submarines, the Japanese modified their midget subs into Kaiten one man suicide subs. This machine was not successful against US shipping because it lacked long-range detection gear and had a very low performance. The design of the Kaiten could not be improved for the simple reason that its crew could not return to say what had gone wrong.

Towards the end of 1944, the USS Archerfish was on patrol just off Tokyo Bay. For 29 days she found nothing, then one night in November an enormous radar contact appeared on her screens. Archerfish gave chase. The radar contact turned out to be the last hope of the Japanese Fleet Air Arm, the 59,000 ton super carrier Shinano. She had just been launched and was on her way to be fitted with catapults and planes. Archerfish was moving much slower than the Japanese carrier, but her Captain hoped Shinano would change course. After 3 hours of high speed pursuit she did. Archerfish cut in ahead of Shinano, dived and fired 6 torpedoes. Every torpedo struck home but the huge Shinano still took seven hours to sink. Shinano was both the largest warship ever sunk by a submarine and the youngest; downed before a single aircraft had flown from her deck.

Persistent attacks by US submarines, minelaying aircraft and fast carrier attack forces eventually wiped out the Japanese naval air arm. Once Japanese fighter cover had been eliminated, US bombers could attack the remnants of the Japanese fleet, but even with its armed forces in tatters, the Japanese kept on fighting. The nuclear bombs unleashed on Hiroshima and Nagasaki on 6th and 9th of August 1945 marked the end of World War II and the beginning of a new era. ■

THE FIRST POST-WAR SUBMARINES

During the post-war years, Germany and Japan were prevented from producing military hardware. This left the USA, France, Britain and the USSR as the only nations developing new submarines.

In 1948 the US initiated the Greater Underwater Propulsive Power (GUPPY) program. This updated current US Navy submarines with the latest developments from such vessels as the type XXI U-boat. The GUPPY modifications kept the diesels of the 40's in service for the next 30 years.

The post-war movement towards streamlined hulls started to make submarines capable of higher speeds when submerged than when surfaced. All that was needed now was a power source which could be used underwater for extended periods of time. ■

THE FIRST NUCLEAR SUBMARINES

The diesel engine was not ideal for use in submarines. Surfacing to recharge batteries meant that a diesel sub gave away its position frequently. What was needed was an engine which did not breathe air at all.

Germany experimented with a hydrogen-peroxide engine during World War II, and the US and Britain continued with this research after the war. The hydrogen-peroxide engine did not need to breathe air, but the results from sea trials were not satisfactory. It was considered to be too dangerous, costly and inefficient to be used in service, so work began in the USA on an alternative.

The developments in atomic theory led the US Navy to concentrate their research on making a nuclear fission reactor. To run a naval vessel from this it was proposed to use the heat from the nuclear reactor to boil water to generate steam. This steam would then be passed through a series of turbines which would drive the vessel's propellers.

Work began on designing a submarine which would use this new powerplant. It needed to be fairly large, not only because the reactor was large, but also because the reactor needed to be fitted with a series of thick lead plates to shield the crew from the effects of radiation.

In January 1954, the USA launched the world's first nuclear submarine, the USS Nautilus, named in recognition of both a distinguished sub of World War II and the fictional Nautilus from Jules Verne's visionary novel 20,000 Leagues Under the Sea. In 1958 the Nautilus became the first sub to navigate under the Arctic icecap, finding its way by using an advanced new navigation device; the Ship Inertial Navigation System (SINS).

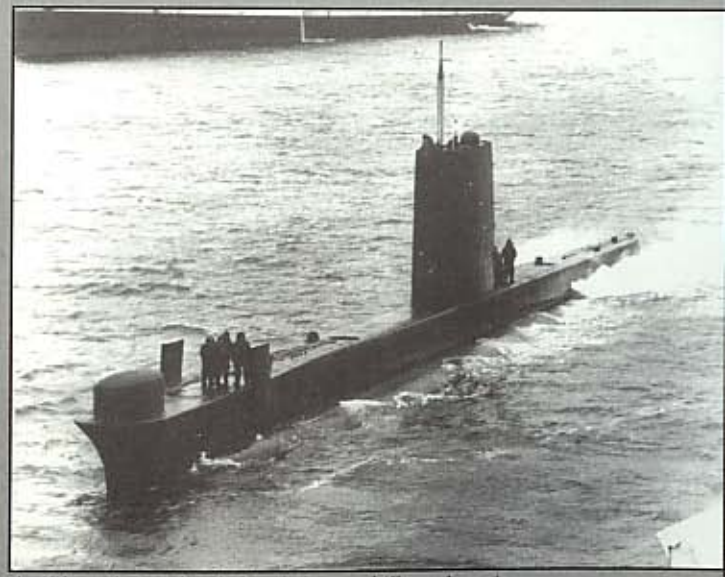
A nuclear submarine has one major advantage over conventional diesel subs: endurance. The time between refuellings for a nuclear sub is measured in terms of years instead of days. This allows a nuclear powered sub to remain hidden under the waves for a long time.

In 1959 the USS George Washington was launched. Developed as a response to the diesel powered Russian Zulu V ballistic missile sub of 1955, the George Washington was nuclear powered and carried 16 Polaris ballistic nuclear missiles. The 6,700 ton George Washington was an awesome vessel; it could stealthily cruise for long periods of time under the oceans of the world and could fire its Polaris missiles at targets up to 1200 miles away. The Polaris submarines ensured that even if a pre-emptive nuclear strike knocked out all US land based nuclear missiles, the invisible submarines would be able to inflict heavy destruction on the aggressor.

In 1960, two major submarine records were set by two very different submarines. On 23 January 1960, the tiny two-man US Navy bathyscope Trieste dived to a record depth of 35,800 ft in the Challenger Deep, off the Marianas. Also in 1960, the 8,000 ton nuclear-powered sub USS Triton retraced Magellan's route around the world, remaining submerged for the whole journey. Triton carried out this circumnavigation of the Earth (36,300 nautical miles) in 84 days, 19 hours. This event proved to the world that the future of the submarine lay with nuclear power.

The 1960's and 1970's saw refinements in the design of both strategic missile submarines and attack submarines. The changes made to attack submarines were particularly noticeable, with the deletion of the large sonar 'noses' which had become so familiar.

The appearance of American strategic missile submarines changed very little from the Benjamin Franklin class of 1962 to the Ohio class of 1981. Most US research was directed at developing new, longer ranged and more destructive nuclear missiles. In Russia, however, a highly streamlined prototype submarine was being designed using hydro-dynamic and laminar flow techniques. This was to eventually evolve into the sleek, fast Alfa class nuclear missile submarine.



An 'Oberon' class diesel-electric hunter-killer submarine. These subs served with the Royal Navy from 1960-1993.

The End of the Cold War

The 1980's saw the last period of accelerated development of the nuclear submarine, which slowed down when the Cold War came to an end in 1990.

In 1981 the US launched the 560 foot USS Ohio. Carrying 24 Trident ballistic missiles, each with 12 150 kiloton nuclear warheads, Ohio class subs were over 3 times as powerful as their predecessors, the Benjamin Franklin class.

Ohio had a submerged displacement of 18,750 tons and a maximum speed of 20 kts on the surface and 30 kts submerged. It was armed with 24 Trident ballistic nuclear missiles and 4 torpedo tubes. Ohio had an endurance of 9 years, but the 155 crew generally stayed at sea for no more than about 70 days at a time.

Ohio was not the only 560 foot submarine at sea in the 1980's, however. On 23rd September 1980, a sub was launched at Severodvinsk in the USSR which was large even by today's standards. Tipping the scales at 26,500 tons and carrying 20 multiple nuclear warhead ballistic missiles, the Typhoon class was talked about in hushed tones around the offices of the Pentagon during the early 80's. The Typhoon class also became the inspiration for a book, The Hunt for Red October, in which writer Tom Clancy foresees the silent drive units which we take for granted today. As well as the heaviest submarine of the 20th century, the Russians also built the fastest; the Alfa class.

With a titanium alloy hull and nuclear power, the 260 foot Alfa was capable of a maximum submerged speed of 45 kts. As well as travelling fast, Alfa could also dive to 2,500 feet, over twice as deep as most subs of the time.

The Royal Navy nuclear powered attack sub HMS 'Conqueror', accompanied by the frigate HMS 'Argonaut'. The 'Conqueror' became the first nuclear sub to sink an enemy vessel in action when it sank the Argentine 'General Belgrano' in 1982.

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In the field of fighter submarines, British Hydrospace have always excelled. The Tornado class heavy fighter sub continues this distinguished pedigree. Unlike other fighters, it is fitted with the EuroMil PBRS as standard, giving the Tornado the capability to strike enemies with a sledgehammer blow before they can respond.

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THE 21ST CENTURY

LD-12 loading robots in the docking bay of a modern submarine carrier.

By the end of the 20th century, Russian sub-marine technology was at least 10 years ahead of the USA. Submarines had been using active sonar absorbing surface coatings since the early 1980's, but the search was on for a way of propelling a submarine without a noisy exposed propeller. Russian scientists concentrated their research efforts on developing a practical electromagnetic drive.

An electromagnetic drive functions by taking in water, charging it with negative ions and then accelerating the charged water by using a circular electromagnet array. This high speed water is then passed out of an exhaust, propelling the submarine forwards. An electromagnetic drive has no moving parts; it is silent in operation.

The prototype electro-magnetic 'Silent Drive' unit was given its first sea trial in 2002, on a modified Russian Alfa class nuclear sub. The Alfa escaped passive sonar detection at ranges as close as 200m but had one problem; the silent drive used power at an alarming rate and the Alfa could go no faster than 25kts.

Even though the electro-magnetic drive degraded performance, the Russian navy went ahead with production of an operational silent drive sub, the Akula III class of 2004. When the Russo-American technology sharing agreement of 2005 was signed, silent drive research data was immediately made available to US scientists. Work started in the USA on finding a way of improving the power output from an electromagnetic drive.

US scientists spent two years modifying magnet power outputs and finding alternative ways of introducing negative ions into water, but to no avail. The breakthrough came when Eddy Sowleski, a talented aero propulsion engineer, proposed the ElectroMagnetic-Ducted Impeller (EMDI) drive.

The prototype EMDI drive consisted of a standard electro-magnetic drive exhausting through a tube containing a 32-blade fan. While the EMDI drive was not totally silent, tests proved that it was terrifically powerful. The design was refined and soon it was ready to be given its first sea trial.

The attack sub USS Minneapolis-Saint Paul was chosen to be fitted with the prototype EMDI drive. This sub promptly set up a new world submarine speed record of 59 kts on May 31st 2008, during the first EMDI sea trial. The first production EMDI sub, the 19,800 ton Nevada class of 2007 was also the first EMDI sub to be fitted with a variable pitch fan. By stopping the fan and rotating its blades to align with the flow through the impeller, the Nevada could run in total silence at speeds up to 21 kts. Under full EMDI power, Nevada could run safely at up to 57 kts. ■

The First Advanced Technology Submarines

As silent drive subs became more wide-spread, pioneering engineers at Legendre Sous-Marins (LSM) in France began work on a new concept in submarines. They realised that, as well as being stealthy, a submarine needs to be fast and manoeuvrable.

They established that the main cause of drag on a submarine was tur-bulence close to the surface of the hull. To get rid of this, the new sub would be coated with a very rough skin, the texture of which was inspired by the skin of sharks.

With very large dive planes for increased manoeuvrability, power from a lightweight fusion reactor linked to a standard EMDI drive and all-composite structure, the new sub promised unrivalled performance. Construction began on a prototype to test these new theories. To further emphasise the advanced design of this sub, LSM named it Nautilus.

The Nautilus was launched at Cherbourg on January 21st 2014, exactly 60 years after the USA launched their nuclear Nautilus. The new sub was as much of a revelation as its 1954 nuclear namesake and went on to raise the underwater speed record to 63 kts. More importantly, its advanced design allowed it to outmanoeuvre any torpedo then in existence.

The design of the Nautilus was used as the basis for the Requin Tigre class of 2017 which was produced in very large numbers and sold by LSM to, among others, Russia and America. ■

Corporate Wars

A number of international companies established underwater prospecting teams to gather seafloor manganese and it was not long before these companies started to undertake full-scale underwater mining. Seafloor mining complexes such as the Australian Neptune were built, housing over 300 workers, 1800 feet under the sea. During the late 2010's, the advances in underwater mining techniques were leading to some companies reaping huge benefits for relatively little outlay. This slowly led to the undersea mining companies becoming more economically powerful than any others on the planet.

In 2021, a dispute over mining territory led ConDyn International to use its security fleet of two Requin Tigre class submarines to strike a pipeline owned by the Chinese state-owned conglomerate Norinco in the South China Sea. The situation degraded into a conflict, but at the end of it all ConDyn owned the right to mine an extra 80,000 square miles of territory.

During the early part of the 21st century, the governments of the world were beginning to adopt a more tolerant attitude toward each other. War between countries was becoming rare and after the world depression of the 90's business began to flourish.

The progress of this conflict was followed closely by other mining companies. The result proved that economic success could be achieved through the use of force. Even though corporate wars were forbidden by international law, secret wars went on, especially in the poorer regions of the world where payoffs or the threat of a run on the currency had more influence.

In 2024, the Chinese government passed a ruling that all corporate wars should be registered, allowing companies to legally battle in China's territorial waters. The Chinese stated that the resolution would "protect innocent civilians by forcing corporations to follow government guidelines", but the economic pressure put on China by ConDyn International and SubAm Inc helped in pushing the resolution through.

The Chinese resolution was condemned by many of the world's governments, but over the next year severe economic pressure from several oil-producing multinationals forced these countries to follow China's lead.

Corporate wars soon became an accepted part of business life. They are less violent than the national wars of the 20th century because civilian casualties and collateral damage is rare. After all, a company which has been bled to death in a war is useless to the victor.

By 2026, the smaller companies were suffering at the hands of the tyrannical multinationals.

The establishment of the Mercenaries Union in July 2026 redressed the balance and ensured that any company had access to an effective defence force. Mercenary pilots now make up over 60% of the world's corporate defence sub crews. ■

THE DEVELOPMENT OF THE FIGHTER SUBMARINE

In 2025 the first true fighter sub, the Eagle was launched. It was similar in appearance to the Requin Tigre class, but while the French sub was designed for government forces, Eagle was purely for corporate defence units. This meant that Eagle weighed just 324 tons compared to the 1225 ton Requin Tigre. The Eagle was also fitted with the latest sensor systems to enable it to carry out a complete engagement of the enemy with total stealth. Information gleaned from these sensors was projected within the two-crew cockpit using a 3-D projection system taken straight out of a flight simulator.

Within a month of its launch, it had set an underwater speed record of 68 kts and had the manoeuvrability to match. Eagle was soon being sold to mercenary pilots, and was even adopted by some government forces.

Due to the cramped cockpit of the Eagle, it was unsuitable for long journeys. Modified transport ships were soon in widespread use as a base for several Eagle class fighters. During the Gulf War of 2028-29, however, all the sub carrier ships in the region were targeted and sunk in the first hour of the war. Warfare had grown too sophisticated for surface vessels to survive. The Eagle continued to be used for short-range defence work, but it lacked the endurance to be used as an effective weapon. ■

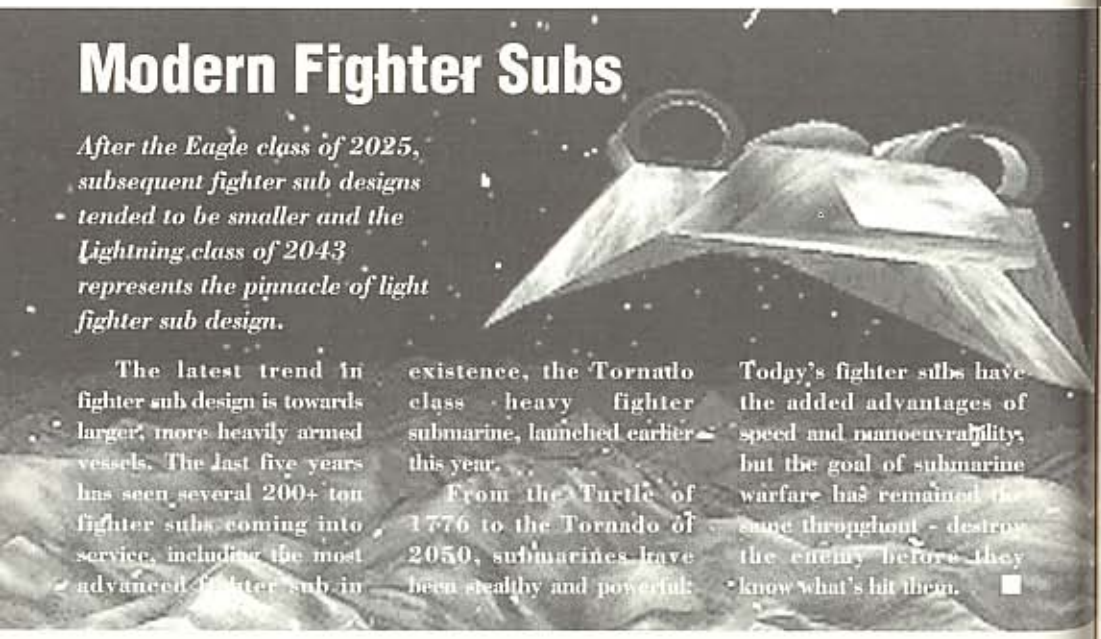
The First Sub Carriers

SubAm Inc, who had the largest underwater mining operation in the world, was finding that their sub carrier ships were poor operating platforms for such a potentially effective sabotage weapon. In 2032, they started work on a very ambitious project: the construction of a submarine which would carry fighter subs into action. By 2038, the project had taken SubAm to the brink of bankruptcy but, just as the company was selling off their last mine, the orders began to flood in for the new vessel. SubAm were catapulted to the forefront of sub manufacture, and have not looked back. Today, they offer a complete range of subs including the fastest production sub in the world.

The launch of the first 60,000 ton Enterprise class sub carrier took place on October 1 2039, heralding a new era in submarine warfare. Capable of carrying up to 6 Eagle class fighter subs, it could take them to trouble spots anywhere in the world and operate them indefinitely. As well as the fighter subs, Enterprise carried an arsenal of 20 cruise missiles, making it a complete offensive weapons system.

Upgrades to the Enterprise class now allow it to operate ten fighter submarines and even though the Tsunami class has stolen some sales from SubAm, the Enterprise is still the world's most popular submarine carrier. The Enterprise has only one fault - the price tag of $2360 million puts it out of reach of all but the very richest buyers. ■

Modern Fighter Subs

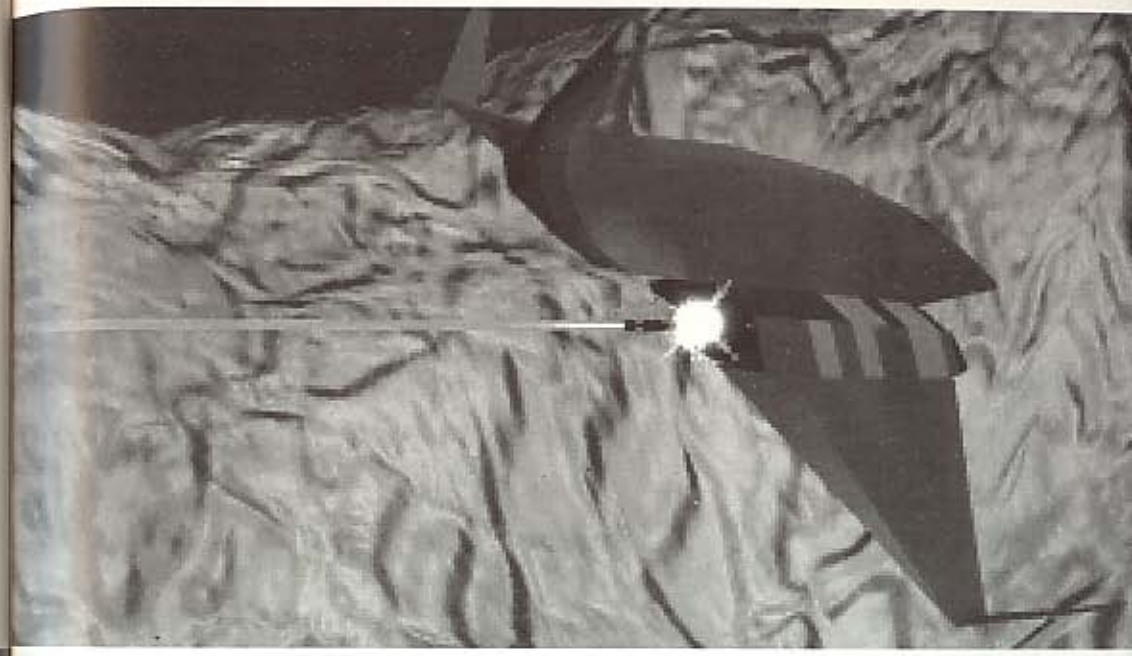


After the Eagle class of 2025, subsequent fighter sub designs tended to be smaller and the Lightning class of 2043 represents the pinnacle of light fighter sub design.

The latest trend in fighter sub design is towards larger, more heavily armed vessels. The last five years has seen several 200+ ton fighter subs coming into service, including the most advanced fighter sub in existence, the Tornado class heavy fighter submarine, launched earlier this year.

From the Turtle of 1776 to the Tornado of 2050, submarines have been stealthy and powerful. Today's fighter subs have the added advantages of speed and manoeuvrability, but the goal of submarine warfare has remained the same throughout - destroy the enemy before they know what's hit them. ■

STRIKE FAST



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ONE DAY

..... on board the

In the second of our 'One Day' series, we look at a typical day in the life of Captain Roberto Deladra, a fighter sub pilot on the Enterprise class sub carrier Verona, operated by Milaro Inc.

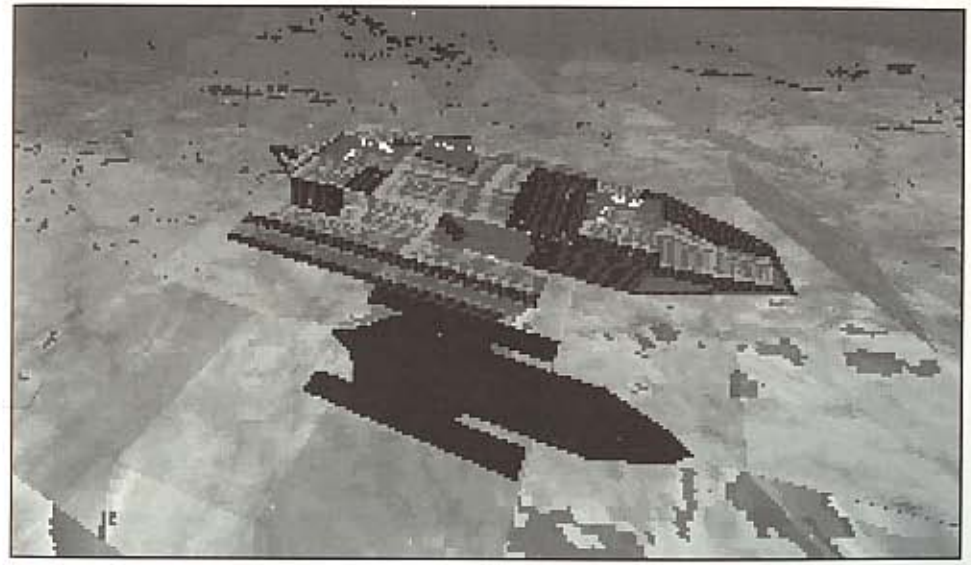
"Milaro, as one of the largest companies in Italy, have been forced to operate Submarine Carriers to protect our marine facilities against attack from hostile companies. Our two American built Enterprise class sub carriers are equipped with a wide variety of weapons to deter any aggressor.

Our main armament consists of ten Italian-made Aquila class fighter subs, which are comfortable and handle beautifully. I was one of a team of Italian pilots who evaluated the American Lightning class back in 2046 and even though the American sub is faster, I prefer the Aquila.

The Verona normally patrols the ocean on its own. The Roma, our sister ship, will usually be at port while we are at sea, but she may be called to assist us in time of emergency.

ONE DAY

Sub Carrier Verona



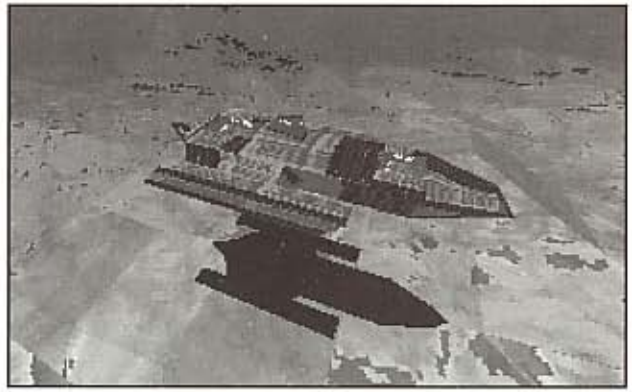
A sonar visualisation of Verona at 3600 feet taken from Captain Deladra's Aquila.

My day begins with the gentle sound of classical music, normally Vivaldi, from my alarm, the lights in my quarters slowly get brighter and soon I am awake. The time I get up is governed by when I last slept. Shifts run 14 hours on and 10 hours off and are organised so that Verona always has qualified personnel at every battle station.

After washing and dressing, I leave my spacious and comfortable quarters to get some breakfast. The canteen is well equipped, but serves fish far too often. When I am at sea, I prefer to stick to eating vege-meat with pasta, rather than fish. ➡

ONE DAY

...on board the Sub Carrier Verona



➨ When I come on duty, I report to the briefing room for updates on the tactical situation. How I spend the rest of the day is determined by this briefing:-

If there is no threat, I will either spend the time sorting out any crew problems in my role as an officer, or I might be scheduled to take an Aquila out for a training mission. Most of my non-combat time is spent in the crew room, where we have the finest entertainment systems available today. As well as holographic TV, we have the latest interactive video systems. The software from an Aquila simulator is linked to the interactive video /holo TV, and this gets a lot of use from the pilots.

If we are in a time of tension, I may have to crew one of two 'Ready Alert' subs, fully armed and ready to launch within 90 seconds of receiving the call. Strapped in for 5 hours at a time, the cosy cockpit of the Aquila is essential for Ready Alert duties.

If we are in a full scale battle, I will brief and fly missions with both corporate and mercenary fighter crews. During battle operations over my last two years with Milaro, I have claimed six enemy subs including two fighter subs.

I come off duty after 14 hours of operations. I might catch a movie in the cinema, go to the swimming pool or even go for a walk around the 3 miles of corridors on the Verona before retiring to my quarters and going to sleep.

The pay as a Milaro fighter sub crewman is pretty good. I earn as much as a senior executive, but of course I am frequently in very dangerous situations, so it is not unreasonable to expect a decent salary. Mercenary fighters can earn even more, but it's a tough life. For us, a conflict may last a week or two and we've never been involved in more than two a year. The freelance guys are almost always at war and I haven't met a mere who's survived the business more than a couple of years.

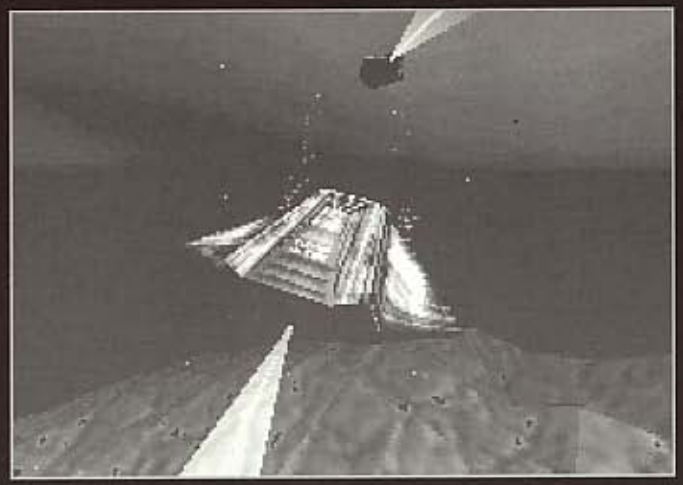
Overall, working as a fighter sub pilot is rewarding, well paid and can be very demanding. I know that I could never return to a desk job, but it doesn't matter. Even if my contract with Milaro is terminated I know there's plenty of work available for me as an experienced fighter sub pilot."

Our thanks to Captain Deladra and Milaro for their help in the preparation of this article. ■

In August's UnderCurrents...
ONE DAY on the 1200-ton Russian sub-Arctic prospecting vehicle Novoselov.

The Verona returns to its home port of Naples at the end of a 3 month cruise.

THE BEST JUST GOT BETTER



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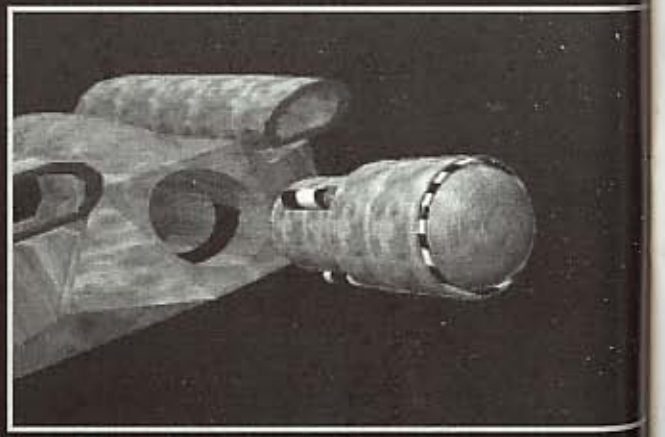

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