



MARCONI
UNDERWATER SYSTEMS

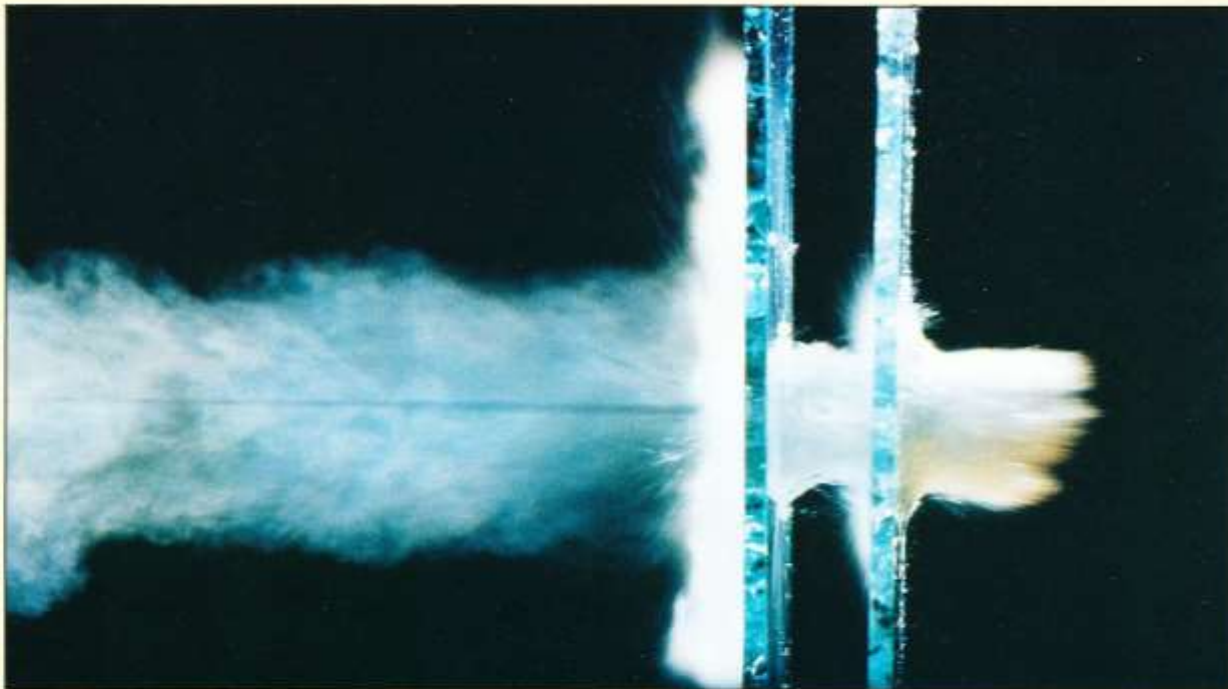
Courtesy Marconi Instruments Heritage



MARCONI

UNDERWATER SYSTEMS

**AN INTRODUCTION TO
ADVANCED UNDERWATER
GUIDED WEAPON SYSTEMS**





INTRODUCTION

Ensuring command of the sea has always been the major challenge for Naval Planners; it's a challenge that Marconi Underwater Systems Limited (MUSL) can help them to meet. MUSL designs and manufactures guided underwater weapons and is committed to researching new weapon systems and underwater sensors to counter evolving maritime strategies.

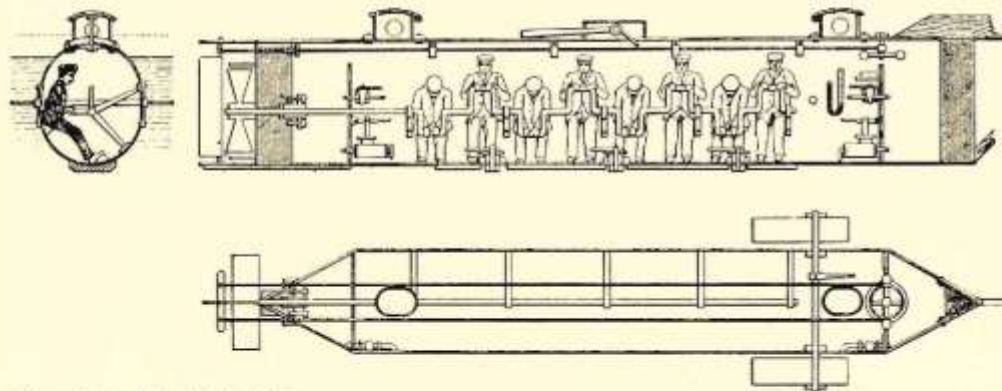
The Company is part of the GEC-Marconi Group and has a close relationship with the British Government as a prime contractor to the Royal Navy.

MUSL are also applying their unrivalled understanding of underwater technology to the development of underwater countermeasures, remote controlled vehicles, and the design of coastal defence systems.

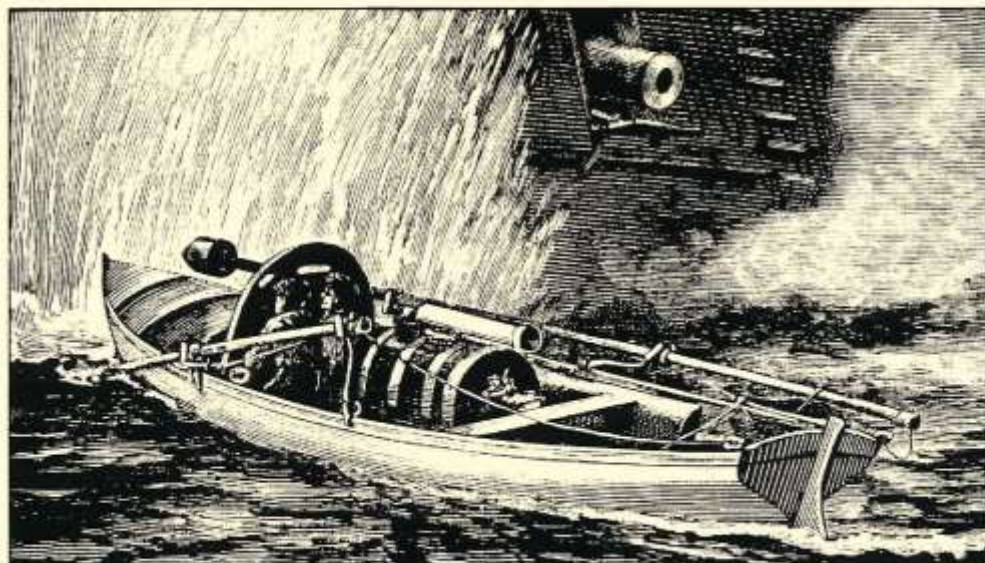


UNDERWATER WARFARE

In 1864 the Confederate ship Hunley, armed with a rudimentary spar torpedo, slipped into Charleston and became the first semi-submersible to sink an enemy vessel – the USS Housatonic. Maritime warfare would never be the same again.

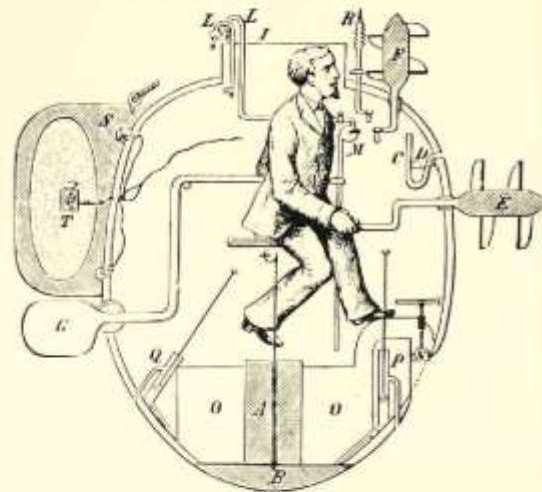


A spar torpedo boat attacking a battleship, circa 1877.



The credit for the first successful fully automobile torpedo goes to Robert Whitehead, who developed a hydrostatic valve which enabled his torpedoes to run at a constant depth. Then the development of the gyroscope in 1895 made torpedoes much more accurate and, more importantly, reliable. Later during the First World War torpedoes were to play an important part in Germany's submarine blockade of Britain. In the Second World War in 1943 came the forerunner of today's more sophisticated torpedoes – the T5 Zaukoenig torpedo which homed in on the propellor noise of its target vessel.

The semi-submersible Confederate ship 'Hunley'.



Bushnell's 'Turtle'. This remarkable submarine once sank a ship by using the woodscrew mechanism to fix an explosive charge, circa 1775.

The mine owes its origins to Fulton. As early as 1812 Fulton was proposing moored mines using gunpowder with a flintlock firing mechanism. During the First World War mines were used extensively, in fact the Great North Sea Barrage remains probably the largest minefield ever laid.

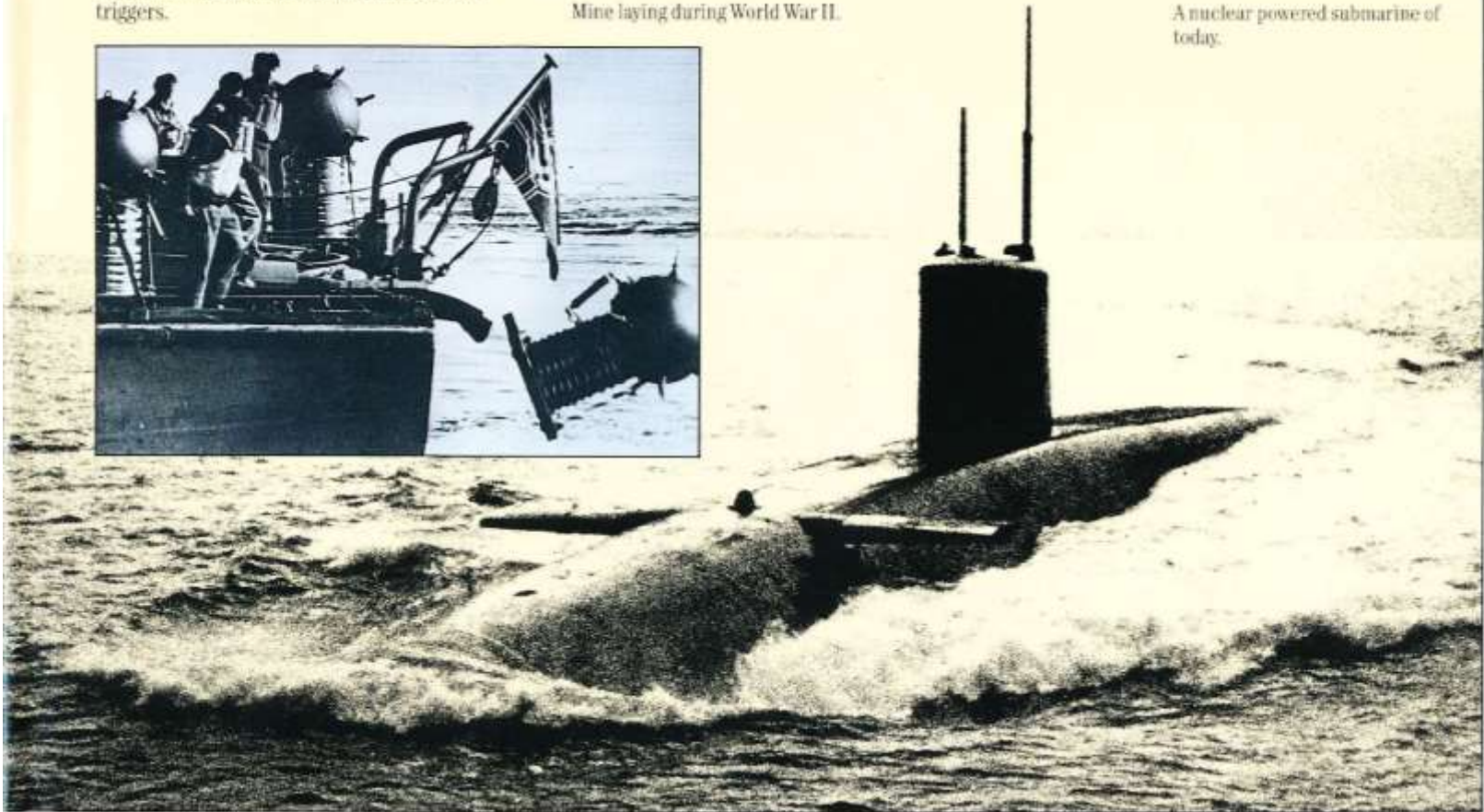
Throughout the Second World War the mine continued to develop. Mines changed from being simple induction triggered devices, through magnetic induction, to acoustic and pressure triggers.

Underwater weapons now play a vital role in Naval Strategy, and the 'intelligent' mines and torpedoes of today are far removed from the designs of Fulton and Whitehead.

Mine laying during World War II.



A nuclear powered submarine of today.



THE OCEAN SPACE

In the ocean immense pressures, abrupt temperature changes and the density of water, as compared with air, make much of man's technology inapplicable. Visibility is severely limited and sometimes non-existent, and man must make the adjustment from receiving information at the speed of light, to receiving data at the slower speed of waterborne acoustics.

The Ocean Space demands a new technology. It's technology in which MUSL excel. By collating thousands of hours of trials data and close liaison with both the Oceanographic Analysis Division of the US navy and their Royal Navy counterparts, MUSL have developed a unique understanding of the underwater 'climate'.

Rain

Wherever the sea meets the land the Ocean space is affected by the climate of the land.

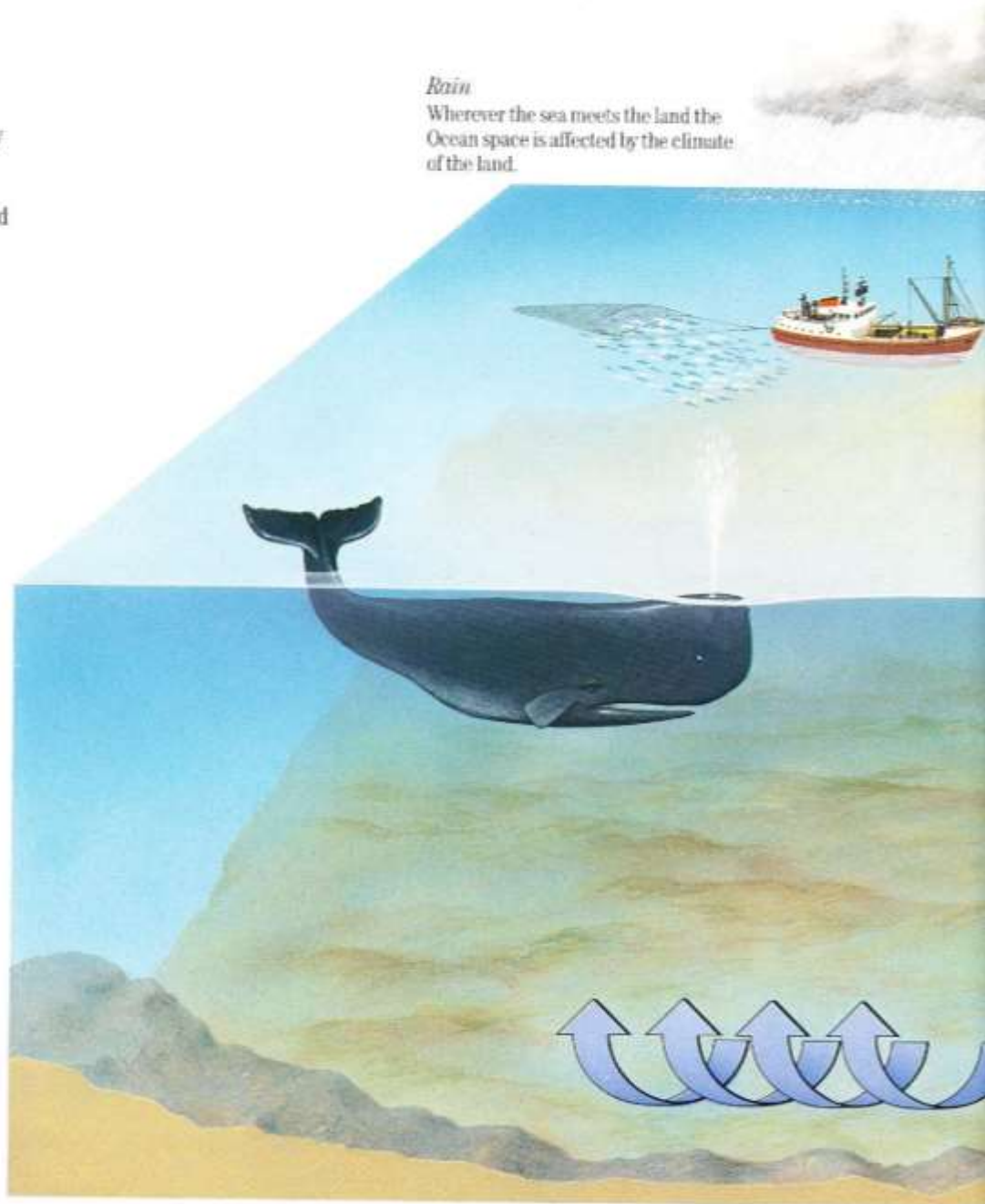
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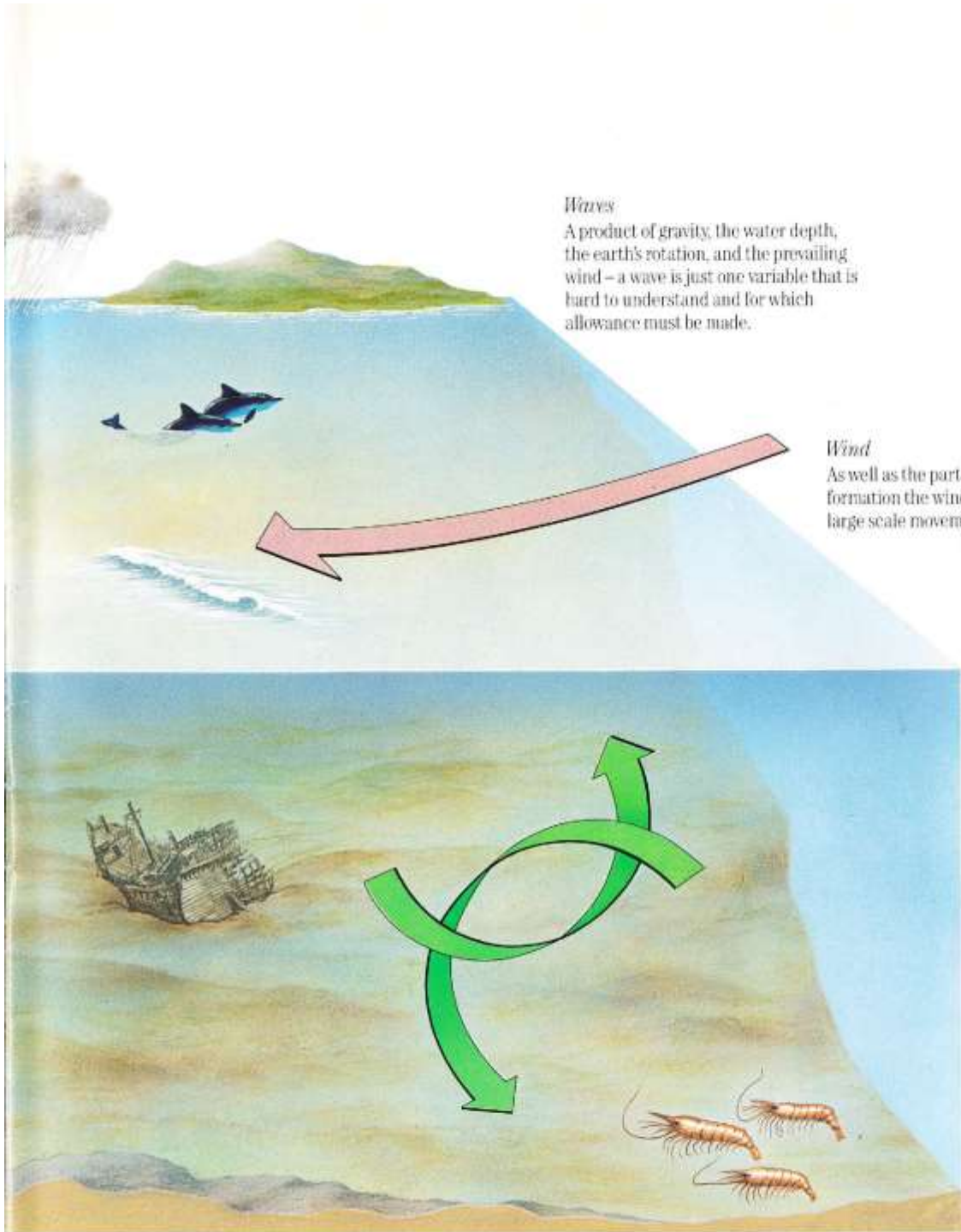
Water Density

The water density depends on depth, mineral content and particularly temperature. The close proximity of bands of water at different densities makes for an ever changing acoustic picture.

Undersea Topography

The Ocean Space has its own mountains and valleys, all of which must be interpreted and recognised.





Waves

A product of gravity, the water depth, the earth's rotation, and the prevailing wind – a wave is just one variable that is hard to understand and for which allowance must be made.

Wind

As well as the part it plays in wave formation the wind contributes to the large scale movement of water masses.

Temperature gradients

There are steep temperature gradients to be found in the Ocean Space. These usually occur at the meeting place of two currents of different temperatures. They affect density and density affects sonar.

Noise

The sea is a very busy place, it is full of creatures whose contribution to the background noise makes the sonar picture even more complex.

PRODUCT PROFILE

Tigerfish

The Mk24 MOD 1 Tigerfish torpedo is a submarine launched heavyweight torpedo designed to meet the requirements of the Royal Navy. Tigerfish is a wire-guided, acoustic homing anti-submarine and anti-surface ship torpedo; it has the distinction of being the quietest long range torpedo in the world.

In the initial stages of its attack Tigerfish is wire-guided; this means that the weapon can be accurately positioned by its operator for the final attack phase. A comprehensive trials programme has ensured that Tigerfish offers reliability, ease of preparation and simple maintenance. Tigerfish is compatible with most submarine weapon systems, but some may require some simple interface modification.

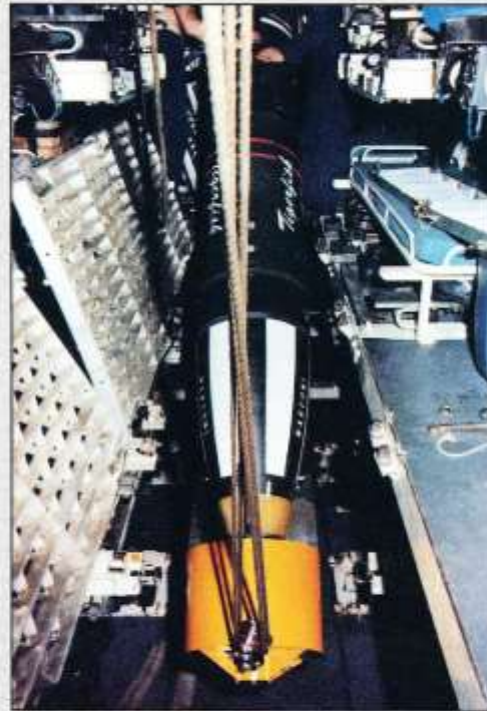


Homing

The torpedo first acquires the target with its integral acoustic head and then uses its computer to home in accurately.

Fuze and Warhead

Tigerfish has both an inertia-impact fuze and an all round proximity fuze. Several safety devices are fitted to protect the firing submarine and friendly surface vessels.



Re-arming a Royal Navy submarine with Mk 24 Tigerfish torpedoes.

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Lost contacts

Computer controlled lost contact procedures enable the weapon to regain contact with the target.

Guidance

The wire guidance system enables a continuous flow of information to the torpedo, thus providing the weapon with the most up-to-date fire control solutions as it enters its final attack phase.

PRODUCT PROFILE

Sting Ray



Sting Ray is the first torpedo with its own on-board computer – a computer that makes Sting Ray a 'fire and forget' weapon.

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Once launched Sting Ray's computer searches for and locks onto its target, while an advanced computer programme enables it to consistently reject target released counter-measures.

Extensive systems and software expertise validated by numerous in water trials give Sting Ray an intelligence second to none. Sting Ray offers a potent anti-submarine capability in a wide variety of scenarios and throughout the entire environmental envelope. The weapon can be launched by maritime patrol aircraft, helicopters, sea or land bases, and all surface vessels from frigates (or even larger ships) to small coastal patrol craft.

Endurance

Sting Ray offers unusual endurance and can pull out from launch in shallow water adding to its versatility.

Agility

Sting Ray is remarkably agile and has a fast turning capability. This means it can search larger areas faster, and outmatch any evasive actions of the target.



Profile

Sting Ray also has a specially designed warhead giving it the best possible profile and providing a directional explosion to focus the energy of the warhead.

Intelligence

Sting Ray's on-board computer enables it to skim the seabed, and make tactical decisions including predicting the target's future position.

Kingfisher

Sting Ray being launched from the Kingfisher launcher system.



Versatility

Sting Ray's versatile computer can readily be updated, enabling it to combat developments in torpedo counter-measures.

Kingfisher provides a simple to use and simple to install bolt-on launching system for the Sting Ray torpedo. It enables small craft to take on a Kingfisher launcher pre-loaded with a Sting Ray torpedo at the dockside, and simply plug it into the vessel's fire control system to make it fully operational.

Kingfisher gives a real anti-submarine capability to even the smallest craft, and further development will make Kingfisher available to shore-based installations.

PRODUCT PROFILE

Spearfish

Spearfish is the world's most advanced heavyweight wire-guided torpedo, and will come into service with the Royal Navy towards the end of the 1980s.

12 Spearfish incorporates the latest computer technology and is programmable both on the dockside and on board ship; it draws on the experience MUSL has gained from the successful Sting Ray project.

Spearfish's high degree of autonomous intelligence means that it is highly effective even in the presence of target released counter measures. This high degree of on-board capability reduces the demands made on the submarine operator and increases the probability of success.



Warhead

The warhead's sensors can be attuned to specific target signatures.

Autonomous

Spearfish is pre-programmed before launch and can be fully autonomous in use, although the operator has always the option of control through the wire guidance system.



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Speed

Spearfish has a proven open cycle thermal engine giving it sprint speeds of up to ■ knots and a range in excess of ■ km.

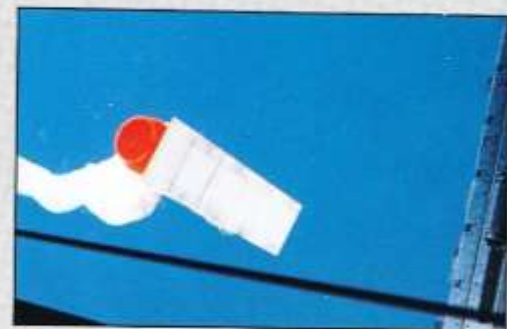
Stealth

Spearfish is very quiet, a telling advantage when attacking both surface and submarine targets.

PRODUCT PROFILE

Stonefish is an intelligent mine that combines all the advantages of a modern microprocessor and microelectronic technology with a modular design. The electronic module contains its own microprocessor for control of the mine and target assessment, and can be linked to either one, or a pair, of two different sized explosive charges – 100kg and 300 kg – this means that Stonefish can be made up to the following weights 100, 200, 300, 400, or 600 kgs to cope with any variety of water depth and target.

Stonefish discriminates too. With MUSL's command of computer software Stonefish can be programmed to compare the data signal of the potential target with the readout from its three different sensors – acoustic, magnetic and pressure – and only to explode when all criteria are met. Because of its 533 mm diameter, Stonefish can be laid by submarines on covert operations.



Microprocessor

Before laying, the Stonefish is pre-set with operational data including target information and the time at which it must become operational. It then self-adjusts to its environmental background to achieve optimum performance.

Intelligent

Multiple sensors mean that even a target with a low magnetic signature will not escape.



Stonefish is also easily deployed from ships, submarines and Hercules C130 transport aircraft. Even merchant ships would need only minor modification to make them suitable for mine-laying.

Life

Stonefish has a shelf life of 20 years and a life in the water of 700 days.

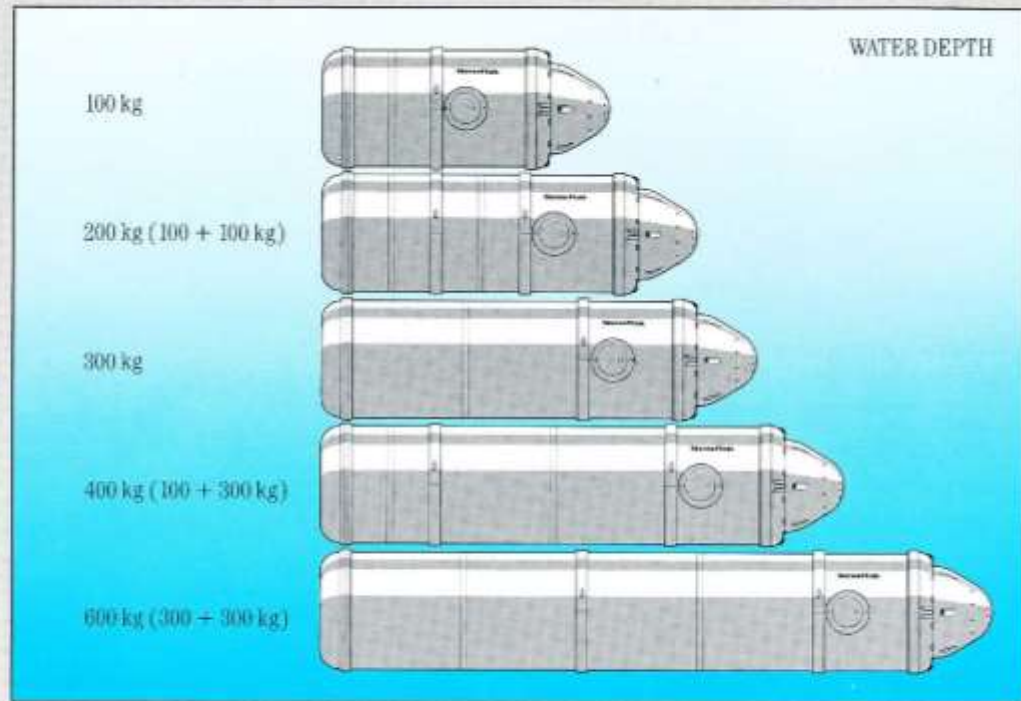
Hidden

As it has a low acoustic signature and because it employs three sensors and an on-board computer, Stonefish is virtually immune to counter-measures.

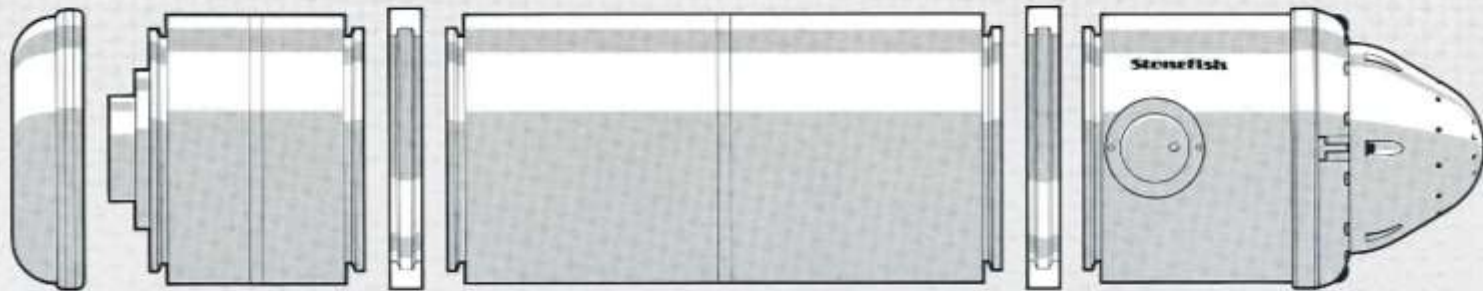
Stonefish

Commonality

Training and exercise variants are available which share common components with the warshot. This commonality ensures cost effectiveness, operational realism and flexibility of use while minimising stockholdings.



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Nose Cap

100kg warhead module

Coupling

300kg warhead module

Coupling

Electronics module

PRODUCT PROFILE

Minnow

The Minnow is a newly developed remote control mine countermeasure vehicle. It is controlled by an umbilical cable and is highly responsive. This manoeuvrability enables it to seek out and identify targets and position destructive charges much more accurately than was possible before.

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Minnow's ability to place the charge accurately means a compact charge can be employed, simplifying ship magazine requirements and reducing costs. In addition, by carrying more than one charge, Minnow can attack more than one target before it must be recovered and re-armed.

Minnow is kept in a housing whilst on board ship, and this whole housing is lowered into the water to launch the vehicle. This gives the submersible extra protection during raising and launching. Minnow and its launch and control equipment can be containerised. This means that as well as its standard role as equipment on a conventional mine counter-measure vehicle, the Minnow and container can act as a 'bolt-on' facility for any 'ship of opportunity'.



Sensors

Minnow has a high-resolution scanning sonar, a low-light video camera and full instrumentation available to the operator by means of the umbilical cable.



Charges

Minnow can deploy compact charges with great precision even to the extent of attaching them to the tether cable of moored mines. Charges are detonated from the surface ship by means of a coded acoustic signal.

Propulsion

Minnow is small because it has no on-board batteries, and so is lighter and more manoeuvrable. It is propelled by four variable pitch propellers.

TACTICAL FLEXIBILITY

The Heavyweight Torpedoes

Secrecy is the key to submarine attack, so it's vital that both the submarine and its torpedoes are designed to stay hidden.

Tigerfish has a specially profiled nose, and a special cavitation-free propulsion system. This makes it exceptionally quiet and means that Tigerfish can be guided straight along the target's bearing – ensuring maximum endurance as there is no need for any offset guidance.

Spearfish extends these principles with the addition of a tremendously uprated computer capability. This enables the torpedo to make autonomous decisions as to running depth and targetting. Spearfish also offers very high speeds – speeds that will be more than competitive with the fastest submarine.

Long Range

Both Tigerfish and Spearfish are designed to be hard to plot so that the submarine can remain hidden and fire from longer range.

Spearfish

Spearfish will carry a revolutionary warhead that is designed to focus the effects of the explosion.





Software

MUSL's unrivalled command of computer software means that both Tigerfish and Spearfish are unusually successful at avoiding seducers – ship deployed counter-measures.



TACTICAL FLEXIBILITY



Fixed-wing platform

Sting Ray launched from a Nimrod maritime patrol aircraft against a hidden submarine.

Helicopter launch

Sting Ray being launched from a ship based anti submarine helicopter.

The Lightweight Torpedo

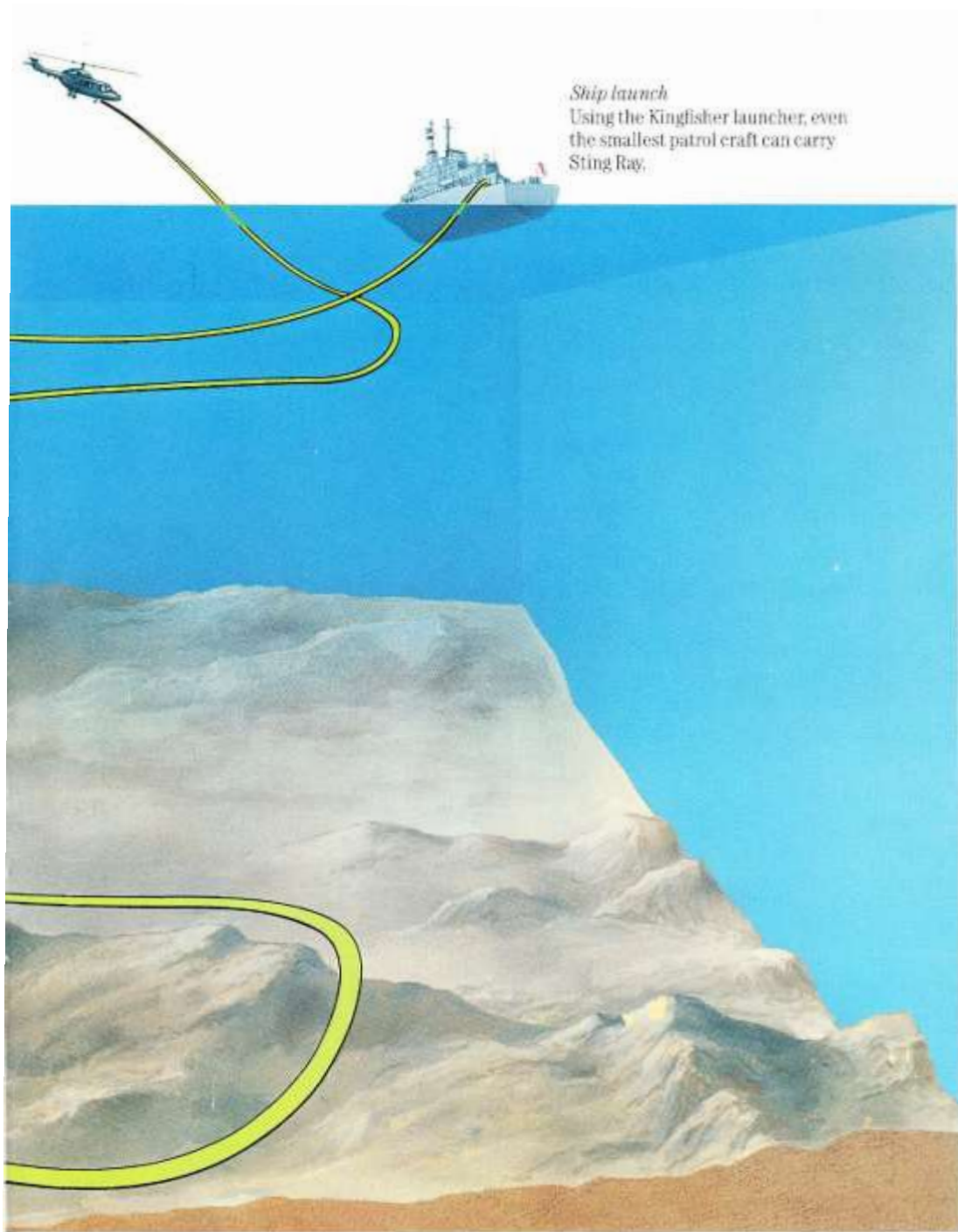
Sting Ray's vital tactical importance lies in its simplicity of operation at launch. Because it is inert until it reaches the water, it can be launched from helicopters, carrier-based aircraft, and maritime patrol aircraft, as well as all kinds of ships; both military and even non-military ships fitted with the new Kingfisher launching system. Sting Ray's minimal interface with fire control equipment and huge on-board computer capacity makes it a uniquely versatile anti-submarine weapon.

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Lynx, an important launch platform for Sting Ray.





Ship launch
Using the Kingfisher launcher, even
the smallest patrol craft can carry
Sting Ray.



Sting Ray anti-submarine torpedo
fitted to the Pilatus Britten-Norman
Defender aircraft.

PROPULSION AND CONTROL

Overcoming the problems of sending a massive object at incredible speeds through an unsympathetic environment is the challenge faced by the Propulsion and Control Group.

An electrical engineering function covers the design of microprocessor boards, the development of software, and power and control electronics. Vehicle dynamics consists of a team of engineers who model the dynamics of underwater vehicles.

The Radiated Noise Group see that noise is both suppressed in the design of friendly weapons and detected in enemy weapons. The Hydrodynamics Group are responsible for the design development and proving of all hardware.

Propulsion and Control have made Marconi torpedoes the fastest and the quietest in the world.

HOMING AND ELECTRONICS

The Homing and Electronics team have an extensive understanding of acoustic interpretation. MUSL has a vast data bank built up from the transmissions of thousands of homing heads during trials, and when combined with electronics expertise, data processing, and digital encoding systems, Homing and Electronics achieve the highest levels of reliability.

The Marconi homing head has been so refined that it can filter out nearly all extraneous noise and can clarify and locate its target whilst rejecting any counter-measures.



WEAPONS ENGINEERING

Weapons Engineering encompass a design office, Stress and Thermal Analysis, Electro-Magnetic Compatibility Group and a Configuration Control Group and an Electrical Engineering Group.

The Mechanical Engineering Department provides an area of specialisation both in terms of the weapons themselves and the recovery and handling systems.

The Electrical Engineering Group provides expertise and many years of torpedo and related product development experience over a variety of electrical engineering problems.

Together these groups emphasize the thoroughness that is a vital part of engineering in the hostile underwater environment.



SYSTEMS AND SOFTWARE

It is the task of the Systems and Software team to provide Marconi torpedoes with an intelligence second to none. More than two hundred man years of effort have gone into the Sting Ray computer to provide a highly advanced error force programme capable of guiding the weapon through the most complex environments.

Computer simulation is vitally important in the development of new software since it enables new strategies to be tested in every conceivable environment before the weapon actually enters the water. The Real Time simulator is capable of modelling a range of underwater environments and of proving the weapon against a variety of targets with and without countermeasures.

TRIALS

The Trials team play a vital role in proving the design of all underwater weapons. The trials group uses two permanently instrumented ranges. The Ministry of Defence BUTEC range between Raasay and Applecross off the West Coast of Scotland and the United States' AUTEK range in the Bahamas. Also, by using mobile tracking facilities, trials are also carried out in the North Atlantic beyond the Continental shelf, in both the North West and South West approaches and in the Mediterranean Sea.



PROJECT MANAGEMENT

Project Management is a field in which MUSL excel. It can be summarised as achieving a true understanding of the skills and resources inherent in an organisation, and then combining them to their best advantage.

For example Project Management ensures that MUSL get maximum advantage from their hardwon expertise in computer software preparation, and can transfer that capability from product field to product field.

Project Management is the application of lateral thinking techniques to more conventional management systems. This means that MUSL is constantly seeking new approaches and new answers. This in turn proves invaluable in the resolving of clients' problems and in the implementation of the resulting solutions.





MUSL AND THE ROYAL NAVY

Marconi Underwater Systems Limited has had a long and successful special relationship with the Royal Navy.

MUSL has an unrivalled success record in meeting customer targets. The Sting Ray project came in on schedule and the new Spearfish project is running well to time. Because we work closely with the MoD on development trials, we are able to develop weapons in actual service conditions and our operational analysis unit helps assess operators as well as the equipment.

With the growing importance of the computer element in underwater weaponry, sophisticated software becomes necessary. Co-operation with the Royal Navy gives us the facility to analyse a vast number of trials and exercises and this is a major factor in our reputation for ultra-reliable, practically designed, highly effective underwater weapons.

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Sting Ray – in service with the Royal Navy.

GEC AND MARCONI

The General Electric Company PLC is the UK's largest electronics and electrical company. It has world sales of over £2 billion and incorporates 130 specialist operating companies.

GEC has specialised in telecommunications electronics and automation, and the electronics side has been the prerogative of the GEC Marconi Group.

In March 1982 Marconi Underwater Systems Limited became a separate company and won a major defence contract for the development of Spearfish – the Royal Navy's new heavyweight torpedo.

MUSL is part of a group of companies with the resources, both in terms of size, finance and skills, to insist on the highest standards and to maintain excellence as the prime objective.

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Neston – the manufacturing centre for Marconi Underwater Systems opened by the Prime Minister in 1981.



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