# *British submarine policy 1853–1918*

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# Abstract

The submarine is used as a case study to examine British attitudes to developing naval technology. Study of the Royal Navy's submarine policy suggests that the Admiralty was less conservative and more able than is often supposed.

The British were thoroughly conversant with all significant developments in underwater warfare from 1853. There was an early, if abstract, appreciation of the potential of submarine boats, but a distinction must be drawn between adequate technical assessments of early submarines and inadequate appreciation of the strategic consequence of developments in submarine warfare.

Development of British policy was greatly influenced by restrictive agreements concerning the type of vessels to be built by the Vickers arms firm, by the character and personal beliefs of successive Inspecting Captains of Submarines, and by the Royal Navy's decision to resume partial responsibility for coast defence from the Army.

British experience is put into context by a study of the submarine policies of other powers. The importance of the coastal submarine to Imperial defence is discussed, the patrol submarine's influence on the British policy of blockade is assessed, and the failure to anticipate unrestricted submarine warfare examined. In the final chapter, the performance of RN boats in the Great War is set against pre– and post–war submarine policy.

# BRITISH SUBMARINE POLICY 1853-1918

Chapter 8: Revelations 1914-1918



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# Introduction

Between 1914 and 1918, U–boats sank 11,148,027 tons of British and allied shipping and nearly won the war for the Central Powers [1]. This bald statistic is a measure of the terrible impact of a new weapon of destruction. Quite simply, the submarine was and remains the single most dramatic innovation in naval history.

It upset the existing balance of naval power in a way that the Dreadnought, the ironclad – even the naval gun itself – had never done. It was more mobile than the mine, more insidious than the simple fish torpedo. It brought a new dimension to naval warfare, striking a heavy blow at British naval supremacy; and though no power hoping to gain command of the sea could do it with submarines alone, it offered predominantly military nations the means with which to hazard maritime lines of communication and supply without building a ruinously expensive surface fleet. By exposing merchant shipping to the continual danger of an unseen attack, the submarine made the new war at sea as terrible as the war to come on land.

It may seem perverse, then, for this study to concentrate on *British* submarine policy. French inventiveness forced the Royal Navy to build its own boats. American business sense provided the Admiralty with the means to do so, and it was German ruthlessness that made the new weapon so formidable. Great Britain, whose flag flew over of 75% of the world's merchant shipping as well as the battle squadrons of the most powerful navy ever seen, had more reason to fear the submarine than any of her rivals, and was nearly ruined because she failed to appreciate the true magnitude of the threat it posed. But the roots of Britain's failure lie in the naval history of the preceding 60 years.

[1] Arthur Marder, *From the Dreadnought to Scapa Flow: the Royal Navy in the Fisher era, 1904–1919* (Oxford 1961–70), V, 110

This study has two main aims: to explore the ways in which a complex organisation such as the Royal Navy adapted to new technology in an era of change, and to explain why that organisation was so poorly prepared for the submarine war of 1914–1918 that it was nearly humbled by the "weapon of the weaker power".

In structure, the thesis can be divided into two fairly distinct sections. The first, which consists of the long opening chapter and the first part of chapter two, looks at nineteenth century submarine policy in some detail and puts the history of British submarine warfare in the years 1900–1918 in context for the first time.

Underwater craft are used as a tool with which to explore naval attitudes to technological change because the submarine can be introduced as a control in an assessment of the degree to which the Royal Navy was open to innovation. The major inventions of the nineteenth century – steam, ironcladding, shell guns, rifling and breech–loading – combined to enhance the efficiency of the battleships on which British naval power depended. To a lesser extent the same could be said of the torpedo, which the RN expected to use in the melee of a fleet action. For this reason the Navy was more or less bound to adopt these inventions, sooner or later, whatever the level of conservatism and apathy in the service.

The Victorian submarine, on the other hand, was almost entirely useless to a naval power such as Great Britain. There was no pressing need for the nineteenth century Royal Navy to possess submarine boats. For this reason, British submarine policy can tell us much about the Navy's real attitude to technological change: whether RN decisions were based on technical or strategic assessments, and more particularly the degree to which moral revulsion and blind conservatism afflicted the naval hierarchy.

The Royal Navy's response to developing submarine technology in the years 1853–1900 has never been properly examined before, but the wealth of new evidence uncovered suggests that the Admiralty did not – as all earlier histories have argued – close its mind to the submarine. Nor did the RN sneer at the immorality of a weapon of sneak attack and base its policy upon an irrational distaste for underwater warfare, as popular works commonly suppose.

The Navy's conservative strategy was developed from a realistic policy opposed to innovation for its own sake. The Admiralty was generally well informed of developments in underwater warfare and made accurate technical assessments of most of the submarines built in this period, though it never understood the strategic potential of underwater warfare. But the inability of its intelligence organisation to evaluate the progress made by the French navy in the 1890s, combined with a failure to appreciate the significance of the work being done by the American civilians John Holland and Simon Lake, left the RN vulnerable and forced it to place hurried orders for Holland type submarines in December 1900.

The second portion of the thesis deals with British submarine policy in the period 1901–1918, and though no less detailed it is somewhat more concise, the bare bones of the story being better known. Chapter three examines the construction history of the submarine and discusses the important part played by the Vickers arms firm in the development of British boats. The Admiralty's motives for granting Vickers an effective monopoly over construction are outlined, and in the second part of the chapter the degree to which the monopoly influenced the design of submarines built for the Royal Navy is assessed. Chapter four looks at British submarine personnel and the role played by successive Inspecting Captains of Submarines. By discussing the compromises forced upon the Admiralty as it attempted to recruit and train submarine crews, it offers a new perspective on the RN's puzzling belief that enemy submarines could not operate off the east coast of England or in the Atlantic by suggesting that serious under–estimation of crew endurance was directly responsible for neglect of the underwater defences of British ports and contributed to the lack of urgency shown in the development of anti–submarine warfare.

The early history of British ASW is dealt with in chapter 7, and the major theme of British failure to evaluate the true potential of submarine warfare is discussed in more detail in the fifth chapter, which examines RN attempts to assess a developing weapon by examining its performance in manoeuvres and in service with rival navies. In chapter six the submarine is placed in the context of contemporary British naval strategy, and its impact on both defensive and offensive operations is described. General naval ignorance of the type's potential, caused in part by the decision to make the submarine branch a closed service, delayed the incorporation of the submarine into the Navy's offensive strategy, while Admiral Fisher's unrealistic decision to resume full responsibility for coast defence from the army at short notice had the unwelcome effect of pigeon–holing underwater craft as defensive craft long after they were technically capable of operating offensively. The tardiness with which the RN recognised the role submarines could play in re–establishing a close blockade, and the failure to anticipate

German unrestricted submarine warfare, were both due in part to the tendency to identify the submarine as a defensive weapon.

The performance of RN submarines in the Great War only emphasised the existing strengths and weaknesses of British policy. Individual submarines performed extraordinary feats made possible by the excellence of pre–war training and the soundness of pre–war design. But in struggling to incorporate submarines into a coherent overall strategy, the Admiralty doomed itself to devoting resources to useless projects: the steam–powered fleet submarine, whose strategic value obsessed the surface fleet and obscured the tactical problems of using underwater craft in close co–operation with capital ships; the submarine monitor; and, eventually, the aircraft–carrying submarine. The inadequacy of British anti–submarine tactics was ruthlessly exposed. Only by looking in detail at submarine policy in the seventy years from 1853 to 1918 can we understand why the Royal Navy was taken largely by surprise by the submarine's performance in the Great War and fully explain why the British empire came so close to defeat by starvation.

Three earlier studies – Dr Alan Cowpe's *Underwater weapons and the Royal Navy, 1869–1918*, Dr David Henry's *British submarine development and policy, 1919–1939*, and Dr Michael Wignall's *Scientists and the Admiralty: conflict and collaboration in anti–submarine warfare, 1914–1921* – have helped to shape the present thesis. Thanks to these works I have felt able to exclude much that would otherwise have had to be written on the history of the torpedo, on the anti–submarine branch's activities during World War I, and on those classes of submarine, subsequent to the K–boats, whose development was begun before 1918 but which really belong to the post–war period.

The whole work has been read and criticised by my supervisor, Dr Geoffrey Till of Kings College, London, and by Commander Richard Compton–Hall of the RN Submarine Museum at Gosport. It has benefited greatly from the savaging it received. Mr Clive Trebilcock of Pembroke College, Cambridge, the historian of Messrs Vickers, has read and criticised chapters two and three. He also has the dubious distinction of being the first to suggest the study of British submarine policy to me. Nick Lambert of Worcester College, Oxford, very kindly supplied me with a copy of his analysis of the performance of British torpedoes in World War I. Finally, Richard Furlong and Andrew Wilton performed the arcane task of

computerising statistics and graphs. Remaining errors of fact, interpretation and typing are all my own work.

*Abbreviations used in the text and footnotes*

ABSP Arthur Marder, *The anatomy of British sea power: a history of British naval policy in the pre-Dreadnought era, 1880–1905* (London 1940)
Add.Mss. Additional Manuscripts series in the Department of Manuscripts, British Library
Adm Admiralty papers in the Public Records Office, Kew, and the National Maritime Museum, Greenwich
AMC Armed merchant cruiser
AS Anti–submarine
ASW Anti–submarine warfare
bhp Brake horse power
BNA *Brassey's naval annual*
CERA Chief Engine Room Artificer
CinC Commander–in–Chief
CO Commanding officer
Commodore (S) Commodore (Submarines)
Cowpe Alan Cowpe, *Underwater weapons and the Royal Navy, 1869–1918* (London University PhD, 1979–80)
DEY D'Eyncourt papers, National Maritime Museum
DNC Director of Naval Construction
DNI Director of Naval Intelligence
DNO Director of Naval Ordnance
DOD Director of the Operations Division
DSF Arthur Marder, *From the Dreadnought to Scapa Flow: the Royal Navy in the Fisher era, 1904–1919* (5 vols, Oxford 1961–70)
EBC Electric Boat Company
ERA Engine Room Artificer
FIC Foreign Intelligence Committee, the precursor of the Naval Intelligence Department
FG Arthur Marder (ed), *Fear God and dread nought: the correspondence of Admiral of the Fleet Lord Fisher of Kilverstone* (3 vols, London 1952–59)
FO Foreign Office papers in the Public Records Office, Kew
FP Fisher papers in Churchill College Archives Centre
Halpern Paul Halpern (ed), *The Keyes papers: selections from the private and official correspondence of Admiral of the Fleet Baron Keyes of Zeebrugge* (3 vols, London 1972–81)
GF British Grand Fleet
HSF Imperial German High Sea Fleet
ICS Inspecting Captain of Submarines
IGF Inspector General of Fortifications
IJN Imperial Japanese Navy
KP Keyes papers in the Department of Manuscripts, British Library
M–branch Mobilisation branch of the Royal Navy, concerned with manning
MM *Mariner's Mirror*
NID Naval Intelligence Department
NM Roger Keyes, *The naval memoirs of Admiral of the Fleet Sir Roger Keyes* (2 vols, London 1934–35)
NYPL New York Public Library
PRO Public Records Office, Kew
RA Rear Admiral
RMA Reichs Marine Amt, the German Navy Office

RN Royal Navy
RUSI Jo. Royal United Services Institution *Journal*
SM Submarine
SRLB Surveyor's recommendation letter book, Admiralty papers, Kew
TB Torpedo boat
TBD Torpedo boat destroyer
TH *Technical history of World War I* in the Naval Library, Ministry of Defence
TrINA *Transactions* of the Institution of Naval Architects
USN United States Navy
USNI Proc. *Proceedings* of the United States Naval Institution
WO War Office papers in the Public Records Ofice, Kew
W/T Wireless telegraphy

/ Submarine specifications depend on whether a boat is submerged or at the surface. The slash denotes surface/submerged specifications. Thus "displacement 198/220 tonnes" indicates a surface displacement of 198 tonnes and a submerged displacement of 220 tonnes.

Author's note

All *emphases* in quotes from primary and secondary sources are from the original.

# Genesis

## BRITISH SUBMARINE POLICY 1853–1898

### An incident at Valparaiso, 1866

Valparaiso lies at the foot of hills that tumble towards the Pacific at about latitude 33° South. It is the second city of Chile and in the last century had a population of about 80,000, most of them supported by the seaborne trade around the Horn. Even in the 1860s the city was a cosmopolitan place, full of Italians and Britons, though German was the foreign language most commonly heard; the ships of a dozen nations swung at anchor in the bay. But the broad sweep of the coast offers no natural protection to shipping. The deep water harbour can be frighteningly rough, and has claimed vessels displacing more than 3,000 tons.

In 1866 Valparaiso was a city under siege. Two years earlier a Spanish naval squadron had siezed two guano–rich islands off the Peruvian coast; Chile was drawn into the subsequent hostilities as an ally of Peru, and Valparaiso was blockaded by six ships commanded by Admiral Mendez Nunez. Seeing that conventional naval power would not defeat the Spaniards, the Chileans searched desperately for novel weapons. Early in 1866, a group of patriots planned a torpedo attack on the Spanish squadron in the bay, and at the same time – possibly in connection with this scheme – two submarines were laid down in factories by the harbour wall. A German named Karl Flach supervised the construction of the larger boat; she was built rapidly and launched towards the end of April, a few weeks after Mendez Nunez had bombarded the city, causing $15,000,000 of damage to trade and merchandise and creating a profound sensation in

Europe. After her preliminary trials, the craft was submerged for experiment on the morning of 3 May with eleven people on board. So confident was the builder the submarine would be a success that he took his only son with him.

The boat had an anticipated underwater endurance of eight hours. When 4 May dawned and Flach's submarine had not reappeared, the alarmed Chileans turned for help to the British frigate *Leander*, flying the broad pendant of Captain Michael de Courcy, Commodore of a flying squadron detached from Rear Admiral Denman's Pacific command. The situation was already hopeless, for de Courcy reported that when "application was made to me for the aid of divers and diving apparatus... the spot where the torpedo had gone down was clearly indicated by air bubbles rising to the surface, which continued to rise during that day, gradually getting weaker towards evening, and which by Saturday morning had all ceased." [1] The inventor, his son, and nine crew were drowned.

Flach's submarine was a 45 foot long hand–cranked boat, armed with a short breech–loading 42–pounder gun and a 2.5 inch cannon carried in a waterproof cupola. She was designed to creep up to the blockaders unseen and bombard them with the 42–pdr, which could be fired while she was submerged. Despite the provision of primitive hydroplanes to control her movement underwater, however, the boat had the fault of many early designs, lacking longitudinal stability when submerged. It seems probable that she took on an uncontrollable forward inclination and, going down in 150 feet of water in the deepest part of the harbour, her sides must have collapsed under the increasing pressure.

Flach's craft was a fairly typical example of the nineteenth–century submarine. Built and crewed by enthusiastic amateurs, she was conceived to fulfil a specific tactical function, but lacked the most basic qualities of an efficient warship. Her motive power was inadequate and her weaponry dubiously useful. Insufficient attention had been paid to hull strength and to the difficulty of navigating submerged, blind and with zero buoyancy.

[1] De Courcy letter of proceedings no.18, 22 May 1866, Adm 1/5970. For the background to this story, see William Columbus Davis, *The last Conquistadores: Spanish intervention in Peru and Chile, 1863–1866* (Atlanta 1950), especially pp.285–6, 300–06, and Roderigo Fuenzalida Bade, *La armada de Chile desde la liberacion de Chiloe (1826) hasta el fin de la guerra Espana (1866)* (np, Chile 1978) pp.638–9. Bade names a German engineer, Benen, as the designer of the submarine. Flach's crew is said to have comprised five Germans, two Frenchmen, two Chileans and an un–named Englishman. The latter thus became the first Briton to die in a true submarine.

As an experiment the submarine was a failure; as a weapon of war she was useless, since the blockade of Valparaiso had been lifted before the boat was even launched – and by a bitter irony hostilities were suspended within a week of her loss. But this incident at Valparaiso shows British submarine policy at work. Commodore de Courcy, and the Navy, looked on as the inventor experimented. They took careful notes, but neither encouraged Flach nor showed enthusiasm for his design. The help they offered was too little, and came too late.

When it became clear that rescue was impossible, the Chileans asked de Courcy to raise the wreck. As his divers struggled, fruitlessly, to attach hawsers and chains to the boat, the Commodore cannot have known that his attempts at salvage were as close as the Royal Navy was to get to acquiring a submarine in the nineteenth century.

## Inspiration, utilisation, limitations: a survey of submarine development in the nineteenth century

The first significant name in the history of submarine warfare is that of David Bushnell. The Yale graduate and his *American Turtle* were the inspiration, direct or indirect, for every subsequent attempt to construct a submarine, and although Bushnell himself drew on a vigorous tradition of submarine experimentation, it was his example that fired both his contemporaries and his successors. "An effort of genius", George Washington called it, while John Holland (a man with a better claim than most to be remembered as 'the father of the submarine') believed the *Turtle* to be "a remarkably complete vessel, by far the most perfect and effective submarine boat built before 1881." [2]

Bushnell was born in 1740 in Connecticut. At the age of 31 he went to Yale to read divinity, but instead immersed himself in the study of underwater warfare, his principle preoccupation being what would today be called mining. It was a common fallacy of the day that an explosion would

[2] Alex Roland, *Underwater warfare in the age of sail* (Bloomington, Indiana 1976) pp. 67, 70–4; Richard Compton–Hall, *Submarine warfare: monsters and midgets* (Poole 1985) p.93; John Holland, 'Submarine navigation' in *Cassier's Magazine*, marine number 1897 p.541

dissipate itself under water and do no damage to solid objects. Bushnell realised that, on the contrary, water pressure could be harnessed to determine the extent and direction of an explosion with devastating effect. He began his experiments by detonating 2lb gunpowder charges in the coastal waters off New England, and – spurred on by the outbreak of the War of Independence – quickly designed a much larger mine. In 1775 he and his brother built the *Turtle* to carry this charge into battle.

Bushnell was not the first man to construct a submarine boat, but he was the first to arm one, and the *Turtle* was the first underwater craft to go into action against an enemy. The submarine herself was a tiny one–man vessel whose exact description does not survive. In shape she resembled two turtle–shells joined together – hence the name – and she was armed with a 150lb clockwork mine secured via a lanyard to a detachable auger. The inventor intended her operator to paddle the little boat out to the anchorage of a British man–of–war, submerge, and drive the auger into the hull of the intended victim. The mine would then be released and the *Turtle* could withdraw to a safe distance while the clockwork fuse wound down.

The heroic attempt by Sergeant Ezra Lee to attach Bushnell's mine to the stern of the British 74 HMS *Eagle* is perhaps the best–known story in the annals of submarine warfare. Lee set out from the New York shore on the evening of 6 September 1776 and later claimed he had propelled the *Turtle* several miles down the harbour to the spot where Lord Howe's flagship lay off Staten Island, only to find that he could not make his auger bite into the warship's hull. It hardly matters that recent research [3] has shown Lee was probably nowhere near the *Eagle* on that or any other night, that he may well have been overcome by carbon monoxide poisoning, concocting his story in order to save face, and that American pride in Bushnell's inventiveness has ever since been allowed to obscure the facts. The extravagent tributes of Washington and Holland prove that Ezra Lee's exploits had inspired them. David Bushnell's example was more important than his achievement.

Twenty years after the *Turtle* set out to challenge the Royal Navy, another American designed a submarine for use against Great Britain.

[3] Compton Hall, op.cit. pp.88–94

Finding himself in France during the Napoleonic Wars, the civil engineer and portrait painter Robert Fulton presented a set of plans to the Directory of the French Republic in December 1797. Fulton proposed to build a submarine capable of attacking the men–of–war enforcing Britain's blockade of the French coast. Hoping to reap the rich rewards of prize money, he offered to finance the boat's construction himself.

The inventor's suggestion failed to arouse the Directory's interest, but his luck changed in 1799 when Pierre Forfait became Minister of Marine. Forfait was a naval architect and had himself designed a submarine as early as 1783; he was to champion Fulton's cause for the next two years. With Forfait's support, the American laid down a boat called *Nautilus* which he demonstrated at Paris and Brest in 1800 and 1801. The copper–skinned submarine was hand–cranked, but the inventor provided her with a collapsible sail for surface propulsion. She was armed with a mine–and–auger arrangement and incorporated many of Bushnell's innovations, but was 21ft long and carried a crew of four. Fulton was able to dive her to depths of 25–30ft and after some practice found he could retain rough control over her while submerged with the help of a pair of hydroplanes right aft – the first to be fitted to a submarine. In his more candid moments, though, the American would confess that his boat was "extremely difficult to manage." [4]

At one point the inventor received a government grant of 10,000 francs to refit his boat and take her out to attack the British, but the blockaders were (it has been claimed) forewarned by an excellent intelligence system [5] and the *Nautilus* was too slow and too unwieldy to close a target successfully. When Forfait was replaced by the more conventional Admiral Decres in October 1801, the French government lost interest in the invention [6].

[4] Wallace Hutcheon, *Robert Fulton and naval warfare* (George Washington University PhD thesis 1975) p.67, quoting Fulton to Volney et al, 12 March 1810

[5] Cf. warning letters to Captain Samuel Linzee of *L'Oiseau* (14 September 1800, Adm 2/140 and Linzee's reply of 21 September 1800, Adm 1/2067) and Admiral Lord Keith (19 June 1803, in Christopher Lloyd, ed, *The Keith papers III*, London 1955 pp.21–2). The warning issued to Linzee was made after a report on Fulton's submarine dated 9 September 1800 was received from General Gordon; see precis of miscellaneous secret papers, Adm 1/4362. The efficacy of these letters must be in doubt; *Nautilus* was at sea between Le Havre and La Hogue from 12–15 September. See also 'Admiral Lord Keith', 21 June 1803, digest cut 59–8, Adm 12/103; Hutcheon op.cit. pp.60, 62, 82–3

[6] Roland op.cit. pp.89–94; Hutcheon op.cit. p.84

The British were more concerned by Fulton's activities than they cared to admit, and in 1803 the inventor was offered a substantial financial inducement which brought him to London in April 1804. Interviewed by the Prime Minister, Pitt, and the First Lord of the Admiralty, Lord Melville, the American signed a contract which guaranteed him a salary of £200 a month in exchange for the exclusive rights to his inventions for fourteen years [7]. But the Admiralty had rather less faith in Fulton's submarine than had Britain's politicians; the agreement was never fully implemented, and Fulton returned to the United States in 1806 to devote his energies to the construction of the steam ships for which he is best remembered. Submarine warfare progressed no further for a number of years.

The inspiration provided by Bushnell and Fulton was important because it was cherished by a small group of engineers and inventors who had little else to encourage them. The story of Bushnell's *Turtle* seemed to prove that a submarine – even a tiny, man–powered boat – could attack a warship and be foiled only by bad luck; it inspired designers grappling with inadequate technology. Robert Fulton, on the other hand, was one of the most celebrated engineers produced by an age rich in engineering talent. His reputation and his acknowledged genius lent credence to the somewhat extravagent claims made for his submarine. Fulton's experience encouraged other projectors (a contemporary term for inventors) in the belief that governments could be persuaded to finance the construction of submarine boats, and his example encouraged his numerous successors. Since the first *Nautilus* was launched in 1800, at least seven boats have borne the name, from Jules Verne's fantastic creation to the world's first nuclear–powered submarine [8].

The British naval archives contain details of more than 300 submarine inventions submitted to the Admiralty between 1800 and 1900. The would–be pioneers who submitted such schemes had a variety of motives. Many sought naval approval and Admiralty money. A few cranks were

[7] Articles of agreement between Fulton and the British government, 20 July 1804, Adm 1/5121/22. See also Hutcheon op.cit. pp.84–88, 90, and E. Taylor Parks, 'Robert Fulton and submarine warfare', *Military Affairs* 21 (1962) pp.177–82.

[8] On Fulton's influence, see also Roland, op.cit. pp.120–33. So great was the American's fame that in February 1880 a man named Stevenson wrote to the Admiralty claiming to be Fulton's grand–nephew and requested remuneration for his great–uncle's inventions. The application was refused. 'Mr J. Stevenson', 25 February and 7 April 1880, digest cut 59–8, Adm 12/1060.

certain their inspiration was worth a considerable sum, and figures of £10–£15,000 were not uncommonly demanded for a look at some plans; in 1892 a Mr G. Buckley asked £200,000 for the rights to his submarine boat, suggesting that a pension of £500 a week be thrown in for good measure [9]. Thirty–seven years earlier, in 1855, the Surveyor of the Navy had rejected the plans of Cumberland Hill on the grounds that "the object of Mr Hill appears to be to get Employment in the Government Service." [10]

Imagination played an equal part. Man's desire to swim like a fish is as old as his wish to fly like a bird, and the sheer attraction of submarine navigation must be grasped before the effort put into the construction and development of underwater craft becomes intelligible. Indeed most competent inventors were not primarily motivated by commercial considerations. A significant number – the American Simon Lake prominent among them – envisaged the submarine as a tool for exploration. Lake, who turned an obsession into a successful business in the years before the First World War, designed submarines for salvage work, underwater mining and diving operations. His ideas were anticipated by Lodner D. Phillips, a Chicago shoemaker who built two successful craft on the Great Lakes early in the 1850s. Phillips suggested that his submarines would be useful for pearl–fishing and wrecking – that is, recovering valuables from sunken ships [11]. Without private funding, though, such inventors often turned to governments for financial support. The progressive modification of the Phillips and Lake submarines, which were fitted out with guns and torpedoes to make them suitable for military use, indicates a realistic appraisal of what was needed to interest the admiralties of the world.

A third group of projectors constructed submarines to perform very specific tasks. The press of war caused several boats to be built in desperate attempts to counter the overwhelming naval superiority of an enemy; the submarines designed by Bushnell, Flach and a Confederate

[9] 'Plans of a submarine torpedo boat' 29 November 1892, digest cut 11a, Adm 12/1241

[10] Surveyor's recommendation letter book [S.R.L.B.] 24 October 1855, Adm 92/18 fol.2; see also 'Submarine boat invented by Signor CA Regis', 18 August 1865, digest cut 59–8, Adm 12/765

[11] Description of 'Phillips' sub–marine boat', dated 3 January 1859, submitted to Sir Baldwin Wake Walker, the Surveyor of the Navy; Wake Walker papers WWL 1, National Maritime Museum.

The most accessible account of Lake's theories is *Submarine: the autobiography of Simon Lake* (New York 1938). Readers should note that while the book is broadly accurate in outline, it is unreliable in detail.

syndicate led by the New Orleans broker Horace Hunley and an inventor named James McClintock, are typical examples. Such projects achieved unusual prominence for two reasons: they were frequently backed by governments which tended, in wartime, to be less than usually critical of submarine devices, more tolerant of failure (in the short term at least), and more generous with funding; and they often saw action of a sort, thus coming to the notice of contemporaries and historians. Even the not–infrequent fatalities associated with such boats were significant from this point of view.

Wartime submarines were most commonly intended for blockade–busting. The colonialists, during the War of Secession, the French, during the Napoleonic Wars, and the Confederate states, during the American Civil War, were all blockaded by a powerful naval enemy. Innovation was suddenly at a premium, and Bushnell, Fulton and the McClintock syndicate all took advantage of this fact to secure official backing for their submarine projects.

The last notable use envisaged for underwater craft in the Victorian age was the infiltration of harbours and destruction of underwater obstructions. A submarine–cum–diving–bell built by the British naval architect John Scott Russell during the Crimean War was intended to breach the barrier at Cronstadt, which was holding up the Allied fleets in the Baltic. During the American Civil War a French inventor named Brutus de Villeroi produced a submarine with which the Federal navy hoped to attack the rebel base at Norfolk and destroy the formidable CSS *Virginia* while she was fitting out [12].

For all this activity, few significant advances were made in the first eight decades of the nineteenth century. Most inventors worked alone, and there was little continuity of effort. Such men generally lacked the necessary intellectual, technological and financial resources to build successful boats, and submarines intended for service in war were invariably abandoned when peace was restored.

It is important to make a distinction here between inspiration – which was freely available to the aspiring designer – and information, which was

[12] James Baxter III, *The introduction of the ironclad warship* (Cambridge, Mass 1933) p.286; *Official Records of the Union and Confederate Navies in the War of Rebellion*, series I vol.7 (Washington 1902) pp.488, 523–4

not. Many problems confronted the would-be submariner, and it was difficult to stomach continual frustration and disappointment forever. John Holland, the Irish-American inventor of the Royal Navy's first submarines, devoted nearly 40 years of his life to an obsession; few were prepared to make such a sacrifice. In the absence of official encouragement, moreover, an inventor's chances depended as much upon his persistance and financial resources as they did upon the merits of his creation.

The most obvious difficulty lay in finding a propulsion system capable of driving a submarine beneath the sea. Early inventors, including Bushnell and Fulton, favoured hand-cranking mechanisms and relied upon the muscle power of their crew. This imposed severe limitations: Fulton's best speed was some 2.5 knots, about the same as that obtained by the Confederate submarine *HL Hunley* sixty years later [13]. Other designers resorted to specially-designed oars which could (in theory) be feathered while submerged, but the 16-oared boat built at Philadelphia by Villeroi in 1861-2 proved so inefficient that she was converted to screw propulsion by the Federals during the American Civil War [14].

More promising were various proposals to make use of stored power. In the years 1858-9 a French naval captain, Simeon Bourgois, designed *Le Plongeur*, a 420-tonne craft, with the help of the constructor Charles Brun. They filled her to capacity with 23 huge cylinders of compressed air which drove an 80hp engine, but the British naval attache predicted she would not be successful, and he was right [15]. Though the first submarine to be built and systematically developed by a major shipbuilding power, the boat was grossly inefficient and capable of a maximum four knots submerged. A few years later James McClintock calculated that an engine fuelled by the 'ammoniacal gas' he had seen powering street-cars in New Orleans could propel a submarine along at five knots. The gas could not, however, be safely generated on board, and a commission of British naval officers stated that its storage would require "the greatest attainable

[13] Secretary of the Admiralty to Lord Keith, 19 June 1803, in Lloyd op.cit. III, 21-2 (London 1955); statement by James McClintock, 30 March 1872, FO 5/1372

[14] Louis Bolander, 'The *Alligator* – first Federal submarine of the Civil War', USNI Proc. 64 (June 1938) pp.845-54

[15] FO precis of Captain Hore's naval attache's report no.27, dated 23 May 1862, Palmerston papers ND/D/24/2, Broadlands Mss. (Department of Manuscripts, Southampton University Library); Henri Le Masson, *Les sous-marins Francais, des origenes (1800) a nos jours* (Brest 1980) pp.19-27

accuracy of workmanship... to prevent loss from leakage at joints, glands &c., and so to guard against the air in the boat becoming vitiated." [16]

Steam was harnessed to drive semi-submersible Confederate *David* torpedo-boats as early as 1862, but the furnaces needed oxygen which was, of course, in short supply once a true submarine had ventured under water. In the 1870s, however, the Lamm fireless engine was developed to power San Francisco street-cars and adapted for use on the London Underground Railway. It utilised latent heat and the Liverpool curate George Garrett fitted one in his 1879 submarine *Resurgam*, built at Birkenhead. Superheated water (which flashed into steam when released into the boiler) drove the little boat along at two or three knots. Similar engines were used to propel the four submarines designed by Garrett and built by a Swedish arms-maker, Thorsten Nordenfelt, in the 1880s; the partners claimed a submerged speed of five knots for their fourth and last boat [17]. The Lamm engine did, however, have serious disadvantages. It took fully three days to heat the reservoir, and no Nordenfelt submarine had an underwater radius of action of more than 20 miles. Prolonged or repeated travel submerged was therefore impossible. More significantly, the temperature inside a Garrett/Nordenfelt boat rose to over 100$^o$ farenheit when the water was superheated. The effect this had on crew efficiency is easily imagined.

Electricity was the answer. The Frenchman Oliver Riou was the first to suggest it, in 1861; two years later the Confederate engineer Alstitt designed the first dual-propulsion submarine, envisaging a boat powered by steam on the surface and electricity when submerged. McClintock expended considerable effort in attempts to perfect an electric motor for his second submarine in the same year, but abandoned the idea as impractical and converted the boat for hand cranking [18].

Workable electric submarines were not really feasible until the invention of the storage battery, conceived in 1837 but not commercially available

[16] Captain Nicholson and Mr Ellis, RN, 'Report on a submarine boat invented by Mr McClintock of Mobile', 19 October 1872, Adm 1/6236 box II; see also *The Engineer*, 25 August 1871 p.131

[17] William Scanlan Murphy, *Father of the submarine: the life of the Reverend George Garrett Pasha*, (London 1987) p.234; Richard Compton-Hall, *Submarine boats: the beginnings of underwater warfare* (London 1983) pp.48-53, 64-71

[18] Compton-Hall op.cit. pp.72-3; statement by James McClintock, October 1872, Adm 1/6236 box II

until the 1870s. (The lead acetate battery used in the first British Holland craft was developed in 1880.) [19] Even then there were still significant problems to be overcome. The early cells were heavy, inefficient, and worryingly prone to leak poisonous fumes. The first modern electrically–powered submarine, built with government help by a Spanish naval lieutenant, Isaac Peral, in 1888, was not a conspicuous success, and the enquiries of the British naval attache revealed "the general opinion seems to be that the boat is a complete failure... Lieutenant Peral went down three times, but was never able to move more than a few yards." [20] It was the French who finally produced an efficient electric submarine. *Gymnote* was launched in 1888 and powered by a 564–cell accumulator battery which was perfected only after years of frustrating trial and error [21].

Then there was the problem of armament. Here too little useful progress was made before 1880, although a profusion of redundant systems clamoured for a projector's attention. Bushnell, Fulton, and the Polish inventor Stefan Drzewiecki favoured mines which could be planted under enemy warships as they lay at anchor, but which would have been useless against a vessel in motion. Drzewiecki, who built two quite advanced submarines in Russia (the first in 1877 and the second two years later) intended his boats to dive beneath a ship and release floating charges which would bob upwards and be trapped underneath the target's hull. All his experiments with this system failed [22]. Other submarine mining vessels were constructed by the British shipbuilder John Scott Russell (in the 1850s) and the American Oliver Halstead (in the 1860s); both designed submarines which carried divers and explosives to breach underwater obstructions. Holland installed pneumatic 'dynamite guns' in several of his early boats, planning to bombard his victims from an awash position or close to short range and discharge a projectile into the target's side from underwater.

[19] John Maber, 'The history of the electric battery', pamphlet P1001, Naval Library, Ministry of Defence.

[20] Captain William May, 'Spain – fleet, dockyards &c.', NID no.346, April 1893, Adm 231/22

[21] Le Masson op.cit. pp.44, 48, 50

[22] Captain Ernest Rice, 'Report, with tracing, of a submarine boat', 27 November 1880, Adm 1/6551; Consul–General Stanley, despatch no.3 Political, 29 January 1879, FO 65/1054

Phillips and Flach fitted submarine guns to their craft.

Other designers had their own ideas. Fulton and McClintock experimented with buoyant towed torpedoes. McClintock's original idea was to dive his submarine under the target, thus drawing an infernal machine onto the enemy's hull, but in practice he found it difficult to keep the device clear of its parent. Instead his syndicate converted *Hunley* to carry a spar torpedo. A 90lb gunpowder charge was secured to a 22ft yellow–pine pole projecting from the submarine's bow; it was to be detonated by the boat's commanding officer after he had rammed his target. The spar (which was also fitted to *Le Plongeur* and was successfully used by Russian torpedo boats in the war of 1877) had at least the virtues of simplicity and certainty; it was, however, at least as dangerous to friend as it was to foe, and the *Hunley* did not survive her famous encounter with the Federal sloop–of–war *Housatonic* on 17 February 1864 – the first (and for fifty years the only) occasion on which a submarine sank an enemy warship [23].

The pioneer submariners had to wait for the invention of the fish torpedo – a device that could strike at a distance and reduce a projector's dependence on the suicidal courage of his crew – to acquire a weapon of significant potential. For unless they could plausibly hope to do more damage to an enemy than to themselves, submarines would never (wrote Captain Domville, naval attache to France in the late 1880s) "be sufficiently a bugbear" [24].

The problem was, in fact, a little more complicated than it first appeared, and Robert Whitehead's celebrated torpedo – in service by 1869 – was not fitted to a submarine until 1885. This may seem odd, given the enthusiasm with which the weapon was adopted by many navies in the 1870s, but there were good reasons for the delay. Most obviously, those who could afford to purchase the inventor's expensive secret had no intention of fitting the Whitehead to submarine boats. The Royal Navy, which led the world in torpedo development during the 1870s, envisaged its use on board ocean–going warships, perhaps as a sort of long–range ram

[23] On the details of the *Hunley*'s armament, see Milton Perry, *Infernal machines: the story of Confederate submarine and mine warfare* (Baton Rouge 1965) pp.98–99 and Eustace Williams, *The Confederate submarine* Hunley *documents* (np Van Nuys, California 1958, typescript in the New York Public Library)

[24] Captain William Domville, 'France: guns and torpedoes 1889', NID no.211, December 1889, Adm 231/16

in the confused melees that were expected to characterise a war at sea. Britain's 3,000–ton *Mersey* class torpedo cruisers were the logical products of this policy. Other nations preferred small, manouevrable torpedo boats that could press home an attack at short range, but depended for their safety on speeds far beyond any contemporary submarine [25].

The 'secret' of the Whitehead torpedo – the balance chamber that enabled the weapon to travel at any set depth – was well guarded. Little or no information was made available to outsiders, and during the 1860s and the 1870s submarine inventors were kept in profound ignorance of the Whitehead's capabilities. Having paid £15,000 for the privilege of obtaining the inventor's plans, the Royal Navy was not about to reveal them to the world. The majority of its officers knew nothing of the torpedo's workings; neophytes were sworn to silence before being initiated into the secret, and only a handful of men fully understood a Whitehead 'fish' [26].

The torpedo was in any case a controversial weapon. The fate of the *HL Hunley* (destroyed by the explosion of her own torpedo) encouraged the widespread belief that all torpedo–armed submarines were seriously at risk every time they went into action. In 1885 the research station HMS *Vernon* remarked of the *Nordenfelt I* that "it remains to be shown how far this boat and those like her will stand the effect of a submarine explosion at a comparatively short distance." [27] Eleven years later, the officer commanding the French boat *Gustave Zede* suggested to Lord Charles Beresford that "when it fired its own torpedo the concussion could smash the boat." [28] Not until the French conducted careful trials in the 1890s was it acknowledged that a submarine was only endangered if closer than

[25] Alan Cowpe, *Underwater weapons and the Royal Navy, 1869–1918* (London University Ph.D. 1980) pp.26–8, 69, 71, 114–27, 172–81. Proponents of underwater craft often pointed out that Whitehead's torpedo was in effect a miniature automatic submarine boat; and indeed the German Navy considered in 1874 a proposal that the British inventor should design them a submarine. RH Stotherd, 'Report on the German torpedo establishments at Kiel and Wilhelmshaven &c.' 25 November 1874, GT Phipps Hornby papers PHI 109/3, National Maritime Museum. Similarly, the inventor Louis Brennan, designer of a short–range wire–guided torpedo for coast defence, suggested that he should build a submarine for the Royal Navy; Wilson memo 'Submarine boats', 15 January 1901, Adm 1/7515.

[26] Cowpe op.cit. pp.18, 35

[27] HMS *Vernon* annual report 1885 p.63, Adm 189/5

[28] *The memoirs of Lord Charles Beresford* (London 1914) I, 362

about 75 yards to a torpedo explosion [29].

Most importantly of all, the underwater discharge of Whitehead torpedoes was not technically feasible until the early 1880s. The technique of projecting torpedoes from submerged tubes was not perfected until the end of the decade [30], and the impetus for this development stemmed not from concern for the possibilities of torpedo–armed submarines but from a decision to place a ship's Whiteheads where they were least vulnerable to enemy gunfire.

It was, in short, impractical to arm any submarine with a torpedo tube before the middle 1880s, and for this reason Thorsten Nordenfelt at first planned to equip the *Nordenfelt I* with two Lay wire–guided torpedoes, which were mounted on deck. The Swedish arms tycoon also patented an electric torpedo of his own invention in 1883 before fitting his boat with a Whitehead tube in 1885. The Whitehead could only be discharged when the submarine was at the surface, the crew being required to climb out on deck to trigger the torpedo [31].

For a surface vessel, the problem of submerged discharge was one of protecting a 'fish' against the rush of displaced water caused by the ship's forward motion. For a submarine, the chief difficulty lay in compensating for the sudden loss of weight when a torpedo was fired. There is, in fact, no evidence that the *Nordenfelt I* ever discharged her Whitehead, and it was some time before early submariners felt happy about the idea of suddenly lightening one end of their delicately–trimmed craft by firing the weapon. In the early 1900s the Royal Navy got around the problem by arranging for a couple of heftily–built stokers to run for'ard carrying a heavy box at the moment a Whitehead was discharged. The less innovative French preferred to fit the experimental submarine *Gymnote* with two externally–mounted torpedoes, supplied without tubes and fixed by pylons to the pressure hull, where they were difficult to maintain and vulnerable

[29] Theodore Ropp, *The development of a modern navy: France 1871–1904* (Harvard University Ph.D. 1937) p.545; Le Masson op.cit. pp.50–1.

For American experiments (c.1894) see Frank T Cable, *The birth and development of the American submarine* (New York 1924) pp.100–01. For British experiments (1907), see section 7.2

[30] Cowpe op.cit. pp.71–82; Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) pp.153–56. Experiments with submerged discharge were conducted by the Royal Navy's Torpedo Committee from 1870, but the tube was for years fixed and stationary.

[31] CW Sleeman, 'The Lay and other locomotive torpedoes', RUSI Jo. XXVII (1883) pp.63, 67–8; BNA 1887 p.406; Murphy op.cit. pp.93–4

to damage. Later French boats were fitted with a combination of tubes and external Drzewiecki 'drop collars', which permitted the torpedoes to be crudely angled [32].

But many projectors never got the chance to worry about weaponry. Keeping a submerged boat on an even keel proved an almost intractable problem. Submarines dive by taking in enough water to destroy their positive buoyancy, and (broadly speaking) they will then happily plunge to the bottom unless trimmed so that they become neutrally buoyant. For years it seemed almost impossible to maintain the longitudinal stability of so finely–balanced a craft. The Nordenfelt submarines, for example, were decidely tricky to handle when submerged because the water in their partially–full boiler tanks swilled about, upsetting trim. Nordenfelt, Lake and the Portuguese naval lieutenant Don Fontes Pereira de Mello (with *Fontes*, 1892) were among the designers who steadfastly refused to dive a submarine at an angle, as Holland recommended. Instead, their boats were stopped and carefully trimmed down until just awash, then clawed under by vertical propellers mounted on deck, for fear that the submarine might take on an uncontrollable forward inclination and dive to her destruction [33].

The solution to this problem eluded even the determined French. The trials of *Le Plongeur* were abandoned in the 1860s when it was realised that she was excessively unstable. At 140 feet in length, she was by far the largest submarine built in the nineteenth century. It took an hour to trim the boat for diving, and even then she showed a disturbing tendency to veer uncontrollably between the surface and the sea–bed [34]. Hydroplanes, which act as horizontal rudders to control a submarine's pitch, were fitted to many boats from the *Nautilus* onwards, but were rarely placed abaft the propeller where they were most effective. The *Gustave Zede* underwent six years of trials (1893–99) before her hydroplanes were satisfactorily arranged, and the problem was by no means solved by the time she was formally commissioned. In May 1899 the British Admiralty learned from a reliable source that she was "a failure, that her ever coming back from

[32] Le Masson op.cit. pp.48, 51, 59; Bacon report 'Drzewiecki discharge gear for submarine boats' 2 July 1901, Adm 1/7522

[33] Thorsten Nordenfelt, 'On submarine boats', RUSI Jo. XXX (February 1886) pp.159–60; 'A new submarine boat', *Scientific American* 66 p.137, 27 February 1892

[34] Captain Hore, naval attache's report no.11, 19 February 1864, Adm 1/5901

Marseilles, after her recent trip, was problematical, ...[and]... that she has never dived for more than eleven minutes, and that only once. That was during the trip back from Marseilles, and they thought they would go lower and lower and never come back again... the Captain is not at all happy..." [35]

The underwater endurance of early submarines was limited by more than simple reluctance to plumb the ocean depths. The physiology of oxygen consumption in enclosed spaces was not well understood in the nineteenth century, but prudence (and a not–unnatural fear of suffocation) encouraged most pioneer submariners to err on the side of caution when estimating the supply of air available to them. Many inventors, including Fulton, installed cylinders of compressed air, and without it submerged endurance tended to be measured in minutes rather than hours. Holland's *Fenian Ram* had air "for at least half an hour" under water [36], an early submarine designed in 1863 by the Russian photographer IF Alexandrofsky was credited with the ability to dive for 45 minutes [37], and the hour's grace claimed for a submarine built at Chicago early in the 1890s by the American George Baker was described by the British naval attache as "considerable" [38].

Such estimates were needlessly pessimistic. The tiny *Hunley* – 40ft long, 42 inches in the beam and crewed by eight hard–working hand–crankers – established an endurance record in the winter of 1863–4. Twenty five minutes after she had submerged the air was so foul that a candle would not burn, but the crew stayed down for more than two and a half hours [39]. Numerous disasters and near–disasters have since confirmed the surprising endurance of humans trapped in a submarine; the artificers who cut a hole in *K13*, a British boat stranded for 35 hours on the bottom of the Gairloch in January 1917, were almost overwhelmed by the Stygian

[35] Jeffreys to Egerton 27 May 1899, Adm 1/7422. (Jeffreys was DNO and Egerton the Captain of HMS *Vernon*.)

[36] Archibald to Thornton 20 December 1880, FO 5/1746 fols. 186–9. (Archibald was Consul–General in New York, and Thornton the British Ambassador to Washington)

[37] Arthur Wellesley, military attache's report no.9, 22 January 1873, Adm 1/6281; DW Mitchell, *A history of Russian and Soviet seapower* (London 1974) p.181

[38] Captain Gerald Langley, 'United States: Navy dockyards, materiel &c.', July 1893, Adm 231/22

[39] Personal account by WA Alexander in the New Orleans *Daily Picayune*, 29 June 1902, copy in RN Submarine Museum archives A1985/63

blackness of the air which escaped from her – but with it came 47 survivors [40].

Not until 1901 did Captain Reginald Bacon, the Royal Navy's first Inspecting Captain of Submarines, lock himself and two full crews in one of the submarines then building for the Navy at Barrow to measure their oxygen consumption. "Although we know better now," wrote Bacon in his memoirs, "it was then by no means certain that human bodies in close confinement did not give off poisonous exhalations." In the event, he and his men suffered less from the effects of vitiated air than they did from the efforts of "an elderly representative of the Holland company who had brought along a flute wherewith to while away the time", and who played on through the long watches of the night. "At the best of times the flute is not an inspiring instrument," recalled Bacon, "but the dirges to which we were treated that night, in the bowels of the submarine, I believe caused us all, ever after, to look on the flute with a large measure of personal enmity." [41]

The last great technical problem was that of submarine navigation. There were no charts detailing underwater currents. The thick iron pressure hulls and electric motors of a submarine combined to distort compass bearings, while the chances of makings accurate observations at the surface were restricted by the longitudinal instability of most early boats; periscopes were useless if a submarine could not be controlled at a specified depth. It was, therefore, difficult to attain the pin–point accuracy necessary for a succesful attack.

Contemporary appreciations made much of this point. Sir Astley Cooper Key, Senior Naval Lord from 1879 to 1885, thought "very little of any vessel intended to be navigated under water as it is not possible to see any distance," [42] and as late as 1902 a Major Marrow sent the Admiralty details of an invention to secure "immunity from submarine attack... inky

[40] Don Everitt, *The K boats: a dramatic first report on the Navy's most calamitous submarines* (London 1962) p.76

[41] Reginald Bacon, *From 1900 onward* (London 1940) pp.56–7. Further experiments were conducted by the RN as late as 1905, when Professor Haldane and 15 men shut themselves inside *A5* for 24 hours and emerged unscathed. Talbot diary 20 + 21 September 1905, Imperial War Museum 81/42/2

[42] Bound volume of reports on the 'Supposed Fenian submarine torpedo boat in the course of construction at New York', fol.25: Key minute to Archibald despatch Secret no.70, 7 January 1881, Adm 1/6551

fluids to be discharged to becloud and discolour the water surrounding the vessel to prevent a submarine from finding its whereabouts." [43] Alexandrofsky's boat was accounted "a failure inasmuch as it was found almost impossible to see a vessel at a distance of more than two yards," and the DNO, Lord Hood, drew the Board's attention to the problem with the remark: "The difficulty of seeing a vessel at a very moderate distance from an underwater boat, is one of the great difficulties, as it must be necessary to be frequently coming to the surface to ascertain one's position." [44] Several boats – notably those of the Holland type – were in fact designed to 'porpoise', showing themselves briefly at the surface to get their bearings and diving again before guns could be trained on them. The system worked, but the element of surprise was often lost, giving an enemy the chance to manouevre out of harm's way.

The failure to evolve an efficient motor, a useable periscope, an effective weapon and reliable hydroplanes had obvious and important consequences. It meant that early, hand-cranked submarines were very restricted in their choice of targets. Stationary vessels and fixed defences were the most probable victims. In 1873 Lord Hood observed that "a submarine boat might probably be of considerable value for destroying torpedo defences, but not so efficient nearly as a means of attack against vessels especially when in motion." [45]

Similarly, primitive submarines had a tiny radius of action – usually a few miles at best. The perspiring oarsmen who rowed John Scott Russell's submarine could manage no more than four miles without relief. Robert Fulton's *Nautilus* was rendered impotent when the British vessels it had set out to attack raised anchor and moved further out to sea, and the Confederate privateer submarine *HL Hunley* spent months waiting for a Yankee blockader to come within range; she could travel no more than twelve miles in a night [46].

[43] 'Immunity from attack from submarine vessels' 9 January 1902, digest cut 11a, Adm 12/1377

[44] Wellesley report no.9, 22 January, and Hood minute 8 March 1873, Adm 1/6281

[45] Ibid

[46] Scott Russell 'Memorandum for consideration' 28 January 1856, Palmerston papers GU/RU/1149 enc.1; Roland op.cit. pp.100-01, 103; Alexander's account 29 June 1902, RN Submarine Museum archives A1985/63

It can hardly be emphasised too strongly that, when applied to boats constructed during the nineteenth century, the term 'submarine' is quite misleading. Without an efficient periscope, any torpedo-armed submarine would have to attack while awash or at the surface, and complete submergence was, therefore, generally contemplated only when evasive action was required. Diving was an essentially defensive manoeuvre. An 1893 Intelligence Department report observed that "the idea of attacking under water actually is not believed to be practicable." [47]

At this transitional stage in her development, the submarine was really no more than a torpedo boat which relied for protection on her invisibility rather than her speed. "It would appear that no recent design aims at the production of a real sub-marine, or actual sunken vessel, but that all projectors now desire to construct a craft which shall be only partially submerged," noted Captain Cyprian Bridge in 1889 [48]. The American Holland submarines purchased by Britain in 1900 were subject to the same criticism: "The United States appear to have acquired a successful vessel," reported the NID in May 1900, "but she can hardly be called a 'submarine', being more of a 'submersible' type as it is apparently intended to navigate her awash until she gets under fire, but even then, she will have to come to the surface from time to time, so as to rectify her course." [49]

Most submarine builders therefore devoted themselves to designing boats with as low a silhouette as possible. (It was the inventor's boast that no more than 18" of *Nordenfelt I* was visible when the submarine was steaming on the surface [50].) It was this imperative, not some technical difficulty, that persuaded the early submariners not to fit their boats with decks and conning towers, the absence of which kept hatches only a few inches out of the water. This in turn severely restricted the commanding officer's field of vision and left the danger of swamping ever-present; steaming with the hatches closed, on the other hand, both officers and men

[47] Langley report 'United States: Navy dockyards, materiel &c.', July 1893, Adm 231/22

[48] Bridge minute 17 April 1889, Adm 1/6998

[49] Intelligence Department report 'Submarine boats', NID no.577, May 1900 p.5, Adm 231/31

[50] Statement cited in despatch from Horace Rumbold (HM Ambassador, Stockholm) 1 May 1882, FO 188/144

were denied fresh air and kept cooped up below while the vessel was at sea – usually in conditions so cramped and unpleasant that crew endurance was minimal.

That was why the Royal Navy had little use for the sort of submarines being built in the nineteenth century. It was a highly mobile, offensively-minded service. If submarines were taken seriously at all, it was as weapons of desperation and defence. Their low freeboard rendered them useless in the steep coastal waters of the British Isles, and they had neither the speed nor the weapons to attack warships on the move. They dived slowly, reluctantly, and for seconds rather than minutes, minutes rather than hours. On the rare occasions that a submarine lived up to her fine title, she was a menace to nothing but herself.

### Wilhelm Bauer and the Prince Consort

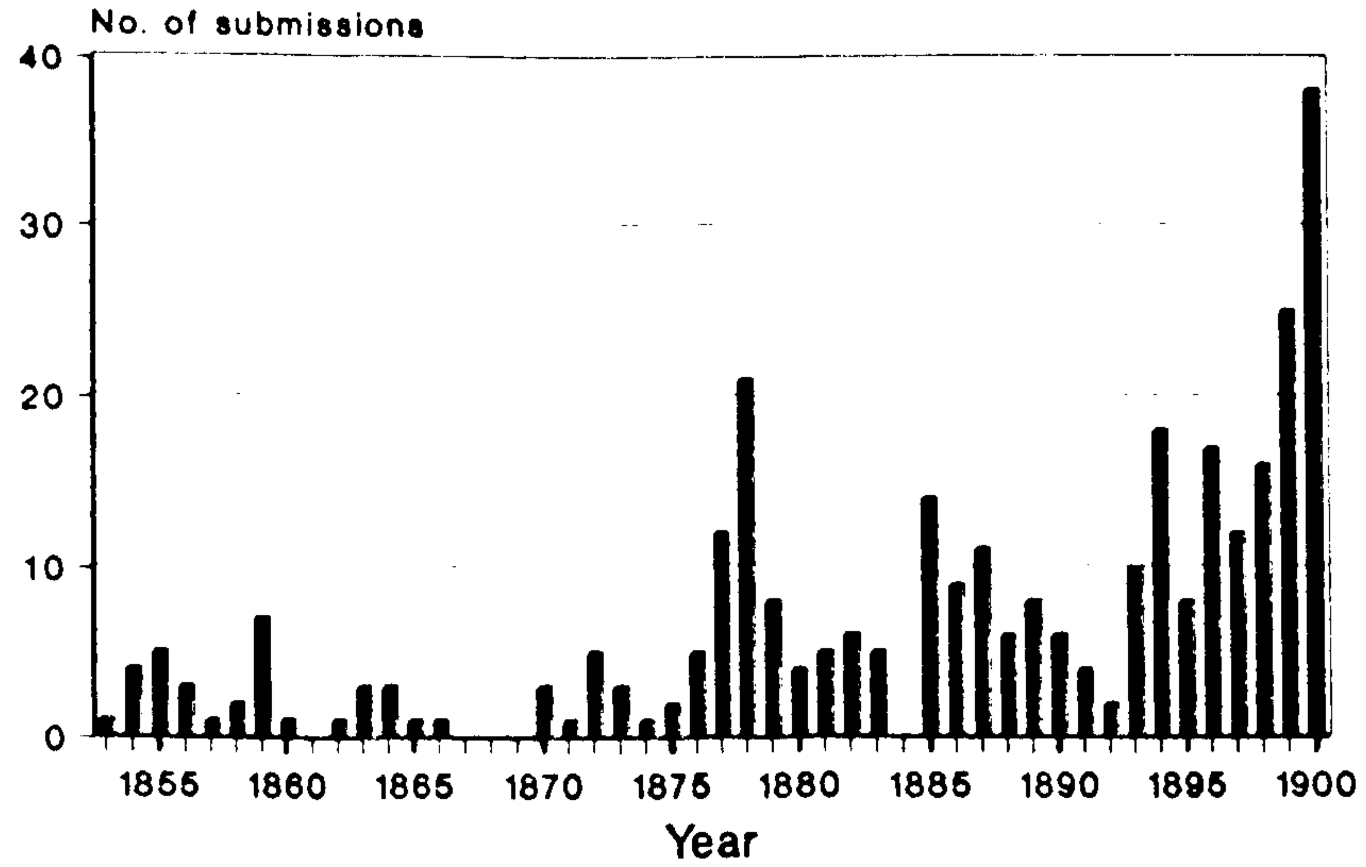
Real British interest in submarine boats can be dated to the Crimean War. Only one communication on the subject [51] had reached the Admiralty in the first 16 years of Victoria's reign, but from 1853 a steady stream of inventions and reports were digested in the bulky volumes that record every letter and submission received by the Secretary of the Admiralty. The amount of business transacted by the Admiralty was huge, even in the relatively quiet years of the mid-Victorian era, and the proportion of that business which concerned submarines was, of course, tiny. But the Royal Navy soon became familiar with underwater weapons. As early as 1859 the Surveyor rejected Lodner Phillips' submission with the weary observation, "it does not appear that there is any great novelty in the plan or any advantage in it over the numerous propositions in regard to the construction of boats for similar purposes." [52]

[51] 'Bassett's submarine gun boat' 9 August 1849, digest cut 59-8, Adm 12/509. During the research for this chapter, the Admiralty digests were searched for the period 1793-1900, and the Surveyor's Department records for the years 1812-1860. Three projects were submitted between 1800 and 1809, four between 1810 and 1819, two from 1820 to 1829, and none between 1830 and 1849. Aside from its dealings with Robert Fulton, the Admiralty did become involved in one other submarine project early in the nineteenth century: the RN's relationship with the submarine-builder Tom Johnson is described in Appendix 2.

[52] S.R.L.B. 2 June 1859, Adm 92/20 fol.591

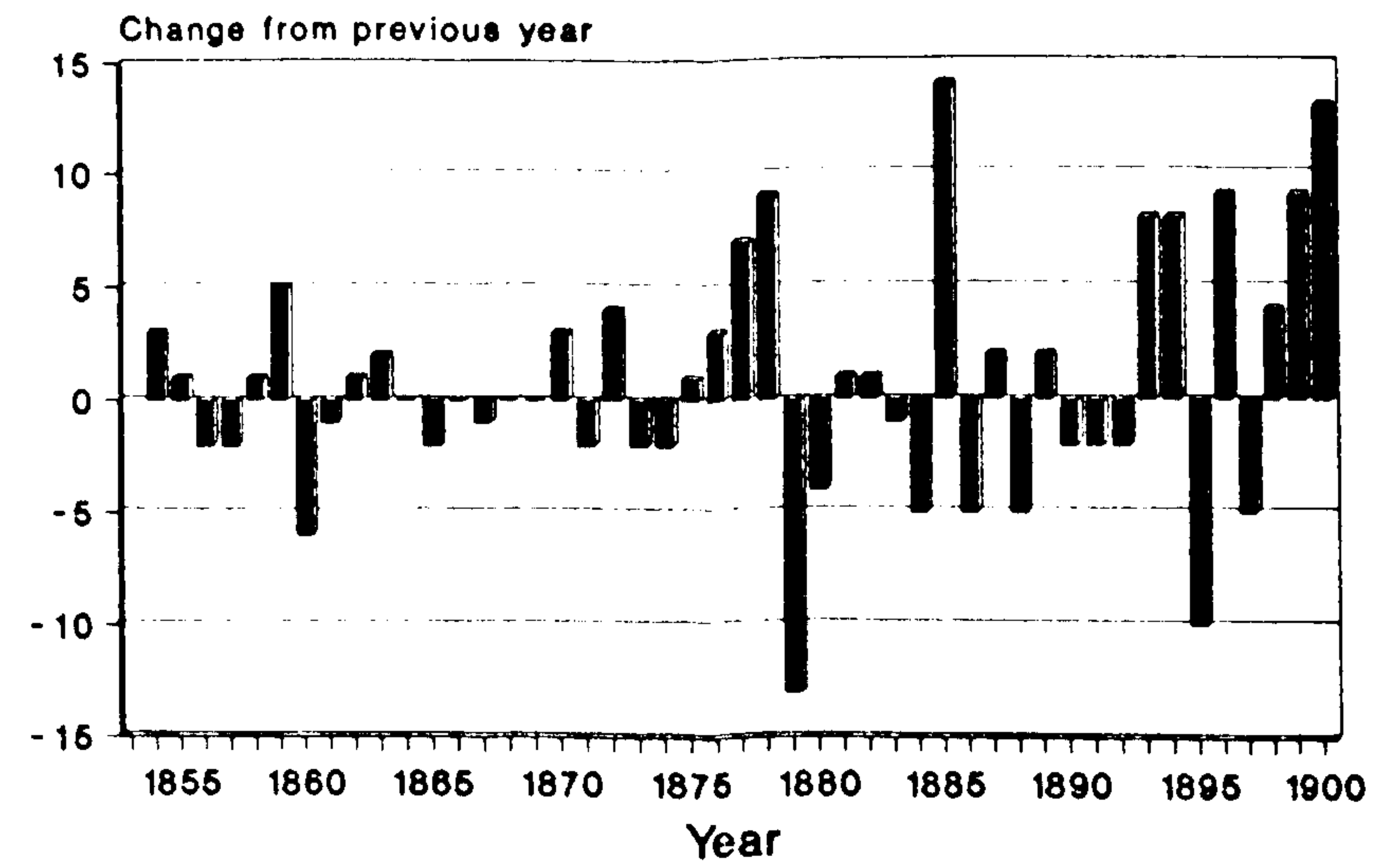
1a Submarine submissions

Total received annually by Admiralty



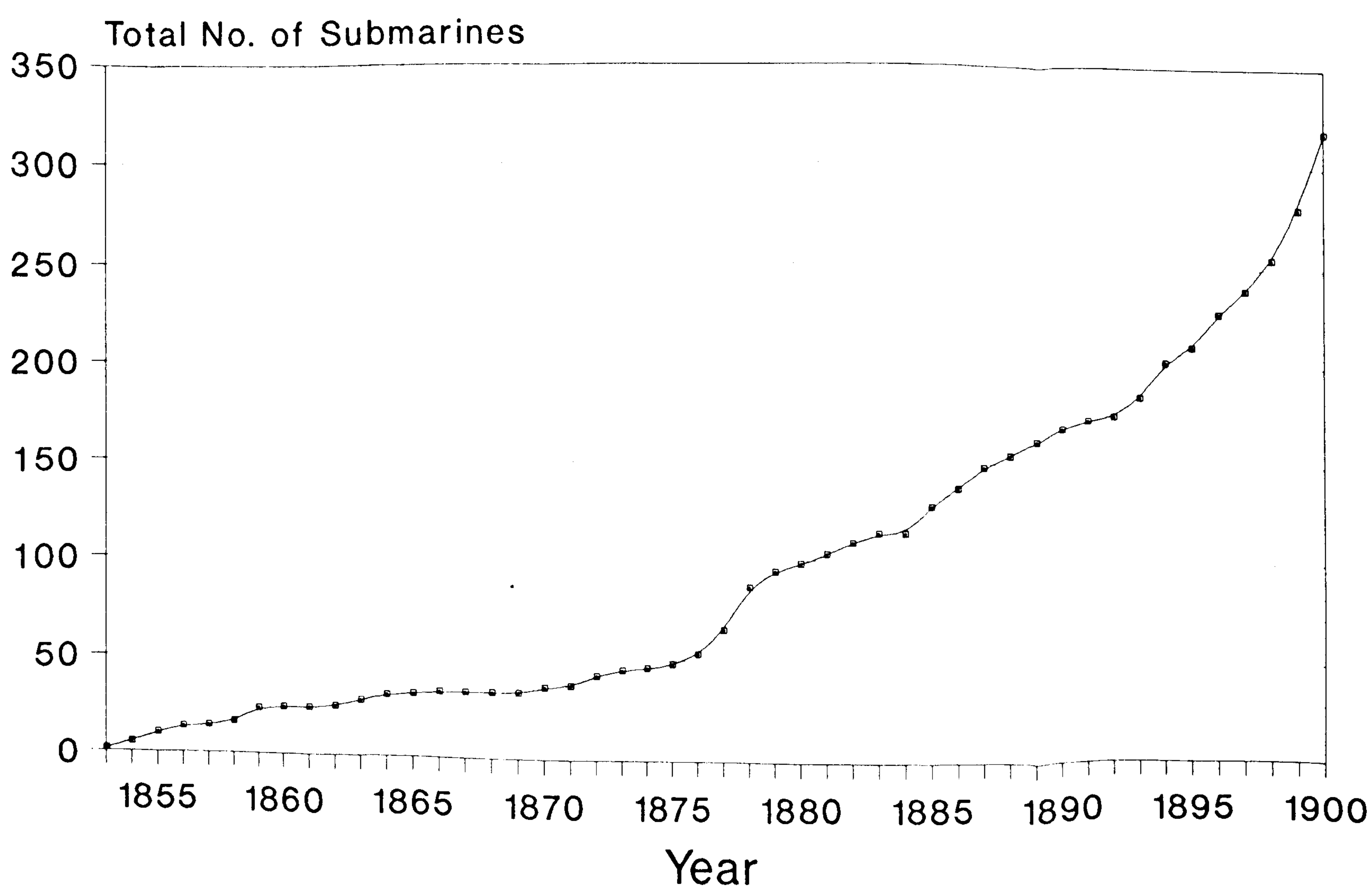

1b Submarine submissions

Annual change




1c Submarine submissions

Cumulative total




**DISCUSSION**

*Graph 1a* shows the number of submissions concerning submarines received by the Admiralty between 1853 and 1900. Data has been drawn from the Admiralty digests, cuts 11a (boats) and 59−8 (projects for annoying the enemy), and from the Surveyor's department records for the period 1853−1860. The latter series was discontinued in its old form in 1860.

The digest entries record all submissions sent to the Secretary of the Admiralty, and the Surveyor's papers all submissions sent to his office. If the Surveyor found a submission of some merit or significance he would submit a brief report on it to the Board of Admiralty; thus some of the Surveyor's records are duplicated in the secretariat papers. (I have counted duplicated submissions only once for the purpose of preparing these figures.) The less meritous of the Surveyor's submarine submissions were never seen by the Secretary of the Admiralty. In 1860 the Surveyor was elevated to the Board of Admiralty with the title of Controller, and thereafter all submissions were channelled through the Secretary − and, hence, into the digests.

The total number of submissions recorded between the inception of the Admiralty digest in 1793 [1] and the British adoption of the submarine in 1900 was 328 [2]. Of these, 318 were received between the years 1853 and 1900, an average of 6.8 per year. This statistic should be enough to dismiss the popular notion that the Admiralty remained in happy ignorance of the submarine until very late in the nineteenth century. It is, indeed, apparent that the Royal Navy was perfectly well−informed about developments in submarine warfare during the Victorian era. The use to which it put this knowledge is, of course, another matter.

Discussion of a simple average is, nevertheless, misleading, and the number of submissions received varied significantly from year to year. Notable peaks are recorded in the years 1878, 1885, and 1893−4, and from 1893 to the end of the century the number of submissions exceeds the average in every year. *Graph 1b* shows these peaks more clearly by illustrating the difference between each year's total and the number of submissions received during the previous year. Thus the *increase* in the number of submissions received in 1877 was 7, in 1878 it was 9 and in 1885 − the largest increase recorded − it was 14.

The probable significance of these peaks is debatable, but at least two appear to represent increased interest in submarine designs generated by popularly−reported trials of experimental vessels. The great increase recorded in 1885 was almost certainly the result of Nordenfelt's experiments with his first boat. The greater number of submissions made in the 1890s probably reflects the increased pace of development in France (note the peak in 1893−4, which coincides with the launching and early trials of the *Gustave Zede*) and the growing certainty that the development of a truly efficient submarine was just around the corner. *Graph 1c*, a cumulation of the 318 submissions received between 1853 and 1900, could legitimately be said to reflect in visual form the pace of nineteenth century submarine development.

**Notes**

[1] The scheme was worked out in the years 1808−1812, but the system was applied retrospectively to the correspondence from 1793 to 1808.

[2] For the record, the earliest submission (dated 14 September 1800) was a letter to Captain Samuel Linzee of *L'Oiseau*, warning him to be on his guard for Fulton's submarine. Digest cut 59−8, Adm 12/87; Linzee to Admiralty 21 September 1800, Adm 1/2067.

The first notable invention submitted to the Surveyor's Department was the 'hyponaut apparatus' devised by a Bavarian projector, Wilhelm Bauer, in 1853. But Bauer was evasive when questioned by the naval constructors Isaac Watts and Thomas Lloyd and refused to give details of the allegedly revolutionary engine that was to power his submarine. Predictably enough, the Admiralty was unimpressed by the invention [53]. On 26 August 1854, however, the Surveyor's Department took the unusual step of re–examining Bauer's scheme, asking no less a figure than Professor Michael Faraday to come to the Admiralty to interview him [54].

The Admiralty had several reasons for taking an interest in Wilhelm Bauer. Firstly, he was one of the few submarine inventors to have built a workable submarine and to have persuaded other governments to take him seriously. In January 1850, while an artillery corporal in the army of the Duke of Holstein, Bauer submitted the plans for a submarine boat to the Duchy's Ministry of Marine. He suggested that such a vessel might break the blockade instituted by Danish naval forces during the Schleswig–Holstein revolt, and persuaded the Ministry to allocate him 30 Prussian talers from the naval budget. With this money he built a large, clockwork–driven working model which was successfully demonstrated to an assemblage of notables. In due course a commission was charged with the construction of a full–sized boat.

The submarine was built at Kiel with the help of voluntary contributions from members of the army and local civilians. Named *Der Brandtaucher*, she displaced 30 tons and was manned by a crew of three – a captain and two crewmen who turned large treadwheels connected to a screw, driving the craft along at a maximum speed of three knots. Unfortunately for Bauer, a shortage of funds had forced him to weaken the boat's structure. On her first diving trial (1 February 1851) she shipped enough water through leaky glands to become unmanageable, and Bauer and his companions were lucky to escape alive from the stricken submarine. *Der Brandtaucher* was unsalvageable, and the inventor eventually left Germany for Austria and then Britain. By the time he reached London, Wilhelm

[53] Surveyor to Bauer 30 July and 5 August 1853, Adm 91/15; 'Bauer's hyponaut apparatus', S.R.L.B. 16 August 1854, Adm 92/17 fol.82. Brief details of Bauer's submarine may be found in his patent application (25 May 1853), copy in RN Submarine Museum archives A1853/1

[54] Surveyor to Bauer 24 August 1854, Adm 91/16; S.R.L.B. 22 August 1854, Adm 92/17 fol.82

Bauer had demonstrated his model submarine to Ludwig I of Bavaria, to his successor, Maximillian II, and to the young Austro-Hungarian emperor Franz Joseph [55].

The second and far more compelling reason for Admiralty interest in Bauer was the patronage the Bavarian secured from Prince Albert. Arriving in Britain late in the summer of 1852 he demonstrated his model submarine to the Royal family at Osborne [56], and Albert was sufficiently impressed to provide Bauer with the funds to construct another model when the first was lost. The Prince Consort had a lifelong interest in science and technology, took an interest in a wide variety of naval inventions, and was sufficiently unconventional to become a prominent proponent of Captain Cowper Coles' controversial turret ship a decade later [57]. The Bavarian's proposals gripped his imagination, and he became convinced that "it is '*a priori*' impossible that so important and new a fact as submarine navigation should be useless in the hands of men of genius." [58] By acquiring so powerful a supporter, Bauer ensured he would be treated with respect. Indeed the Admiralty's first contact with the inventor was made at the instigation of the Prince Consort, who wrote to Sir James Graham, the First Lord, to request a prompt investigation [59].

The RN's willingness to reinvestigate Bauer's proposals in 1854 may also be attributable to the fact that the German projector's plans took on a much more concrete form between July 1853 and August 1854. At Prince Albert's suggestion, he was introduced to the noted naval architect John Scott Russell late in 1853 [60]. Russell owned a shipyard at Millwall on the Isle of Dogs, and had made the Prince Consort's acquaintance two years earlier as secretary to the committee that had organised the Great Exhibition. By 1853 he was already engaged in building Brunel's singularly

[55] Eberhard Rossler, *The U-boat: the evolution and technical history of German submarines* (London 1975) pp.10-12

[56] *The Times* court circular 6 August 1852 p.5 col.c

[57] Stanley Sandler, *The evolution of the modern capital ship* (Newark, Delaware 1979) p.184; George Emmerson, *John Scott Russell: a great Victorian engineer and naval architect* (London 1977) p.84

[58] Albert to Palmerston 9 January 1856, Palmerston papers RC/H/59

[59] Albert to Graham 25 June 1853, microfilm 43, Graham papers, Cambridge University Library

[60] Rossler op.cit. p.12

ambitious *Great Eastern* – by far the largest ship yet laid down anywhere in the world – and as the inventor of the double bottom, pioneer of the wave–line system of shaping vessels, and co–founder of the Institute of Naval Architects, the Englishman was well qualified to help Bauer construct a new submarine [61].

Bauer moved down to Greenwich, and by August 1854 had fleshed out a new set of plans. Russell's contribution was to help the poorly–educated, intuitive Bavarian to present his ideas in a form acceptable to the Surveyor's Department, but no submarine was laid down in the Millwall yard prior to the submission of 26 August. Bauer and Russell may well have hoped to persuade the Admiralty to back the project before incurring major expense.

If so, they were unsuccessful. Bauer's lack of English (he spoke through an interpreter) and mistrustful nature combined to make him an unsatisfactory witness, and two days after the meeting he was "acquainted that his explanations have not been sufficiently distinct." Shortly thereafter Bauer became convinced that his co–workers were poaching his ideas. He had proved equally suspicious of French collaborators during a brief trip to Paris in 1853, but by now the Crimean War was under way and the inventor took himself and his plans to Russia. There, with the patronage of Grand Duke Constantine, the Minister of Marine, he built a large submarine, *Le Diable Marin*, which was intended to attack the Allied Fleet in the Baltic. This boat was quite successful and conducted numerous trials in the waters off Cronstadt [62].

Several interesting conclusions can be drawn from Bauer's experiences in Britain. The German inventor enjoyed some unique advantages which persuaded the Admiralty to take him seriously. No other projector could boast a powerful patron and a track record of government–sponsored submarine construction; none had the help of a respected naval architect and the resources of a major shipyard to back them up. From this point of view, it is unsurprising that those who followed in Bauer's footsteps did not enjoy even his limited success.

[61] Robert Rhodes James, *Albert, Prince Consort* (London 1983) p.185; Emmerson op.cit. pp.85–6

[62] 'Bauer's hyponaut apparatus' 28 August 1854, digest cut 59–8, Adm 12/589; Hans–Georg Bethge, Der Brandtaucher: *ein tauchboot – von der idee sur wirklichkeit* (Rostock 1968) p.36

It is, moreover, evident that when the Bavarian first arrived in Britain, the Royal Navy had no intention of building a boat to his specifications. The country was at peace, and the brief report submitted by the Surveyor's committee made it clear that Faraday and his associates were more interested in the inventor's 84hp "Gas–Steam–High–Pressure–Engine, in which Rocket Composition is to be used as the source of heat and gas" than they were in his submarine [63]. This preoccupation was fairly typical of the Navy's attitude to submarines in the Victorian era, and the Admiralty more than once showed considerably more interest in some feature of a submarine project than it showed in the submarine itself. In 1878, for example, the Navy requested details of the submarine developed by the well–known Liverpool shipbuilder Josiah Jones. The Admiralty was particularly intrigued by the boat's electric light, their Lordships being eager to ascertain whether it could really be made to work underwater [64]. This attitude suggests that – while there were so many technical problems to be overcome – the nineteenth century naval authorities were not much concerned with the submarine for its own sake.

### John Scott Russell and Lord Palmerston

Bauer's departure for Russia passed unnoticed in the scramble to prepare a British fleet for operations in the Baltic. The Royal Navy had entered the Crimean War quite unprepared to meet the special problems that were to confront it; its line–of–battle fleet was unsuited to operations in the

[63] 'Bauer's hyponaut apparatus and gas engine: report upon', S.R.L.B. 28 August 1854, Adm 92/17 fol.83

[64] 'Submarine boat and electric light' 9 and 22 January, 2 February, 2 March 1878, digest cut 59–8, Adm 12/1023. Like many submarine projectors, Jones was a notable innovator in other fields. He had come to the Admiralty's attention in 1859 as the inventor of a system of inclined armour; cf James Baxter III, *The introduction of the ironclad warship* (Cambridge, Mass. 1933) pp. 162–3. Similar examples are legion: Fulton did significant work as a canal designer and proponent of the steam engine; Holland puzzled over the problems of mechanical flight; Bauer invented a 'camel' for use in salvage operations, and George Garrett the pneumataphore, a self–contained diving dress. James McClintock devised a machine for the manufacture of minie balls, while Simeon Bourgois was an early proponent of the screw propeller and a leading *jeune ecole* theorist. The first British submariners were no less original. Murray Sueter contributed to the development of the tank and claimed to have originated the concept of the torpedo bomber; Hugh Williamson was a major figure in the early development of the aircraft carrier.

restricted waters of the Gulf of Finland, and a host of unusual vessels had to be designed to meet these new conditions. Suddenly innovation was at a premium. Gunboats, mortar vessels, armoured rafts and floating batteries were built in numbers [65].

Meanwhile, the Russian 'fleet in being' at the great naval base of Cronstadt controlled the approaches to St Petersburg and prevented the Allied fleet from gaining command of the strategically vital waters of the eastern Gulf. Cronstadt itself was protected by a great barrier, several miles long, stretched across the shallows outside the harbour. The Royal Navy had to break through this barrier before it could attack the Russian fleet.

John Scott Russell revived the idea of building a submarine early in 1855. A new design was sketched with the help of the well-known civil engineer Sir Charles Fox, one of the principals of Fox & Henderson, the firm that had built the Crystal Palace. Together the two men drew up the plans of a large mobile diving bell to be crewed by divers and used to destroy the barrier at Cronstadt. Whether or not Russell had been examining Bauer's plans behind the Bavarian's back, the new invention bore little relation to *Der Brandtaucher* or *Le Diable Marin*. Bauer designed screw driven, completely enclosed boats. Russell's new craft, according to one officer who examined it, "was merely a large diving bell, like an inverted boat... It went down to the bottom with men under it; they were to walk along the bottom and propel the boat by pressing against against thwarts fixed to the under side." Crew members in diving dress were to leave the vessel and attach explosives to the target [66]. Russell and Sir Charles Fox seem to have drawn more consciously on the inspiration of a French designer, Dr Payerne, who built the submarine *L'Hydrostat* in 1846 and later converted her into a diving bell. In her new guise Payerne's boat was successfully employed in the construction of a breakwater for Cherbourg harbour [67].

[65] Baxter op.cit. pp.69–91; Andrew Lambert, *Battleships in transition: the creation of the steam battlefleet 1815–1860* (London 1984) pp.41–52

[66] Key at the Royal United Services Institution, 5 February 1886, RUSI Jo. XXX (1886) p.164; Andrew Lambert, *Great Britain, the Baltic and the Russian war 1854–1856* (London University Ph.D. 1983) p.280, citing Palmerston to Wood 17 December 1855, Halifax papers A4/63 fol.54, Borthwick Institute, York. Lambert has expanded on British naval policy in the Baltic in a recent book, *The Crimean War* (MUP 1990)

[67] See F Forest and H Noalhat, *Les bateaux sous-marins* (Paris 1900) vol.I pp.28–37. The Fox/Russell boat deserves the title 'submarine' insofar as it was both mobile and independent of any surface ship.

Whatever her deficiencies, Fox's and Russell's un–named vessel was the creation of two famous engineers, and with the war in the Baltic at a stalemate her inventors had little trouble in persuading Viscount Palmerston to sponsor the project. Like Winston Churchill in later years, the Victorian Prime Minister had a strong interest in novel military devices, and was excited by the possibilities of submarine warfare. The nineteenth century historian Herbert Paul observed that "there was no public man who could plausibly pretend to be more warlike than Lord Palmerston" [68], and according to Andrew Lambert, "Palmerston's enthusiasm for new weapons knew no bounds; he pressed every scheme that was sent to him onto the Admiralty and the Ordnance." [69] Disraeli noted in November 1855 that "Palmerston is for blowing up Cronstadt having got a discoverer who builds submarine ships worked by submarine crews, & who are practising on the Thames with, they say, complete success." [70].

The Prime Minister was unable to interest the Admiralty in Russell's experiments, but he told the inventors to press on and leave the problem of finance to him. This high–handed attitude drew an irritable response from the First Lord, Sir Charles Wood, who hastened to explain the Admiralty's position: "I do not quite understand from your note of yesterday what you have done as to Sir Charles Fox's proposed boat," he wrote in March 1855.

> "I understood before he was building... [her]... at his own risk to be bought or not as it turned out. If that is all you mean I have not a word to say. If you mean that you have authorised him to build his boat at the risk of the Govt., it is quite a different matter.
>
> "He has never brought any of the plans or information which... [I]... asked for when I saw him. We know enough of him to know that he is not a man to be depended on and we cannot be answerable for an expedition upon which we have not had the opportunity of forming an opinion." [71]

[68] Quoted in Bernard Semmel, *Liberalism and naval strategy: ideology, interest and sea power during the* Pax Britannica (Boston 1986) p.57

[69] Lambert op.cit. p.279

[70] Disraeli to Lord Derby 20 November 1855, quoted in Emmerson op.cit. p.86. The trials referred to were, in fact, conducted at Poole. (See below.)

[71] Wood to Palmerston 26 March 1855, Halifax papers Add.Mss. 49562 fols.27–8

With the support of Palmerston and Prince Albert (who had kept up his interest in submarine warfare), the Fox/Russell submarine was nevertheless ordered on 22 March 1855 and launched on 5 October [72]. She carried a crew of 12, most of whom were employed in sculling the boat along at her maximum surface speed of two knots. Russell hoped that his oarsmen would also be able to row the submarine while submerged but this dangerous technique was never tried, the boat's captain, Chief Diver McDuff (who had been strictly enjoined by Russell "to train his men gradually, and on no account drown any of them"), reporting that "there must be several descents before the men will have sufficient confidence to propel her under water; although they are willing, still they are timid." McDuff's caution was entirely justified. Although the submarine killed no-one, there were some exceedingly narrow escapes [73].

Anxious for secrecy, the designers sent the boat to the seclusion of Poole Harbour and persuaded a reluctant Admiralty to appoint a committee to examine their invention. The three officers selected were Captains Bartholomew Sulivan, Astley Cooper Key and James Hope. The first was a brilliant hydrographer, whose surveys of the Baltic and the approaches to Cronstadt had made him thoroughly familiar with the waters in which the submarine would have to operate. Of the latter two, Key (whose name had been suggested by John Scott Russell) was a noted technical officer and future Senior Naval Lord. Hope, another talented scientist, presided over the HMS *Captain* court martial and became an Admiral of the Fleet [74].

The initial investigation was not very thorough; the commissioners remained in London and contented themselves with examining the inventors, the captains of the submarine and her tender, and some Thames divers who testified to the difficulty of seeing any distance under water. Key, Sulivan and Hope then reported that although the boat might be useful in other circumstances, the murky waters off Cronstadt would preclude her successful employment there [75].

[72] McDuff's 'Journal of the submarine ship 1855', Palmerston papers GC/RU/1149

[73] Scott Russell to Palmerston 28 January 1856 and his enclosed 'Memorandum for consideration', ibid.

[74] Wood to Palmerston 17 December 1855, Add.Mss. 49565 fols.44–5; HN Sulivan, *The life and letters of Sir Bartholomew James Sulivan...* (London 1896) pp.372–3

[75] Albert to Palmerston 9 January 1856, Palmerston papers RC/H/59; Wood to Albert 31 January 1856, Add.Mss. 49565 fols.67–9

The matter might, perhaps, have ended there, but a copy of the committee's report was sent by Wood to the Prince Consort. Outraged that the three naval officers had not seen Scott Russell's craft in action, Albert wrote to Palmerston insisting that the invention should not be forgotten. Wood's response was to reconvene the committee, and late in January 1856 he sent its members to Dorset to examine the submarine.

Both Hope and Sulivan were optimistic that the boat would be a success in the clearer waters of the south coast, but they were severely disappointed by the trial that took place at Poole on 25 January 1856. While the Admiralty committee watched from Scott Russell's tender, McDuff and his crew completed a preliminary dive. Then they submerged again, and a buoyed air hose advancing slowly across the harbour marked their progress through the icy sea. After 20 minutes, the prow of the submarine suddenly shot out of the water, blew like a whale and went down again. Moments later the boat reappeared briefly before slipping back in a swirl of water. Soon those at the surface heard the sounds of a hammer being struck against the iron sides of the submarine. This was the agreed distress signal, and the craft was hurriedly brought to the surface by a safety line which Russell had thoughtfully attached to her beforehand. The crew were pulled out, gasping but alive, to explain that they had become stuck in a patch of Poole mud. McDuff had attempted to surface, but one of the two weights that had to be released snagged on some obstruction. The other end of the submarine rose unchecked to the surface and most of the air escaped. The Chief Diver's presence of mind saved his crew, for he gathered the men by one of the tanks of compressed air used to keep the sea out of the boat, and fed them oxygen while they waited to be rescued.

This concluded Britain's first official submarine trial. Not surprisingly, the Admiralty officers left Poole in what Russell termed "a state of considerable alarm and disappointment." They retrieved their earlier report, which they now considered too favourable, and submitted a second, more damning indictment of the submarine [76]. The boat was brought back to

[76] Scott Russell to Palmerston 28 January 1856, Palmerston papers GC/RU/1149; Wood to Albert 31 January 1856, Add.Mss. 49565 fols.67–9. There are two slightly distorted versions of events by members of the Admiralty committee; see Key's account in RUSI Jo. XXX (1886) pp.164–5; Sulivan op.cit. pp.373–4

London and left to rust [77].

On 31 January 1856, Sir Charles Wood sent the Prince Consort a summary of the committee's revised judgement. The officers had concentrated on three points, he wrote – the boat's qualities as a diving bell, her means of locomotion, and the difficulty of seeing any distance through the water. As a diving bell, they felt that Russell's craft had little to recommend her, and she was considered inferior to the Cherbourg bell and to the latest American designs. Nor was she fast enough to be useful in action. Finally, there still seemed to be very little chance of the submarine being used in waters clear enough for the crew to see where they were going [78].

Palmerston made one last attempt to involve the Royal Navy in what had been little more than a personal project of his by forwarding the bill to Sir Charles Wood. The First Lord was not amused. "I really do not know what has been gained by Mr Russell's experiment which was not known before, and actually in use before," he rejoined. "If we had undertaken the experiment we should have looked after it and paid for it. We knew nothing of its being going on, and never till I received your note yesterday that we were to pay for it. I have spent my last farthing of this year's votes and made no provision in the next. It would come I suppose under experiments, for we can make no use of the machine and I have no such vote as would cover a hundredth part of the expense." [79]

Two important conclusions can be drawn from this analysis of early British submarine construction. The first concerns naval and civilian attitudes to the new weapon. By 1856, the Admiralty had established a policy it would maintain for the next 40 years. The Royal Navy refused to sponsor Russell's project, believing (correctly) that the submarine would be a failure. In so doing it resisted strong pressure from the highest authorities in the land. The boat owed her existence to the private enthusiasm of Prince Albert and Lord Palmerston, both of whom were keen innovators and firm

[77] Delaney to Walker 10 January 1859, Wake Walker papers WWL1, National Maritime Museum

[78] Wood to Albert 31 January 1856, Add.Mss. 49565 fols.67–9

[79] Wood to Palmerston 19 March 1856, ibid fols.84–6. The cost of the submarine was about £10,000; 'Journal of the submarine ship 1855' (entry for 22 March), Palmerston papers GC/RU/1149

believers in the Victorian 'new technology'. Furthermore, Russell's craft was intended for a specific (and offensive) operation, the destruction of the barrier at Cronstadt, and would never have been completed had the country been at peace.

When Sir Charles Wood bowed to the wishes of the Prime Minister and the Prince Consort, he did so with good grace and ensured that the Fox/Russell boat was given a trial by highly qualified naval officers, just as the Surveyor had gone out of his way to secure the services of Michael Faraday in August 1854. For all their lack of initial enthusiasm, the officers appointed to examine the submarine made a sound assessment of her mechanical demerits. This pattern – considerable reluctance to become involved, *reasoned* resistance to the idea of submarine construction, civilian rather than naval enthusiasm for such projects, and the technical rather than tactical criticism of those that were investigated – was evident time and again during the next four decades.

The marked enthusiasm of civilian projectors for dramatic but impractical gadgets has been described by Lee Kennett [80]. Analysis of both the records of the Crimean War and the 44,000-odd inventions sent to the Munitions Inventions Department during the World War I suggests that front-line troops devoted their ingenuity to the development of defensive and protective equipment, while the inventions submitted by non-combatants were "overwhelmingly offensive", based on up-to-the-minute technology (electric death-rays in the 1850s, tanks and aircraft 65 years later) and intended to "destroy the enemy in some massive and spectacular way." The submarine projects of the Crimean War fit Kennett's model rather well.

Equally significant is the fact that the Royal Navy believed as early as 1855-56 that the development of an efficient submarine was inevitable. "There is no doubt in the world of the possibility of a submarine boat, as far as the existence of people inside her goes, or of the power of depressing or raising," Wood assured Lord Palmerston. "The questions are

[80] Lee Kennett, 'Military inventions and popular involvement, 1914-1918', in *War and Society* 3 (1985) pp.69-73. According to Guy Hartcup, only 30 of the 100,000 inventions sent to the Board of Invention Research during World War I "were likely to be of any use". The Munitions Inventions Department received 47,949, of which 226 were useful. The equivalent French body developed 781 of 44,976 inventions. Hartcup, *The war of invention: scientific developments 1914-1918* (London 1988) p.189

the means of propulsion and seeing and steering." [81] Less than a year later, the First Lord could envisage a solution to two of his three problems: "Locomotive power seems to me to have undergone a very insufficient trial," he informed the Prince Consort, "but I do not entertain any serious doubt of this being accomplished. There can be no more difficulty about a compass in an iron vessel under water than above water. The real obstacle to the use of these machines for offensive purposes is the difficulty of seeing under water in a horizontal direction." For this reason (and with peculiar forsight), the First Lord concluded his letter: "I am afraid that as far as the Naval operations of England are concerned they are more likely to be used against us than for us." [82]

Hope, Sulivan and Wood were not the only Admiralty officials with faith in the long-term future of the submarine. In May 1880 William Arthur, the first Captain of the torpedo school HMS *Vernon* and a member of the 1870 committee appointed to examine Whitehead's torpedo, declared that the construction of a successful submarine was certainly possible, and observed that "the capabilities of such a vessel would be great." [83] Arthur's colleague AK Wilson did not doubt that he was right, for "a very well thought-out design for a submarine boat was brought to my attention while commander of the *Vernon* about 1879, which only required only one small addition which any Torpedo Officer could have supplied to make it efficient." [84] These were not the sentiments of naval officers whose minds were closed to the possibilities of innovation.

## 1.3: INNOVATION IN THE VICTORIAN NAVY

Although the predominant image of the nineteenth century Royal Navy is still that of a service stagnating in the reactionary backwaters of ultra-conservatism, modern research has suggested that this view is

[81] Wood to Palmerston 10 May 1855, Add.Mss. 49562 fol.85

[82] Wood to Albert 12 February 1856, Add.Mss. 49565 fols.72-3

[83] Arthur naval attache's report no.26, 19 May 1880, FO 115/673

[84] Wilson memo 'Submarine boats' 15 January 1901, Adm 1/7515. It seems probable that the author is referring here to George Garrett's submarine.

inadequate. The Senior Service had its good and its bad points, it is true, but it is increasingly clear that its administration was broadly competent and its seamen never less than professional.

The Napoleonic Wars were, naturally enough, followed by a period of retrenchment, but Britain could not afford to rest upon her naval laurels much beyond the mid–1820s. The *Pax Britannica* was not an era of universal peace; the nation's resources were stretched by anti–slavery patrols off the coasts of Africa and China, by the host of minor wars fought in the name of policing an empire, and by the demands of maintaining almost a dozen naval stations overseas. Serious challenges to the supremacy of the Royal Navy had to be met from both France and Russia, and it was natural that Britain, the first industrial nation, should exploit her industrial supremacy to retain a lead over these naval rivals. As the century progressed it was the near–impossibility of matching the pace of technological change, not the difficulty of keeping faith with Nelsonic tradition, that most taxed British naval officers. NAM Rodger points out that "if the Victorian era had really been one of peace, they might have had the leisure to reflect on how to wage a future war, and not just on how to operate future equipment. If they had really been reactionaries, they might have held onto some of the hard–won wisdom of former generations. As it was, they were knowledgeable and enthusiastic proponents of technical change and material development who had lost sight of the objects for which the Navy existed: highly trained, and wholly uneducated." [85]

It is not difficult to evidence the statement that the Royal Navy was open to innovation for much of the nineteenth century. Far from being nostalgically wedded to the days of sail, the service was a comparatively early proponent of steam. The Admiralty authorised the construction of a highly experimental steamship in 1792. By 1800 there were engines at work in the Royal dockyards; by 1816 the First Lord, Melville, was urging the acquisition of steam tugs. Britain's first engined warship, the paddle–steamer *Monkey*, was purchased in 1821. By 1830 the RN was probably ahead of its nearest rivals, the French and United States navies,

[85] NAM Rodger, 'British naval thought and naval policy 1820–1890: Strategic thought in an era of technological change', in Craig Symmonds, ed, *New aspects of naval history: selected papers presented at the 4th naval history symposium, United States Naval Academy, 25–26 October 1976* (Annapolis 1981) p.149

in its employment of steamships [86].

The French replied with other innovations, notably the shell-gun pioneered by Henri-Joseph Paixhans. Britain tested a similar weapon in 1829 and adopted it in a limited way over the next decade; French interest was less concerted [87]. Other significant advances in ordnance followed later in the century. Rifling substantially increased the accuracy of naval guns and made long-range fire practicable for the first time. The Royal Navy tested early Armstrong rifles in 1858; in 1863 it accepted the disastrous 110-pounder breach-loader, which was simply too ambitious a product for its time.

The adoption of the Armstrong rifle demonstrated the naval appetite for innovation; its failure did much to dent this enthusiasm. The RN did not return to the breach-loader until 1881, and in the intervening period the quality of its gunnery fell behind that of its continental rivals. Gun calibre, however, increased rapidly in this period – from the 8-inch short-bore muzzle-loaders of HMS *Warrior* to the 12.5-inch muzzle loaders fitted in HMS *Dreadnought* (1875) and the *Benbow*'s 16.25-inch breach-loaders ten years' later [88].

More caution was shown in the development of the steam engine. The pioneer paddle-steamers were powered by large and inefficient single-expansion engines that were continually liable to breakdown and (mounted as they were above the waterline) catastrophically vulnerable to damage in any engagement. In addition, the sheer quantity of coal which the early steam engines consumed made trans-oceanic voyages impossible, and sail was necessarily retained as the principle motive power of the Royal Navy [89].

Not until Victoria's reign was underway did it become practical to provide sail line-of-battleships with auxiliary steam power. The development of the screw propeller made it possible to site engines in

[86] Ibid pp.146-7; Baxter op.cit. pp.10-11; Christopher Bartlett, *Great Britain and sea power 1815-1853* (Oxford 1963) pp.197-200

[87] Baxter pp.17-26, 69

[88] Ibid pp. 125, 131, 154, 197; Sandler, *The evolution of the modern capital ship* pp.99-100, 109; Marder, ABSP p.5

[89] Andrew Lambert, *Battleships in transition: the creation of the steam battlefleet 1815-1860* (London 1984) pp.18-19; Bartlett op.cit. pp.211-12; GA Osborn, 'Paddlewheel fighting ships of the Royal Navy', *Mariners' Mirror* 68 (1982) pp.429-33

protected positions below the waterline, and the screw hoist helped to guarantee reasonable performance under sail – impossible when a ship was fitted with bulky paddle–wheels. Once this problem was solved, the British became the first to fit their ships–of–the–line with screw propulsion [90]. Critics have nevertheless accused the Royal Navy of being over–cautious and reluctant to adopt steam as a motive power, and it is therefore essential to note that the eventual perfection of steam propulsion was by no means certain in the first two decades of the *Pax Britannica.* "Above all," writes Christopher Bartlett,

> "it was reasonable to doubt in the twenties whether the steamer would ever be able to fulfil the traditional requirements of the British capital ship – maximum fire power, maximum sea–worthiness, maximum solidity and maximum stowage capacity to enable it not only to fight, but to maintain a blockade in all weathers or voyage to any port of the globe. The only *tactical* and strategic advantage of the steamer at this time was its independence of wind and tide; on every other respect it was a less effective warship... The ultra–cautious introduction of steamers ...[in the 1840s]... could thus be justified – in no small measure – on the grounds of expediency, economy and technical ignorance, but only as long as no other power took the lead." [91]

The evolution of the wooden steam battleship has been traced by Lambert, who concludes that the Admiralty did an excellent, and suitably careful, job in producing vessels superior to those of its naval rivals in the 1840s and 1850s [92]. The Crimean War, it is true, exposed numerous deficiencies in naval organisation and naval personnel, but they were the defects of a service that had become too highly adapted to its peacetime role and which retained on its Navy List too many officers who had not commanded a ship for twenty years or more [93]. The Royal Navy's

[90] Bartlett op.cit. p.326

[91] Ibid p.206

[92] Lambert op.cit.

[93] Rodger op.cit. pp.142–4, 147–8

performance in the later stages of the war was relatively impressive; innovation was strongly encouraged when it came to the host of small craft needed for the war in the Black Sea and the Gulf of Finland, though battleships were still produced with one eye on their long-term usefulness in the struggle against France [94].

Under Napoleon III, France was anxious to enhance both her naval prestige and her say in foreign affairs. The French navy of the Second Empire was efficient and innovative, and its new construction was in the hands of a man of genius, the naval architect Dupuy de Lome. His wooden steam battleship *Le Napoleon* (1850) and the ironclad *Gloire* (1859) forced Great Britain into a naval race she had hoped to avoid – but the Royal Navy was not slow to surpass the standards which de Lome had set. The British *Warrior* (1860) was a great advance on *Gloire*, whose armour concealed a wooden frame. *Warrior*, the world's first iron warship, was by common consent superior to everything that had gone before her [95]. Under the progressive leadership of two particularly conscientious projectors – Edward Reed, the Chief Constructor, and the Controller, Admiral Sir Spencer Robinson – the RN was able to maintain the lead the *Warrior* gave it throughout the 1860s. Sail, not steam, was now the auxiliary power of British warships. "If the Admiralty was certain of anything during the period of profound technical change that characterised the decade of the 1860s, it was that the sailing war ship was a doomed anachronism," concludes Stanley Sandler. "It cannot be said that the retention of masts and sails throughout the 1860s constituted a conspiracy of obstruction on the part of the Admiralty... It is the hindsight of a century that gives us perhaps a clearer view of the technical imperatives demanding the eventual total abolition of sails." Lance Buhl comes to a similar conclusion in his study of innovation in the post Civil War American navy [96].

The 1870s and early 1880s were a comparatively dispiriting period in British naval history. The so-called 'Dark Ages of the Admiralty' were an era of public disinterest, political interference and strict economy. Naval

[94] Baxter op.cit. pp.70–3; Lambert op.cit. p.43

[95] Baxter op.cit. pp.97–100, 109–11, 122–4, 158–60

[96] Sandler op.cit. p.78, 84–5; Lance Buhl, 'Mariners and machines: resistance to technological change in the American navy, 1865–1869', *Journal of American History* (1974) pp.703–27

conservatism might have been expected to flourish in this climate. Nathaniel Barnaby, the new Chief Constructor, was not a man of outstanding ability, and he was certain ironclad battleships and merchantmen were the only ship types required by a naval power. Sir Astley Cooper Key, who held the post of Senior Naval Lord from 1879 until 1885, was another who unconsciously espoused conservative values by devoting himself to routine administration to the exclusion of strategic planning. He did, however, substantially improve the *materiel* efficiency of the British fleet [97].

The Royal Navy's Dark Age weaknesses were exacerbated by the virtual absence of any naval threat. The French challenge all but vanished in the aftermath of the Franco–Prussian War; the US Navy was in an exceptionally moribund state; the German fleet was tiny and the Russians bedevilled by an unfavourable geographic position. But even the Dark Ages had their bright spots. The leaders of another age were beginning to make their mark; Jackie Fisher was one brilliant iconoclast who gained preferment in this supposedly reactionary period. Alexander Milne, who served as Senior Naval Lord between 1866 and 1868 and again from 1872 to 1876, was one of the most able men ever to hold the post, and Sidney Dacres, who headed the Board of Admiralty in the intervening period, was also entirely competent; he was also one of the few officers who advocated the total abolition of masts and yards. During the Dark Ages the torpedo was adopted and developed with an enthusiasm that overcame budgetary restrictions and resulted in the creation of the pioneering torpedo boat *Polyphemus*. Milne himself was responsible for the creation of rudimentary but not unrealistic war plans in the middle 1870s.

The slow decline in naval efficiency and enthusiasm inevitable in an era of monetary restriction and political restraint was ended by a series of violent invasion scares in the 1880s. The 'Truth about the Navy' panic of 1884, which was initiated by Fisher, HO Arnold–Forster, and the crusading journalist WT Stead, renewed public interest in maritime affairs and encouraged significant increases in the naval estimates, which were bolstered by the French invasion scare of 1888. The result was the Naval Defence Act of 1889, which laid down the policy of a two–power standard. Under

[97] NAM Rodger, 'The dark ages of the Admiralty 1869–1885', *Mariners' Mirror* 61 (1975) pp.331–44; 62 (1976) pp.33–46, 121–28; Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) p.179

the guidance of William White, a naval architect of conspicuous ability, the RN began to build homogenous classes of first–rate warships in the late 1880s and 1890s. *Royal Sovereigns* and *Duncans* ruled the seas of the late Victorian era, and the renewed challenge of France and Russia, newly allied, was vigorously met. The torpedo boat, which many believed would threaten the supremacy of the battlefleet, was decisively countered by the British innovation of the destroyer – planned by the Admiralty but created, it must be admitted, by private industry [98].

This brief gloss is not the history of a stagnant service. Nor did the Royal Navy compare unfavourably with its major rivals. Despite the experience of the Napoleonic Wars and despite Paixhans' experiments in the 1820s, the French took four decades to adopt the shell gun [99]. Like the British, they displayed a suspicion of expensive iron warships in the 1840s, questioning the degree of protection offered and emphasising the dangers of splintering [100]. In the 1850s too many French warships were laid down without the step–by–step trials and experiments favoured by the UK, and the efficiency of the Frech navy suffered in consequence. France's steam warships were less advanced than their British rivals, and most were converted sail–of–the–line; even new construction continued to be wooden–hulled until the late 1860s, while the British turned definitely to iron hulls early in the decade. Royal Navy battleships of the period were superior in size, armament and in performance under sail [101].

The American navy failed to develop the lead in steam propulsion Fulton had given it after the War of 1812; Lance Buhl points out that "it did little more than conduct a distant flirtation with the weapon for nearly thirty years thereafter." [102] Steam remained auxiliary to sail in the United States, as elsewhere, until the outbreak of the American Civil War. And despite the impetus provided by this conflict, the United States did not capitalize on the dazzling innovations made during the early 1860s. The

[98] Mackay op.cit. pp.178– 9; Marder, ABSP pp.65–70

[99] Bartlett op.cit. pp.216–17

[100] Baxter op.cit. pp.63–4

[101] Lambert pp.97–101, Sandler op.cit. pp.44–46
It is interesting to note parallels with French submarine construction policy of the early 20th century, which was similarly biased towards the theoretical. See section 5.3.

[102] Buhl op.cit. p.704

submarine and the machine-gun were just two of the weapons developed during the war that remained unexploited for another half-century [103].

Having very briefly summarised almost a century of naval technical history, we are perhaps better placed to assess the British response to technological change. This response was not consistent and depended upon a variety of factors, some of them external to the Royal Navy and some of them internal. Obviously, both the political climate of the UK and the activities of foreign rivals were key variables. The stringent economies imposed by both Liberal and Tory governments during the 'Dark Ages' encouraged the retention of sails long after steam engines were technically efficient; coal was expensive [104]. Political expediency severely limited the funds available for experimentation and certainly precluded expenditure on weapons as esoteric as the submarine [105]. A desire to economise resources both financial and human underpinned Britain's 'wait and see' construction policy.

As the leading maritime nation, Britain had little incentive to innovate. As things stood she was supreme at sea; why should she introduce weapons or ships that might drastically alter the balance of power? This was the reason for British (and indeed French) unwillingness to adopt the potentially-devastating shell gun, for if the weapon lived up to its potential the navies of the world would have to armour their fleets at phenomenal expense and drain their treasuries merely to maintain a position which they already held. The introduction of any radical innovation potentially gave Britain's rivals the chance to start the naval 'race' again on even terms [106], and St Vincent's unequivocal response to the news that his Prime Minister had lured Fulton across the Channel to have him build underwater

[103] On US development of the machine-gun, see David Armstrong, *Bullets and bureaucrats: the machine gun and the United States army 1861-1916* (Westport, Connecticut 1982)

[104] Sandler op.cit. pp.17, 85-7

[105] The influence of economy on British naval policy has been widely stressed: cf. Semmel op.cit. pp.79-83; Rodger, 'British naval thought and naval policy' p.145; Sandler op.cit. pp.38-9, 79-80; Paul M Kennedy, *The rise and fall of British naval mastery* (London 1983) esp. pp.177-79, 193-4; Baxter op.cit. p.173; Lambert op.cit. p.60

[106] Bartlett op.cit. p.204, 216-17
This argument was, of course, commonly advanced when the RN introduced the *Dreadnought* design early in the 20th century. In this case, however, other navies were already planning very similar ships, and two decades of a naval arms race had increased public interest in naval affairs and made the governments of the day more willing to sanction the expenditure involved.

weapons for the Royal Navy was often quoted when this point was made. "Pitt was the greatest fool that ever existed," the Admiral is reported to have said, "to encourage a mode of war which they who command the sea did not want and which, if successful, would deprive them of it." [107]

In 1858 the Surveyor put St Vincent's policy in writing: "As I have frequently stated," he wrote,

> "it is not in the interest of Great Britain possessing as she does so large a navy to adopt any important change in the construction of ships of war which might have the effect of rendering necessary the introduction of a new class of very costly vessels until such a course is forced upon her by the adoption by Foreign Powers of formidable ships of a novel character requiring similar ships to cope with them... it then become a matter not only of expediency but of absolute necessity." [108]

The significance of this statement for nineteenth century British submarine policy is obvious.

The successful implementation of a strategy of 'wait and see' made it important that a careful watch be kept on foreign rivals, and Sir Baldwin Walker and his successors backed up the policy with an extensive programme of research and experimentation; no reasonable suggestion was rejected out of hand. A fine example of the open–mindedness (though some might say empty–headedness) of the Surveyor's Department may be found in the Admiralty's 1840 investigation of rubberised armour, a compound of rubber and cork which a Royal Marines lieutenant had suggested might be used to coat iron warships in the hope that it would deflect incoming shot and shell. Trials at Woolwich showed that the compound was useless; what is significant is that the Admiralty ordered experiments rather than condemning this unlikely–sounding invention out of hand [109].

[107] St Vincent, supposedly in an interview with Fulton during October 1805. It is entirely possible the quotation is apocryphal; we have only Fulton's word for it. What matters, however, is that St Vincent's adage was widely circulated in the 19th century and was widely accepted as genuine. See Alex Roland, *Submarine warfare in the age of sail* (Bloomington, Indiana 1976) pp.112–13

[108] Walker submission of 22 June 1858, quoted in Baxter op.cit. p.117

[109] Baxter op.cit. p.36

The Surveyor's Department's had an excellent record in such cases. The potential of iron armour was investigated with great thoroughness, the negative conclusions reached in the 1840s being drawn from six years' work and eight major series of experiments. In the 1850s similar trials were conducted to compare rolled iron, cast iron and steel before the navy decided on rolled iron plating for armour, and at the end of the decade puddled steel was also tried and rejected. Inclined (tumblehome) armour experiments were carried out in 1860 and the idea rejected for a variety of technical reasons which showed that under Walker and Isaac Watts, Britain's naval constructors were fully capable of conducting fair trials and drawing reasoned conclusions from the results [110].

There is no reason to suppose that the mid-nineteenth century Surveyor's and Controller's departments displayed significant bias in assessing new inventions, despite the pressures to which they were subjected. In the 1860s, for example, Reed and Robinson gave a fair trial to the controversial armoured turret warship promoted by the British inventor Captain Cowper Cowles [111] and the Swedish-American engineer John Ericsson [112]. The pros and cons of the armoured gun turret have been set out by Stanley Sandler, and it is plain that the controversy that swirled around the weapon had as much to do with party politics as it did with practical policy. From the Royal Navy's point of view, the principal defects of the turret were its weight, which lowered freeboard and therefore adversely affected seaworthiness, and a limited utility when fitted to an ocean-going warship; foc'sle, poop, masts and sails all cut down the arc of fire. In addition, the number of guns that could be carried in turrets was limited, and neither the weight of shot in a turret battleship's broadside nor its rate of fire bore comparison to the ferocity of an 'old fashioned' steam ironclad's short-range hail of shot and shell. These failings rendered the turret ship of doubtful value, and condemned it to remain so until rifling made accurate long-range fire possible and until masts and sails were largely done away with. The Navy's rejection of Coles's initial approaches was therefore sound. It was, moreover, tacitly supported by Britain's foreign

[110] Ibid pp.36-9, 118, 154, 162-3, 201-07

[111] Ibid pp.181-92

[112] Ibid pp.250-67

rivals; none built seagoing turret ships in this period [113].

The inventor and his powerful supporters were quick to condemn Admiralty 'conservatism', and the administration of the day was regularly berated in Parliament and in the press. There was undoubtedly resistance to technological change in the Royal Navy. An active list peppered with officers who had not been to sea for twenty years was unlikely to throw up many deviants from naval orthodoxy; employment was too scarce for many to risk going out on a professional limb. But the Victorian Navy had the nineteenth century's faith in progress, and this meant orthodoxy was never synonymous with reaction. Officers were cautious rather than incompetent, and indeed the Admiralty's own turret-ship, Reed's coastal ironclad *Devastation*, was a far more effective warship than Coles's disastrous *Captain* [114]. Conservatism was rooted in institutions and owed its existence as much to administrative problems as it did to the prejudice of individual officers [115].

The administration of the Navy was always open to criticism. The members of the Board of Admiralty were political appointees, and naval affairs were often caught up in inter-party disputes. The pressure of public opinion forced the Navy into several ill-considered political decisions. Equally significantly, the propensity of incoming governments to install their own Naval Lords meant that the average tenure of a Board of Admiralty between 1834 and 1871 was little more than three years [116]. Nor were the duties of the naval lords properly defined. Between 1832, when Sir James Graham reformed the administration, and 1869, when Hugh Childers became First Lord of the Admiralty, each member of the Board had two potentially incompatible functions. No distinction was made between the individual responsibility of the Naval Lords for the administration of their departments and their collective duty to oversee the administration of the Navy. This system made it impossible to assign responsibility for decisions to individual members of the Board, and in the absence of a staff and of London-based middle-ranking naval officers, the senior officers at the

[113] Sandler op.cit. pp.51, 179-80, 194-5

[114] Ibid pp.183-4, 192-4, 230-5

[115] Rodger op.cit. pp.142, 145, 147

[116] Sandler pp.41-3

Admiralty spent much of their time performing routine clerical duties. "By 1868," writes Rodger, "the Naval Lords had become mere administrators. The Board mechanism now existed only as an engine for dissipating responsibility." [117]

In December 1868, Gladstone made Hugh Childers First Lord of the Admiralty and instructed him to reduce the naval estimates and reorganise the administration. Many of the new First Lord's policies had merit; in particular, by introducing compulsory retirement for aged or permanently unemployed officers, Childers thinned out the Navy List and helped to produce a comparatively young and able generation of senior officers in the 1890s. But the First Lord did not understand the Navy and his decisions were based on political and economic preconceptions. His reform of the Board of Admiralty enhanced his own position, reduced collective discussion and responsibility still further, increased the amount of paperwork to be dealt with, and inhibited the development of strategic policy. Although some of Childers' more damaging reforms were rescinded by his successor, George Goschen, the influence of Gladstone's appointee continued to be felt well into the next century [118]. Not until the 1880s did the Admiralty regain some of the energy it had displayed in the 1860s.

It is in this context that we must view British submarine policy in the mid–Victorian period. This short sketch cannot, of course, do real justice to modern research on the nineteenth century Royal Navy. It omits much of importance, and necessarily glosses over many of the failings of the Senior Service – which was very far from perfect. But it does, I think, suggest that the institution was never unthinkingly reactionary [119], that it was relatively open to innovation, and that it was unlikely to reject the submarine as a moral outrage or a wild and hopeless fantasy.

## British submarine policy 1856–1885

Underwater warfare evolved rapidly in the latter half of the nineteenth century. Mines and locomotive torpedoes were familiar weapons to a new

[117] Rodger, 'Dark ages' in *Mariners' Mirror* 61 pp.332–4

[118] Ibid pp.336–8, 342–3 and *Mariners' Mirror* 62 pp.122–3

[119] As Christopher Bartlett points out, "an intelligent conservative mind could speedily reinforce, and perhaps conceal, its prejudice with reasonable arguments against steam–power. Yet... a certain horse–sense was not lacking." Bartlett op.cit. p.205

generation of naval officers; Fisher and Tirpitz were among those who made their names in the torpedo services of their respective countries. In France a new school of naval thought, the *jeune ecole*, drew attention to the offensive possibilities of submarine weapons; in Russia, service in the torpedo branch meant prestige, accelerated promotion and better pay, and the officer corps was reported to be "enchanted with the torpedo boat" [120]. The British learned to be wary of Russian mines in the Crimean War, and the Federal Navy was taught the same lesson during the American Civil War. The Confederate Torpedo Bureau had more success than all the other rebel naval forces put together, sinking 29 enemy ships and damaging 14 more with mines and spar torpedoes [121].

The Civil War legitimised submarine warfare and emphasised its importance, and there was an appreciable upsurge of interest in the subject from the mid–1860s. In 1866 the Italians used mines to protect ports against Teggethoff's Austro–Hungarian fleet, and during the Franco–Prussian war minefields were sown to defend the German littoral against a materially superior French fleet. Russian torpedo boats scored striking successes with both spar and locomotive torpedos during the Russo–Turkish war of 1877–8. The Royal Navy adopted the Whitehead torpedo in 1870, and experimented fitfully with mines throughout the 1870s and 1880s.

The torpedo boat became the bogey–weapon of the mid–Victorian era. The first crude, spar–armed examples appeared when small but powerful steam engines were developed in the 1860s, and second class TBs were carried by many of the early ironclads. Improvements in the 1870s and particularly the 1880s led to the construction of larger, independent boats, lightly armed and armoured and dependent on high speed and raw courage to deliver their attacks – preferably by night.

Torpedo boats were popular with most navies in the late nineteenth century. The newly–unified German navy was among the first to develop the type, constructing semi–submersible spar torpedo boats in the early 1870s and – under the leadership of Tirpitz, who held the commission of Inspektion des Torpedowesens – a number of more conventional boats later

[120] Captain Beaumont report, quoted HMS *Vernon* annual report 1882, Adm 189/2 pp.129–34; Captain Henry Kane report 'Russian manouevres in the Baltic' 3 September 1884, FIC no.50, Adm 231/5

[121] Perry op.cit., appendix A

in the decade [122]. The invention of the fish torpedo made the TB more attractive, for until the development of ship–mounted machine guns and quick–firing artillery in the 1880s it proved difficult for ironclads to ward off torpedo flotillas that did not have to close to ram. The British Torpedo Committee of 1876 reported that neither gunfire nor torpedo nets, guardboats nor extra lookouts could prevent a determined torpedo attack [123], a state of affairs that eventually encouraged other naval powers such as France – which had belatedly began TB construction in the mid–1870s – to develop the weapon in the 1880s.

In the June 1884 manouevres, French torpedo flotillas launched the first full–scale attack on a fleet under weigh, closing to within 1,000 yards of their targets before being seen despite the disadvantage of a bright moonlit night, and coming under fire for less than a minute before discharging their torpedoes at a range of 400 yards [124]. This striking success encouraged members of the *jeune ecole*, a group of naval strategists who pointed out that France could not afford to maintain armed forces capable of opposing Germany on land and Britain at sea. The new school now suggested that French naval estimates could be reduced by abandoning the construction of capital ships and diverting resources into the production of fast cruisers and flotillas of cheap torpedo craft.

A sufficient number of cruisers could (it was suggested) bring the British Empire to its knees by disrupting a seaborne trade thought, in 1899, to be worth £710,000,000 per annum, while torpedo flotillas harrassed British commerce in the Channel and coast defence ships protected the rump of the French battlefleet. So long as the *Marine Francaise* had a fleet in being, argued the *jeune ecole*, the Royal Navy would have to institute a blockade of the enemy coast and would be unable to concentrate its resources on commerce protection [125].

[122] Charles Chesney report no.56, 'Submerged iron torpedo boats of Germany' 14 October 1871, Adm 1/6241; Carl–Axel Gemzell, *Organisation, conflict, innovation: a study of German naval strategic planning 1888–1940* (Lund 1973) pp.58–9; Mackay op.cit. pp.129–30

[123] Cowpe op.cit. p.19

[124] Ibid pp.119–20

[125] Geoffrey Till et al, *Maritime strategy and the nuclear age* (London 1982) pp.34–8; Bryan Ranft, *The naval defence of British seaborne trade, 1860–1905* (Oxford University D.Phil 1967) pp.23–7

The strategy was an attractive one for obvious reasons. France, it suggested, could strike at the heart of her old enemy's prosperity without attempting to wrest command of the sea from the RN in a decisive battle which most admitted would have to be fought on British terms. She could, moreover, do so cheaply (dozens of torpedo boats could be built for the price of an armourclad) and in the knowledge that a wholly disproportionate effort would be required to track down and despatch each raiding cruiser.

Sadly for the hopes of the *jeune ecole*, however, naval developments of the late 1880s and 1890s did much to discredit the torpedo boat. Later manoeuvres were inconclusive or downright discouraging; in 1887 the French flotillas failed to locate an enemy battle squadron – which had taken the simple precaution of dousing its lights by night – though they themselves were visible for miles, betrayed by the showers of sparks emitted by their over-heated engines. TB crews soon became exhausted; the efficiency of the flotillas declined swiftly after several days at sea in poor weather, and those torpedoes that were discharged sometimes acquired deflections of up to 15° from the engine vibrations that shook the little boats [126]. In 1889, 1892 and 1893 the *defences mobiles* of the Mediterranean Fleet could not prevent 'Italian' squadrons from ravaging the French coast more or less at will [127].

British experiences with the TB were hardly more positive. In 1894 a flotilla attack on the battle squadron was adjudged unsuccessful despite being pressed to within 300 yards, and other torpedo boats attacked friendly warships. In 1895 Captain AK Wilson succeeded in blockading 'enemy' TBs in their harbour with a flotilla of newly developed torpedo boat destroyers, and British torpedo craft had no more success in the manoeuvres of 1896 [128].

The French nevertheless pressed ahead with TB construction. By 1893 a dozen torpedo boat stations were strung along the coast from Dunkirk to Brest, with more under construction in the Mediterranean, and 80 first class TBs were stationed in the Channel [129]. But useful as the new large

[126] Cowpe op.cit. pp.123–4

[127] Ibid pp.125–6

[128] Ibid pp.151–3

[129] Marder, ABSP pp.164–8

torpedo boats were admitted to be in coastal waters or the sheltered Med., they remained largely useless on the Royal Navy's high seas stamping grounds [130]. According to Alan Cowpe, the historian of the British torpedo service,

> "attempts to make the torpedo boat a seagoing threat to the battleship were discredited by the very manoeuvres designed to prove... [the]... thesis, while in its very reduced role as a harbour and coast defence vessel, the capabilities claimed by its advocates were never demonstrated in practice. The torpedo boat was repeatedly in difficulties merely steaming on the high seas, which dramtically reduced its claimed speed. By night, when it was reputed to be at its deadliest, the torpedo boat was often unable even to find the enemy." [131]

Although the Royal Navy continued to respect the Whitehead torpedo as a potent 'single blow' weapon possessing considerable moral effect and the ability to limit an enemy commander's freedom of action, it was, by the middle 1890s, coming to terms with the torpedo boat menace. Quick-firing guns, the TBD and the development of high-speed evasive tactics combined to make life in a surface TB dangerous and unprofitable, and a NID report on the 1895 manoeuvres quoted one naval officer who was of the opinion "that all the present types of torpedo boat are obsolete, and that probably no more will ever be built." [132]. Despite its advantages of high speed and low silhouette, therefore, the surface TB was – in the eyes of the RN at least – something of a spent force by 1900. The stage was set for the arrival of a different sort of torpedo boat.

*

The naval authorities showed no special concern for the submarine between 1856 and 1885. They could have done so. There were always a multitude

[130] Ranft op.cit. pp.272–3, 283

[131] Cowpe op.cit. p.126

[132] Ibid p.152

of projects in progress at home and abroad, and a good dozen significant attempts to build workable boats were made in this period. The Royal Navy's interest in the subject was at best sporadic, and this suggests two things: that the Admiralty had an established conception of how a useful submarine would perform and what it should do, against which it measured the inventions which came to its notice, and that in the absence of such a machine the RN gathered information about imperfect vessels not because they constituted a threat, but because it wanted to learn something of the activities of its naval rivals. If this model is correct, we would expect the Admiralty to be more interested in underwater warfare generally than it was in submarines in particular, and anticipate that the Royal Navy would find indifferent national projects more compelling than useful but privately–built submarines.

The Admiralty's clandestine dealings with the Confederate submariner James McClintock support this interpretation of mid–Victorian submarine policy. Like Wilhelm Bauer, McClintock was a self–motivated and persistent inventor who had acquired considerable practical experience of underwater warfare. When the American Civil War broke out, he was the part–owner of a machine shop in New Orleans. With the financial backing of a wealthy lawyer and broker, Horace Hunley, McClintock and his partner Baxter Watson designed and constructed a small submarine at the Government Navy Yard. This boat, the *Pioneer*, was launched in February 1862 and underwent trials on Lake Pontchartrain. The inventors intended her to operate as a privateer, applying for and receiving a Letter of Marque. In April 1862, however, Federal forces captured the city and the submarine was scuttled to keep her out of enemy hands [133]. The *Pioneer* syndicate escaped to Mobile and within a few months had built a second boat, which sank in a storm while under tow off Fort Morgan late in the year. McClintock then designed a third submarine, named her for his principal backer, and sent her to the blockaded port of Charleston, where as we have seen she sank the Federal warship *Housatonic* on 17 February 1864 and was herself lost during the attack [134].

[133] 'CSS *Pioneer*', Royal Navy Submarine Museum archives A1872/23

[134] Perry op.cit. pp.90–108. *Hunley* hobbyists have never agreed on the identity of the submarine's designer; most assume from the craft's name that Horace Hunley himself was responsible, but McClintock's technical backround makes him a much more likely candidate ▶

The exploits of the Confederate submarine service were the stuff of legend, and Frederick Cridland, the British consul at Mobile, was one of many fascinated by the story of the *Hunley*. He succeeded in tracing McClintock to a dredger busy clearing the muddy waters of Mobile Bay, and in March 1872 obtained an interview with the Confederate inventor and forwarded a description of his submarine to the British authorities [135].

The Admiralty's response was cagey, and the consul was asked to "obtain all the information ...[you]... can on the subject, and if possible the opinion of American Naval Officers" [136]. In the face of the inventor's refusal to allow a Yankee access to his plans, however, it was decided to send the Flag Captain of the North American station to Mobile with his chief engineer so that a full report could be made [137]. At this stage McClintock, who had contrived without actually lying to give the impression he had a submarine lying in the bay, was forced to admit that the boat existed only on paper, and alternative arrangements were made for him to visit the *Royal Alfred* at Halifax.

On 18 October 1872 the inventor arrived on board the flagship of Vice Admiral EG Fanshawe, and in the course of a two–hour conversation Flag Captain Nicholson and the chief engineer, Josiah Ellis, were "strongly impressed with the great intelligence of Mr McClintock, and with his knowledge of all points, chemical and mechanical, connected with submarine vessels." [138] The persuasive Confederate even convinced them that, if only he had had better resources, "these submarine boats would have attained a terrible celebrity and materially have affected the course of the war."

Nicholson and Ellis concluded that "Mr McClintock's boat is capable of performing all that he promises of her, and we consider his invention of

for the honour. According to McClintock's partner, Baxter Watson, McClintock designed the boat, Watson built it and Hunley and his associates paid for it. Letter from Baxter Watson II to Eustace Williams cited in Williams, *The Confederate submarine* Hunley *documents*, (np Van Nuys, Calif. 1958, typescript in the New York Public Library). But see also the contrary arguments advanced by Ruth Duncan, *The captain and submarine HL Hunley* (privately published, Memphis 1965; copy in the NYPL). Given the importance of McClintock's dealings with the RN, it seems worth noting that I tend to accept he was the *Hunley*'s designer.

[135] Cridland to Foreign Office 5 April 1872, FO 5/1372

[136] Cridland to Foreign Office 17 July 1872, ibid

[137] 'Submarine boat invented by Mr McClintock...' 9 August 1872, digest cut 59–8, Adm 12/897

[138] Fanshawe to Goschen 21 October 1872, Adm 1/6236 box II

the greatest possible value." [139] Admiral Fanshawe endorsed their report, and believing that submarine boats had an important future he suggested that "it would be very desirable to bring Mr McClintock to England and afford him with all the necessary means to construct, or superintend the construction of, a boat of good capacity according to his plans, at the public expense – which would not be great in comparison with the object." [140]

In December 1872 McClintock was invited to visit Britain and lay his plans before the Admiralty [141]. After a certain amount of hesitation, he refused the offer on the grounds that he could not afford to bring himself and his family to London because the trip to Halifax had cost more than $600. "If I should sacrifice my present means of support," he wrote, "and not make any definite arrangement with the Admiralty I should find myself in England in a very uncomfortable predicament." [142] British interest waned. The Royal Navy did attempt to persuade the Foreign Office to meet the inventor's past and potential expenses "from the secret service money" [143], but was simply not prepared to fund McClintock's trip itself.

What conclusions can be drawn from this unusually well–documented episode? The investigating officers were impressed by McClintock's expertise in underwater warfare generally, and drew attention to it in their report: "He produced two documents to shew the extent of the torpedo work he had done for the Government of the Confederate States," they noted, "we venture to submit that the vast experience he must have acquired in this work would be of great value to any government interested in perfecting a system of torpedo defence." [144] For its part, the Admiralty took the

[139] Nicholson and Ellis 'Report on a submarine boat invented by Mr McClintock of Mobile, US of America' 19 October 1872, ibid

[140] Fanshawe to Goschen, 21 October 1872, ibid

[141] Cridland to Foreign Office 3 January 1873, FO 5/1441

[142] McClintock to Cridland, letter dated 7 January 1873 but probably written late December 1872, ibid. When the Admiralty queried his seemingly excessive expenditure, it learned that "on Mr McClintock's return homeward he was seized with typhoid pneumonia at Bangor, Maine, and had to remain there confined to his bed for over six weeks. It appears that through a mistake a large quantity of morphine was administered to him in place of quinine. His recovery was not expected..." Cridland to Foreign Office 3 January 1873, FO 5/1441

[143] 'Inability of Mr McClintock to visit England...' 8 February 1873, digest cut 59–8, Adm 12/920

[144] 'Report on a submarine boat invented by Mr McClintock...' 19 October 1872, Adm 1/6236 box II. Similarly, Alexandrofsky's submarine was considered firmly in the context of ▶

inventor seriously because of this experience and because he had designed what they understood to be a successful submarine. The fact that the Flag Captain of the North American station had been detailed to leave his ship and travel several thousand miles to Mobile strongly suggests that the British authorities were suitably impressed by the wartime achievements of the Confederate submarines.

McClintock did not disillusion them. He carefully avoided mention of the *Hunley*'s inadequate armament and grisly safety record – she had drowned almost 30 crew members during trials – glossing over her destruction during the attack on the *Housatonic* as "a totally unnecessary part of the performance." [145] Significantly, too, the Admiralty was anxious to learn as much as it could about the submarine at the least possible cost. In 1872 the Royal Navy was subject to severe financial constraints, jibbed at the cost of bringing McClintock and his family to Britain, and met only a part of his expenses (he received $250). Despite the enthusiasm of its representatives on the spot, it is unlikely in the extreme that the Admiralty ever had any intention of paying the inventor to build a submarine.

Most projectors received less consideration from the British naval authorities than had McClintock. Those without practical experience of submarine warfare continued to be treated with scepticism, and though the Admiralty sometimes expressed tentative interest in schemes that seemed likely to reach fruition, it was always on the understanding that the costs of construction and the risks of trials were to be borne by the inventor [146]. Despite this caution, occasional disputes arose. In 1879 the Reverend George Garrett built a small steam–powered submarine, *Resurgam*, at his own expense and offered to put the boat through her paces before a committee of naval officers. His proposal was accepted, but while the submarine was being towed from Birkenhead to Portsmouth, the Manchester curate lost her in a storm. The boat had cost Garrett £1,400 to build, but when he asked the Navy to refund his costs the Admiralty replied by

Russian expertise in underwater warfare. See William Houston Stewart minute 9 March and Admiralty to Foreign Office 15 March 1873, Adm 1/6281

[145] McClintock statement 30 March 1872, FO 5/1372

[146] Cf. 'Letter from Mr William Steel' 5 August 1812, digest cut 59–8, Adm 12/155; 'Mr Maguay' 19 February and 18 March 1878, digest cut 59–8, Adm 12/1023; 'Submarine torpedo launch submitted by Mr F. Windham' 4 May 1885, digest cut 11a, Adm 12/1138

denying responsibility, and a correspondence took place "relative to trials by Admiralty officers and alleged encouragement to Mr Garrett to build the boat." The authorities steadfastly refused to compensate the inventor, and in December 1880 rejected the further suggestion that he should build another submarine in exchange for £10,000 on the successful completion of trials [147].

The Admiralty ignored other would–be submariners completely. "You will be tired enough of projectors before you have done with them," Sir Charles Wood had warned Palmerston in 1855 [148], and the Royal Navy showed little patience with the majority of civilian inventors. It refused to send officers to Slough to inspect the 'patent submarine ship' built by Mr Henry Middleton [149], and turned down a request that naval officers be sent to Annapolis to witness the trials of Professor Josiah Tuck's promising *Peacemaker* [150].

Further evidence that the Admiralty was not especially interested in submarine projects that did not have the backing of one of its naval rivals can be found in an examination of the early career of John Philip Holland. Born in 1841 in County Clare, Holland emigrated to the United States at the age of 32. He took with him the rough plans for a submarine boat drawn up during the years he had spent instructing children in mathematics and mechanics at schools run by an Irish teaching order, the Christian Brothers [151]. Soon after his arrival in America, Holland began to cast about for backers. The inventor's most likely source of funds was one of the then–active Fenian societies, and in 1876 his brother Michael introduced him to just such a group of people: Jeremiah O'Donovan Rossa and the leaders of the Fenian Brotherhood. These men were impressed by the possibility of striking a blow at Britain's maritime supremacy, and

[147] 'Submarine invention – Revd GW Garrett' 8 April 1878, digest cut 59–8, Adm 12/1023; 'Revd. GW Garrett's submarine torpedo boat' – precis dated 8 April 1878 in digest of 1880, cut 59–8, Adm 12/1060. See also William Scanlan Murphy, *Father of the submarine: the life of the Reverend George Garrett Pasha* (London 1987). Although of a fairly advanced design, Garrett's little boat had no ballast tanks and no weapons system. Prolonged dives and effective attacks were therefore out of the question.

[148] Wood to Palmerston 26 March 1855, Add.Mss. 49562 fols.27–8

[149] 'Mr Henry Middleton's patent submarine ship' 12 November 1888, digest cut 11a, Adm 12/1186

[150] 'Professor Tuck's submarine boat' 12 January 1887, digest cut 11a, Adm 12/1170

[151] Donal Blake, 'John Philip Holland: his connection with the Christian Brothers', privately published paper in RN Submarine Museum archives A1985/49

Rossa's Skirmishing Fund agreed to finance the submarine project.

Holland set to work, building a working model and then a tiny steam–driven submersible 'canoe', 14ft. 6in. long and crewed by a man in a diving suit. She worked sufficiently well for a much larger boat to be laid down. This craft, the *Fenian Ram*, was built in New York City by Delamater's Iron Works at a cost of $20,000. She displaced 19 tons, had a crew of three, and was powered by a 15hp Brayton petrol engine. The boat was armed with a pneumatic 'dynamite gun', and upon her completion in 1881 made some well–publicised cruises around New York harbour. Eventually, in 1883, Holland's backers grew impatient at the slow progress of trials and took possession of the submarine. They were, however, unable to operate her successfully, and in October 1883 the British Vice Consul found the *Ram* tied up and neglected at Sewer Dock, in a disreputable part of the harbour.

The British consulate had begun to take an interest in the *Ram* in March 1880, while she was still under construction at Delamater's yard. Both the British naval attache, Captain William Arthur, and Consul General Archibald visited the shipyard while the submarine was building, and although initially sceptical of rumours that the Fenians were behind the project, they quickly obtained evidence that this was indeed the case [152]. Private detectives were employed to keep track of the submarine, and Archibald himself took the trouble of establishing a relationship with Cornelius Delamater [153]. The contractors allowed Captain Arthur to copy Holland's plans [154], and (perhaps by citing the *Alabama* claims) British officials persuaded the US customs authorities to keep a watch on the submarine: "The American government will do anything to carry out the wishes of Her Majesty's Government with regard to this and any other such plans," noted Vice Consul Drummond [155]. British and American officials

[152] Arthur naval attache's reports no.12, 5 March 1880, and no.26, 19 May 1880, FO 115/673 fols. 18–19, 55–6; Thornton to Foreign Office 24 May 1880, FO 5/1745 fol.266

[153] Archibald to Thornton 20 December 1880, FO 5/1746 fols.186–9; Pierrepoint Edwards (Vice Consul, New York) reports political no.35, 14 July 1881, FO 5/1778 fols.315–19; political no.39, 20 July 1881, ibid fols.343–5; political no.41, 25 July 1881, ibid fols.367–72

[154] Arthur naval attache's report no.90, 2 August 1881, FO 115/673 fols.209–10

[155] Drummond (Vice Consul, New York) telegram 3 September 1881, FO 5/1780 fol.13; see also Foreign Office to Drummond 12 September 1881, ibid fol.32; Admiralty summary of Drummond report secret no.223, 1 August 1881, in bound volume of reports titled ▶

watched the *Fenian Ram* for two years, until she was "rusted so she is hardly good for anything... [and] there was some talk of her being sold for old iron." [156].

Britain's diplomats took the *Fenian Ram* far more seriously than did the Admiralty. The Foreign Office sustained a major intelligence operation directed against the several Fenian societies from the 1860s to the mid 1880s, when the Nationalist clamour began to diminish. It was forcibly convinced by a variety of terrorist outrages that the Irishmen represented an appreciable threat. To the Foreign Office the submarine was important because it was a Fenian project, and the New York consulate displayed little interest in her until Holland's links with the Skirmishing Fund were made clear.

The Admiralty approached the problem in a different way. It was prepared to take Holland seriously because of his links with the Fenians – indeed the DNO, Hopkins, minuted that "we should have the authority to take possession of this vessel whenever she gets under our jurisdiction" [157] – but the RN was more interested in the submarine's technical shortcomings than in her political significance. From this point of view, the *Fenian Ram* was not much of a threat. Although (unusually) she performed satisfactorily under water, the submarine was terribly slow, and her weapons system was never perfected. Holland thought of her as no more than an experiment; he intended to build bigger, better boats at a later date. While the Foreign Office was spending heavily on private detectives, therefore, the Director of Naval Construction judged that "there seems no reason to anticipate that this boat can ever be a real danger to British ships... [and] *we should not recommend the spending of any money in order to obtain information.*" [158]

'Supposed Fenian submarine torpedo boat in the course of construction at New York' fol.77, Adm 1/6551; Edwards reports political no.47, 2 August 1881, ibid fols.118–119, and political no.49, 5 August 1881, ibid fols. 151–3; Foreign Office to Admiralty 3 August 1881, ibid fol.106; Drummond report secret no.229, 8 August 1881, ibid fol.164; Edwards report political no.53, 1 September 1881, and enclosures, ibid fols.169–71; Sackville–West to Foreign Office 20 October 1883, Adm 1/6693

[156] Booker report 26 October 1883, Adm 1/6693. The effort which British officials put into monitoring Holland's activities may be contrasted with the total indifference alleged by the Admiralty critic Stanley Bonnett in *The price of Admiralty: an indictiment of the Royal Navy 1805–1966* (London 1968) pp.151–3.

[157] Hopkins minute 9 August 1881, 'Suppposed Fenian submarine...' fol.89, Adm 1/6551

[158] Barnaby minute 12 June 1880, ibid fol.7

Between 1860 and the turn of the century most naval powers of any consequence built at least one experimental submarine. Several of these boats have been mentioned above – the French *Le Plongeur* (1859–67), Russia's Alexandrofsky and Drzewiecki submarines (c.1863 and 1879), the *Hunley* and Halstead's *Intelligent Whale*, both constructed in America during the 1860s, and the Spanish *Peral* (c.1886). In addition, Italy launched a submarine in 1890 and Portugal's *Fontes* was completed in 1892. There were unconfirmed but persistent rumours that Germany had built two boats of the Nordenfelt type and tried them in the naval manoeuvres of 1890.

Even setting aside the *materiel* inadequacies which bedevilled all these submarines, the Royal Navy still had three good reasons, and one bad one, for doubting that any would be a real threat. Firstly, diverse as they were in conception and design, not one of the boats had the unqualified support of the naval authorities. Proponents and opponents of submarine construction came and went, and the type was never developed with the consistency needed for long–term success. In addition, many of the submarine's most fervent supporters were junior officers whose views were as easily ignored by their own navies as they were by the British Admiralty. Secondly, it was obvious that the capabilities of the boats produced in this period were grossly exaggerated in propaganda issued by the inventors and by the patriotic enthusaism of the mass media. No trial could be conducted, it seemed, without it being accounted "a complete success". The Royal Navy never took such press coverage particularly seriously, but its very extravagence set the usually mundane deficiencies of the submarines themselves in perspective. Thirdly, the factions that actually promoted underwater warfare did so for reasons that did not necessarily include actual belief in the short–term future of the submarine.

Carl Axel Gemzell has pointed out that naval innovation can result from organisational conflict within a naval hierarchy, and that groups struggling for power and influence often back some new invention. In doing so, they create a rallying point and create an association of interest that helps to give the group an identity [159]. The histories of many early submarine projects fit this model. In France the submarine was the child of

[159] Carl Axel Gemzell, *Organisation, conflict, innovation: a study of German naval strategic planning 1888–1940* (Lund 1973) pp.129–37

the *jeune ecole*, where one of the new school's figureheads was the same Simeon Bourgois who 20 years before had persuaded the French navy to build *Le Plongeur*. In 1888 the United States Navy appropriated $150,000 for the construction of a boat, but President Cleveland lost an election and "with the change in administration, interest in submarine development languished." [160] The Italian submarine *Delfino* was twice in commission, in 1896 and 1901–02, but she was laid up during the intervening period of naval disapproval [161]. In Britain the type was to be associated with the Fisher administration, and one Inspecting Captain of Submarines was warned, "you are closely connected with, a great man if you like, but one whose influence and interference are deeply resented, and who is regarded with great suspicion by the Service in general." [162]

One factor remains to be considered: British arrogance. The Royal Navy had considerably less faith in the ability of its naval rivals to produce submarines than it had in its own capacity to do so.

As we have seen, many foreign submarine projects were the work of comparatively junior naval officers who received little moral or material support from their naval authorities. For a time the people of Spain were sanguine about the prospects of Lieutenant Peral's submarine "which, according to the Spanish papers, is destined to raise Spain at once to the rank of a first–rate naval power." [163] From Cadiz the British Vice–Consul reported that "the vessel has awakened very considerable interest in Naval and Scientific circles in Spain", but he was shrewd enough to wonder "how much of this is owing to the intrinsic merits of the invention, and how much to its being a national production." [164] Sure enough, Spainish enthusiasm for the submarine and its inventor (who was

[160] Frank Cable, *The birth and development of the American submarine* (New York 1924) pp.331–2

[161] Report 'Relative to the Italian submarine boat *Delfino*' 21 July 1902, Adm 1/7618; Vice–Consul Towey, 'Report on submersible torpedo boats of the Italian navy' 8 October 1901, Adm 1/7554; Captain Douglas Gamble, 'Italy: fleet, dockyards &c. 1900', NID no.586, September 1900 p.8, Adm 231/32

[162] Keyes to Hall nd (December 1913), Keyes papers 4/22, Department of manuscripts, British Library

[163] Captain Cecil Domville, 'Spain: fleet, dockyards &c. 1889', NID no.71, 24 April 1889, Adm 231/15/207

[164] Henry Macpherson to Foreign Office 29 December 1888, FO 72/1850

ennobled) drained away when the boat failed to live up to the extravagent expectations of the public [165]. Peral and his Portuguese contemporary Fontes were too junior to persuade their naval authorities to do more than construct a single prototype; Peral "wished the Government to build a larger boat, and on their refusal to do so, he retired." [166]

In his study of innovation in the United States Navy, Vincent Davis observes that the successful innovator is usually a man in the broad middle ranks of the service, and seldom the inventor of the innovation he is promoting. This would suggest that Peral and Fontes (like Lt. John Parker, the American proponent of the machine gun) lacked the experience to understand and utilise the unwritten rules and administrative subtleties of their respective services in support of their proposals. They antangonised their superiors with their brash certainty that they were right and all others were wrong, and failed to assess the likely impact which the success of their proposals would have on established practice [167]. Of course, the civilian inventors who plagued the British Admiralty had even less chance of securing a sympathetic hearing for these same reasons.

Greed and corruption had their own insidious effect on the naval policies of many nations. The Admiralty was sceptical when it learned in 1880 that the Russian Minister for Coast Defence had contracted for 50 of Stefan Drzewiecki's little two–man submarines because it suspected there was an ulterior motive for the order. The Russian arms industry worked on a commission basis, agents being paid a percentage of the total price charged for the vessels ordered through them. Not suprisingly, costs were kept as high as the market would bear, and there were considerable fortunes to be made by those who could obtain large orders for any sort of warship. "The fact of this order being given," wrote the British naval attache, "points more to the anxiety to make money on the part of some official entrusted with the power of contracting for manufacture and material, than to any conviction on his part of the actual success or value of the invention." He was sure that "little will be done by the Russians in

[165] CH Hilton, 'Isaac Peral and his submarine', USNI Proc. 82 (1956) pp.1194–1202

[166] Captain William May, 'Spain: fleet, dockyards &c. 1893', NID no.346, April 1893, Adm 231/22

[167] Vincent Davis, *The problem of innovation: patterns in navy cases* (Denver 1967) pp.43–4, 51–3

actual warfare with an invention so intricate and so dangerous to the principal actors" [168].

The attache was quite right. The Drzewiecki submarines were under powered, under armed and dangerous under water. Most of them ended their inglorious careers as floating supports for pontoons and oil jetties, and the torpedo school HMS *Vernon*, which kept an eye on the submarine construction of Britain's naval rivals, reported that "it has been observed by the Russians themselves that no–one, except in a state of drunkenness, would go into this boat." [169]

So much, then, for national projects. The Royal Navy did take an interest in the underwater activities of its naval rivals, but then officers were sent to report on battleships and submarines and improvements in pigeon lofts with equal despatch; it was enough that a potential enemy considered the subject worthy of attention. The primitive boats that came to the Admiralty's attention were reported on in spite of their deficiencies and not because the Royal Navy expected much from them.

By now it should be possible to draw a few conclusions about British submarine policy in the mid–Victorian period. It was, firstly, rather more coherent than the varied reports of the Admiralty's far–flung representatives might suggest. Although individual responses to the submarine varied from the enthusiastic interest of Captain Nicholson to the dry scepticism of Nathaniel Barnaby, the conservative Chief Constructor, there was no significant change in the tenor of Board minutes on the subject in the period 1856–1885, and the Admiralty never seriously contemplated the construction of a submarine boat in these years. Furthermore, investigation and assessment of the submarine problem was inadequate rather than altogether non–existent. The technological limitations of a boat were of far greater interest to the sceptical British than her intended tactical or strategic role, and the Admiralty's technical assessments were accurate and noticeably harder–headed than those of most civilian enthusiasts for submarine warfare.

The Royal Navy kept a watch on the doings of its maritime rivals, but

[168] Captain Ernest Rice, naval attache's report no.11, 27 July 1880, Adm 1/6551; Jacob Kipp, 'The Russian Navy and private enterprise: a peculiar MIC' pp.89–90, in Benjamin Cooling (ed), *War, business and world military–industrial complexes* (Port Washington, New York 1981)

[169] HMS *Vernon* annual report 1885 p.61, Adm 189/5

was not interested in their submarine projects *per se*. It was dismissive of the inventions that were submitted to it, and steadily refused to purchase either completed vessels or plans. Nor did it devote energy to the development of anti–submarine weapons. This was sensible enough, in that there was little point in erecting a fanciful body of theory on so slim a *materiel* base. But by making the comfortable assumption that the weapon was imperfect and likely to remain so for the forseeable future, the Admiralty ignored the fact that a workable submarine might force a reassessment of British naval strategy.

This was a failure of some consequence. The problem was certainly not lack of information – the Admiralty was conspicuously well–informed [170]. It was, rather, primarily administrative. The RN suffered from organisational inadequacy, a sort of intellectual arrogance, and a peculiar strategic short–sightedness.

The Victorian Navy was rarely able to process systematically the diversity of information which it received. No Admiralty department existed to determine strategy and tactics. There was no naval staff, no intelligence department existed before 1882, and the torpedo school HMS *Vernon* was over–worked and understaffed [see section 7.1]. The Naval Lords had little time to devote to such minor issues as the submarine, and the only Admiralty officer with his own staff was the Surveyor (known as the Controller after 1860). For this reason, the mid–nineteenth century Royal Navy was better at assessing technology than tactics.

The Controller's department was not without its faults. The Navy's 'wait and see' policy was a safe one only if it was possible to produce a workable submarine design quickly, but the department had no experience of such work and no contingency plans existed. The men of the Controller's staff were fully confident that with the accumulated expertise of British naval architecture behind them, they could out–design and out–build any other navy: "There would be but little difficulty in designing a submarine boat in every way superior to the one under consideration," wrote Captain Arthur of the *Fenian Ram* [171], and Sir William White,

[170] For example, the RN on more than one occasion secured copies of supposedly secret Russian submarine plans. Cf. Wellesley report 22 January 1873, Adm 1/6281; G Stanley (Consul–General, Odessa) report no.3 political 29 January 1879, FO 65/1054

[171] Captain William Arthur, naval attache's report no.90 2 August 1881, FO 115/673 fols. 209–10

one of the greatest of all Directors of Naval Construction, asserted that "there was no difficulty in undertaking here the design or construction of submarines had it been considered desirable to do so... but it was decided to await developments elsewhere before making a start." [172] In retrospect it is apparent that neither White nor Arthur fully appreciated the special problems of designing a submarine from scratch. The Controller's department did not, in fact, have the necessary expertise to produce a successful submarine boat at short notice. When the Royal Navy decided to build its own craft in 1900, it had to adopt the tried and tested designs of John Holland.

Had Holland's plans not been available, Britain would have found herself at a severe disadvantage. She was then ten or fifteen years behind her French and American rivals, and it would not have been easy to catch up. The RN could doubtless have produced a design of sorts, but – inevitably – would have entered the Great War with a far less efficient submarine than it actually possessed in 1914 [173]. This deficiency would have seriously impaired Britain's ability to blockade the German fleet and jeopardised her anti-submarine capability. The turn of the century was a good time for the Navy to order a foreign submarine; it was also its last real chance to do so.

Finally – and perhaps most importantly – the Admiralty failed to think through the strategic assumptions that it did make. The Royal Navy discarded the torpedo boat because it had no place in a fleet action. In doing so, it fell into the trap of assuming that a weapon it thought useless would pose no threat in the hands of an enemy. Britain was as blind to the danger of the submarine. It was evident that no nineteenth century boat was fit for service on the high seas; low speed, low freeboard and low endurance all suggested that the type was best suited for coastal and harbour defence, and as such it was of little interest to the Royal Navy.

Nathanial Barnaby dismissed the submarine because it was useless as an

[172] Sir William White, cited in Murray Sueter, *Submarine boats, mines and torpedoes* (Portsmouth 1907) pp.137–8

[173] The Austro–Hungarian Navy also believed its own naval architects could produce a workable submarine design unaided, but the plans drawn up by the Naval Technical Committee in 1904 were inadequate and the KuK Kriegsmarine was forced to order its first boats from Lake and Krupp. Erwin Sieche, 'Austro–Hungarian submarines', *Warship* V p.16

offensive weapon [174]. Ten years later the Senior Naval Lord, Sir Astley Cooper Key, implicitly rejected it for the same reason by stressing that British torpedo vessels should "be capable of accompanying the squadron to any distance in any weather... having sufficient speed to overtake an ironclad." [175] But in dismissing the submarine as a weapon unfit for service with a seagoing fleet, the Royal Navy neglected its more limited potential as a scourge of the blockade. In the long run this was to prove a costly mistake.

**The Nordenfelt submarines**

Once it had been determined that the submarine was a weapon best suited to local defence, it fell naturally into the province of the British army. In the nineteenth century it was the Royal Engineers who were charged with the responsibility for most of Britain's coast defences; the regiment operated searchlights, boom defences and the minefields ('aquatics') at British and Imperial defended ports, and had a maritime arm in the little boats used to lay and maintain its electrically–fired observation mines. The Engineers therefore kept an eye on promising seaborne coast–defence weapons. Towards the end of the century the regiment expended a considerable amount of time and money developing the wire–guided, shore–launched torpedo invented by Louis Brennan, a weapon the Royal Navy had rejected. But a dozen years earlier the Engineers had recommended the purchase of an altogether more dramatic innovation: the Nordenfelt submarine.

The British delegation sent to Sweden in September 1885 to witness the trials of this peculiar vessel comprised three Royal Engineers and only one naval officer, Captain Thomas Jackson. The senior army representative was Lieutenant General Sir Andrew Clarke, the Inspector General of Fortifications, a man best remembered for his governorship of the Straits Settlement in the 1870s. He was assisted by Major General Hardinge Steward, a leading mining expert, and by Colonel George Clarke, who as Lord Sydenham of Combe later served as Secretary to the Committee of

[174] Barnaby minute 12 March 1873, Adm 1/6281

[175] Cited in Philip Colomb, *Memoirs of Sir Astley Cooper Key* (London 1898) p.447

Imperial Defence.

Nordenfelt's first submarine was a 60–ton, 64 foot steam–powered craft with a crew of 3, allegedly capable of making 9 knots on the surface and 4 submerged. On the first day of her trials the boat was exercised on the surface, dipping underwater occasionally but not proceeding submerged for any length of time. On the second, she steamed ten miles out to sea and returned, and on the third at last commenced her diving trials. The party embarked on Nordenfelt's yacht saw the boat submerge for periods of up to four and a half minutes. At best she steamed 300 yards underwater [176].

A distinguished array of notables had been gathered to witness the submarine's trials. Naval officers from Britain, the major European powers, Brazil, Japan, Turkey and Mexico were present, as were the Prince and Princess of Wales, the Empress of Russia and the King and Queen of Denmark. Never before had such a glittering assembly shown an interest in submarine boats. Yet the *Nordenfelt I* was not an especially impressive craft. Many of the submarine's faults, in particular her longitudinal instability when submerged, were hidden from those who had travelled to Sweden. She fired no torpedo, took 20 minutes to dive, displayed little in the way of endurance, and moved about at low speed. Her most attractive feature was a long, low silhouette which, it was agreed, would make her a difficult target for even a quick–firing gun, and she seemed to have more potential as an awash–boat than as a true submarine.

Two more Nordenfelt submarines, built in British yards at Chertsey and Barrow, were purchased by the Turks in 1886 – reportedly on the initiative of the Sultan, rather than the navy. They too rarely ventured under water, and the British naval attache noted the Ottomans had little faith in the boats and "the general opinion of naval officers is much opposed to them." [177] A fourth Nordenfelt, built in the yards of the Naval Construction Company at Barrow, had an even shorter career. She caused a minor sensation by appearing at the naval review held at Spithead to mark Queen Victoria's diamond jubilee, then sailed for Russia, becoming a constructive total loss on the coast of Jutland during her passage. The

[176] *The Times* 9 October 1885 p.13 col.a

[177] Kane report 'Turkish fleet and dockyards 1886', Adm 231/10

Tsarist government refused Nordenfelt's claims for compensation and denied it had ever intended to purchase the boat [178].

Thorsten Nordenfelt was a businessman, not an inventor. His submarines were designed by George Garrett, and the machine gun that bore the Swede's name was the invention of a compatriot, Heldge Palmcrantz. Nordenfelt's contribution to both projects was money and a shrewd marketing expertise. He built a reputation and an extensive network of contacts on the success of his machine gun, and it was his name that attracted royalty and a host of naval attaches to watch the trials of *Nordenfelt I*. A Nordenfelt invention commanded more respect from the world's press and naval authorities than did that of an unknown.

Suitably impressed by the fairly modest trials they had witnessed in Sweden, Steward forwarded a favourable report on the *Nordenfelt I* to the War Office. He observed that "almost all the officers were very much impressed by it," and was "perfectly certain that foreign war vessels would not lay off a port... if they knew there was a submarine vessel there which could come out without being seen. I certainly think that £10,000 would be very well spent in providing a vessel of this class." [179] But Sir Andrew Clarke outdid even Steward in his enthusiasm, suggesting in April 1885 – five months before he inspected the submarine for himself – that £20,000 be appropriated for the purchase of one or two Nordenfelt boats. Nothing came of this request, but to put Clarke's remarkable suggestion in context, it may be observed that the sum in question was equal to the whole estimate for submarine mines, stores and associated buildings for the defence of British merchantile ports in 1885 [180].

The widespread publicity which attended the Landskrona trials brought the submarine to sudden prominence. The British observer Sir George Clarke understood their true significance when he noted that

> "these first public trials of a submarine boat will... undoubtedly produce results far beyond a mere criticism of the existing craft. Many

[178] Murphy op.cit. pp.152–84; *The Times* 24 September 1888 p.9 col.f

[179] Steward at the RUSI 5 February 1886, RUSI Jo. XXX (1886) pp.168–9; 'Nordenfelt's submarine boat' 1 October 1885, digest cut 11a, Adm 12/1138

[180] RH Vetch (ed), *The life of Lieutenant–General Sir Andrew Clarke* (London 1905) p.248; Clarke memo 'Defence of the maritime ports of the United Kingdom' 31 December 1884, War Office papers WO 33/43, Public Records Office

shrewd heads have been set thinking, and the great possibilities of this form of attack have been brought home with a force which no mere description, however graphic, could have excited. It is one thing to read of vaguely described exploits in the American war, or indefinite rumours of Russian experiments. It is quite another matter to be brought face to face with a boat which disappears before one's eyes to reappear in an unexpected position... It may be taken as certain that the perfection of this most dangerous weapon of attack is only a matter of time and brains." [181]

Nordenfelt's energetic promotion of the submarine thus had its effect. Although the Admiralty continued to display little enthusiasm for the weapon, semi–official service opinion (as expressed at the RUSI) was guardedly favourable in the mid–1880s, and the civilian press was often positively enthusiastic. Samuel Long, who chaired the Torpedo Discharge Committee and captained HMS *Vernon*, suggested in 1886 that a committee be formed to assess the recent development of the submarine boat [182], and the appearance of the *Nordenfelt IV* at the Jubilee review off Spithead caused the level–headed specialist journal *The Engineer* to remark that "in the Nordenfelt we have all the elements of a system of attack and defence which will certainly put blockades to an end... We may – we hope we shall – have quite a little fleet of Nordenfelts when Christmas comes around again." [183]

For all its scepticism, the Royal Navy sent representatives to report on both the *Nordenfelt IV* and a privately–built British submarine, the *Nautilus*, in 1886. At least three senior officers attended the latter's trials at Tilbury on 20 December 1886, and two of them – Charles Beresford, the Junior Naval Lord, and Sir William White, the Director of Naval Construction – were on board when the electrically–powered boat made a practice dive and instantly became stuck in the glutenous mud at the bottom of the deep–water dock. The captain, who had a heart condition, collapsed, and for an anxious quarter of an hour the two Admiralty officials

[181] Anon. report in *The Times* 9 October 1885 p.13 col.a. For authorship, see Lord Sydenham, 'The "weapon of the weak"', *Naval Review* 1933 p.48

[182] 'Submarine boat *Nautilus*' 10 December 1886, digest cut 11a, Adm 12/1154

[183] *The Engineer* 23 December 1887 p.519

were able to consider the merits and demerits of submarine warfare while a series of increasingly desperate measures were adopted in an effort to free the vessel. Eventually one of the two (for both claimed the credit) suggested that passengers and crew should rush in a body from one side of the submarine to the other. The boat began to roll, and this induced the mud to release its grip; the *Nautilus* came to the surface and its relieved occupants dragged the submarine's engineer out of their way and scrambled ashore [184]. It was probably no coincidence that both White and Beresford subsequently displayed dislike of the submarine [185].

Despite this setback, the Royal Navy went ahead with an assessment of the *Nordenfelt IV*, and rumours that the Russian government was planning to acquire the submarine may well have influenced this decision. HR Champness, a second class Naval Constructor from Portsmouth, was sent to Barrow to report on the boat's construction [186], and when the submarine arrived at Spithead in May 1887 her trials were witnessed by Captain Arthur Wilson, the Assistant Director of Torpedoes. Also present were Hardinge Steward and General Nicholson, Clarke's successor as IGF; Captains Long of the *Vernon* and Domville of the *Excellent*; and the naval CinC at Portsmouth, Admiral Willes. Wilson at least was not impressed by the *Nordenfelt IV*, submitting a report which suggested that "the vessel would prove of little value in time of war." [187]

In the week before Christmas another party travelled to Southampton Water to witness further trials. It included half a dozen naval attaches and naval men (one of them, Lieutenant WH Jaques of the USN, a future chairman of the Holland company) and William White, the DNC. By a peculiar chance, White's trip to see the *Nordenfelt IV* came exactly one year after his unfortunate experience at Tilbury [188], but he was no more

[184] The *Nautilus* was an electrically–powered submarine designed and built by Messrs Campbell and Ash. See *The Times* 21 December 1886 p.11 col.f; Frederick Manning, *The life of Sir William White* (London 1923) pp.222–3; Geoffrey Bennett, *Charlie B.: the life of Admiral Lord Charles Beresford* (London 1968) p.140. The third officer referred to was Captain Eardley–Wilmot of the DNO's office; see Sydney Eardley–Wilmot, *The British navy, past and present* (London 1904) pp.56–8

[185] Reginald Bacon, *From 1900 onward* (London 1940) p.53; White at the RUSI, RUSI Jo XLVIII (1904) p.308

[186] 'Submarine boat: Mr Nordenfelt's plans' 15 November 1886, digest cut 11a, Adm 12/1154

[187] '*No.IV* trials' 16 + 30 May 1887, digest cut 11a, Adm 12/1170; Murphy op.cit. pp.161–2

[188] *The Times* 21 December 1887 p.6 col.1

impressed by the Nordenfelt boat than he had been by the *Nautilus*. Professional appraisal of two significant projects therefore confirmed the Admiralty's 1886 decision – reached, it must be said, in advance – to reject Captain Long's proposal on the grounds that "the development of submarine boats has not reached a stage to render it necessary." [189]

## French submarine development

After abandoning *Le Plongeur*, France lost interest in submarine development for almost 20 years. From the early 1880s, however, work was recommenced by a number of designers working in a private capacity. A Lyons engineer named Claude Goubet completed the plans for the first of two submarines in 1885, and early in the same year the highly–distinguished naval architect Dupuy de Lome began to work on a more ambitious scheme. This timing suggests that the revival of French government interest was fuelled in part by the publicity given to Nordenfelt and the Swedish trials.

De Lome was, however, a notable innovator in his own right. He had designed *Le Napoleon*, the ground–breaking steam battleship, and *Gloire*, the first modern ironclad ship of the line; in the late 1860s he had interested himself in the design and construction of airships. But the great man made scant headway with the problems of submarine navigation before dying early in 1885, having done little to flesh out his novel (if impracticable) conception of a troop–transporting submarine which might expedite an invasion of Britain [190]. His ideas were taken up by a protege, the naval architect Gustave Zede, who made a submission to the Minister of Marine in March 1885. It was coldly received, but Zede's luck changed in January 1886 when a *jeune ecole* administration led by Admiral Theophile Aube took control of France's naval affairs [191].

Aube, a noted theorist, encouraged the development of all manner of

[189] 'Submarine boat *Nautilus*' 10 December 1886, digest cut 11a, Adm 12/1154

[190] Le Masson op.cit. pp.41–2

[191] Ibid pp.42–3

torpedo craft, and within a month of taking office had in principle agreed to finance a French submarine programme. Zede's project was approved in March 1887, and a small electric–powered submarine, the *Gymnote*, was launched eighteen months later. She was unarmed, spent most of her long career as a trial vessel for the French navy, and was not formally commissioned until 1908. Enough was learned, however, for a second submarine to be laid down in 1893 and named *Gustave Zede* after the pioneer designer, who was mortally wounded in 1891 while experimenting with torpedoes propelled by an explosive powder. At 261/270 tonnes, the *Zede* was considerably larger than her predecessor, which displaced no more than 30/31 tonnes, and after fitting out she embarked on a lengthy and frustrating series of trials.

The French did not, therefore, possess a militarily useful submarine until the *Zede* was formally commissioned in 1898, and her immediate successors were only slightly more formidable. By the end of the century the *Marine Francaise* had built an electrically–powered improved *Zede*, the *Morse*, and a longer–range, dual–propulsion submarine named *Narval*. The former was laid down in 1897, the latter a year later.

*Morse* was designed to incorporate the lessons of the *Gustave Zede*'s lengthy trials. Realising that the *Zede* had been, perhaps, too ambitious an experiment, the French made *Morse* rather smaller (she displaced 143/149 tons), gave her a small conning tower, and equipped her with a single internal tube. But like her predecessor, the new submarine was electrically–powered and had to return to port at regular intervals to charge her batteries at a shore station. The *Narval*, on the other hand, was the winner of a competition organised by the then Minister of Marine, Lockroy, to find a boat capable of steaming 100 miles on the surface and 10 submerged. She was a double–hulled submersible capable of 10/5 knots and armed with four torpedoes in drop collars.

The *Narval*'s most remarkable feature was a 42% reserve of positive buoyancy, which made her far more seaworthy than her predecessors. "All French submarine boats before *Narval* are driven entirely by electricity stored in accumulators...", noted a British intelligence report. "The limited speed renders attacks on other than ships at rest the exception while their small radius of action makes it almost impossible for any of these boats, except the *Narval*, to go in search of an enemy." [192]

The technical problems of submarine navigation occupied the attention of the French navy, and it was slow to develop strategical and tactical doctrines for its underwater craft. Submarines were initially expected to protect the battlefleet by patrolling harbours and the coast. They were not intended for – nor were they capable of – commerce raiding, but beyond this little was decided. The *Gustave Zede*'s armament (which would, of course, partly determine the submarine's usefulness) was still under debate in 1889; in that year the Minister of Marine was reportedly asked to choose between a torpedo–armed boat and a submarine ram, the latter being Zede's preferred choice [193].

Indecision was rooted in the naval factionalism rife in the Third Republic between the Franco–Prussian war and the early 1900s. The French submarine service was very much the child of Admiral Aube and the *jeune ecole* theorists; when the French navy began to evaluate the *Gymnote* in November 1888, Gustave Zede wrote to Aube to assure him that "I have not forgotten that it was you who asked me to draw up the plan of the submarine which has just been tried at Toulon, and you also who... ordered it to be constructed." [194] Frequent changes of administration and disputes between the leading naval schools significantly slowed French submarine development: there were 32 Ministers of Marine between 1871 and 1905, many of them personally opposed to submarine boats. "The delay of about ten years in completing the *Gustave Zede* is due... partly to changes of opinion of the numerous Ministers of Marine on her possible value," wrote the British naval attache in January 1899. This made the Admiralty sceptical of the *Zede*'s true worth: "Of course, for political reasons she was bound to succeed," asserted the DNO, "and they said she did so, but she is not worth much." [195] The French spent little on submarine construction after Aube had been forced out of office in

[192] Admiralty report 'Submarine boats', NID no.577, May 1900 p.51, Adm 231/31

[193] Captain Domville report 'France: Guns and torpedoes 1889', NID no.211, December 1889 pp.13–14, Adm 231/16

[194] Zede to Aube 21 November 1888, quoted in 'Papers on naval subjects 1903' vol.1, April 1903 pp.70–1, Adm 231/37

[195] Captain Jackson, naval attache's report no.14, 22 January 1899, Adm 1/7422; Jeffries to Egerton 27 May 1899, ibid. (Jeffries was DNO, Egerton the Captain of HMS *Vernon*.)

1889; between 1893 and 1899 total expenditure on constuction amounted to no more than £154,000 [196].

The *jeune ecole* and the torpedo boat were out of favour for much of the 1890s, and the fuss made about the new weapon was regarded with deep scepticism by most Frenchmen. "The most curious thing about the appearance of the submarine was not the considerable sensation which it created, but the fact that comparatively little real notice was taken of it," writes Theodore Ropp. "The New School had a good deal of trouble to drum up the enthusiasm that they did, and the submarine was then regarded as just another form of torpedo boat which was being taken up by these gentry, just as they had taken up successively every naval fad for the last 15 years... The vigour with which the New School hailed it was enough to bring it into some discredit." [197]

The Royal Navy had little chance of making an accurate assessment of French submarines through the swirling uncertainties of continual policy changes and the smokescreen thrown up by over–enthusiastic press coverage. The problem was exacerbated by the strict secrecy observed by the French navy, which persisted up to about 1906 [198]. Between 1886 and 1900 the British relied largely upon guesswork and negative evidence: few submarines were being built, they reasoned, so those that existed must be failures [199].

Only the private manufacturer Claude Goubet was happy to supply the Admiralty with information. In 1895 he invited the Royal Navy to send an officer to see a two–man submarine in which the Brazilian government had taken an interest. The Admiralty despatched the naval attache, Captain Lewis Wintz, to Paris and also instructed Captain Henry Tudor to attend the boat's trials – hoping no doubt to glean some insights into the work being undertaken by its principle naval rival. The strong British interest in this small and largely discredited type underlines the RN's determination to

[196] Reports on the French naval estimates in BNA 1893–1900 (see Appendix 3.) See also John Walser, *France's search for a battlefleet: French naval policy 1898–1914* (University of North Carolina (Chapel Hill) PhD 1976) pp.166–7

[197] Ropp op.cit. pp.540–1

[198] 'Reports on foreign naval affairs: France – fleet, dockyards &c. 1906', NID no.804, September 1906 p.11, Adm 231/46

[199] Cf. 'France – fleet, dockyards and coast defences of the South of France', NID no.70, 16 March 1889 p.10, Adm 231/15

find out anything it could about French submarine development, but the Admiralty did not have much to learn from M. Goubet. The inventor had been rebuffed by the French navy in the 1880s and (as Wintz's successor, Captain Henry Jackson, reported) "for some years they have practically ignored him." [200]

The Royal Navy was forced to rely on very inadequate information in assessing French submarine policy, and this – together with the discredit brought on the subject by the *jeune ecole* and the numerous technological shortcomings of even the best French boats – accounts for the Admiralty's unwillingness to take its rival's submarines seriously before 1898. Only the publicity generated by the apparently successful trials of 1898–1901 forced a reconsideration of this position.

[200] '*Le Goubet*' 12 + 13 June 1895, digest cut 11a, Adm 12/1282; 'Capabilities of *Le Goubet*' nd (1896), digest cut 11a, Adm 12/1295; Jackson report 2 April 1898, quoted in HMS *Vernon* annual report 1899 pp.115–16, Adm 189/19.

The submarine was eventually rejected by the Brazilian navy, and in 1899 Goubet presented her to France.