CHAPTER 2

Prelude to a battle

2.1 The first great submarine war

On 10 April 1917 Admiral Jellicoe, First Sea Lord, commander of a British Navy, which had held undisputed command of the seas for three generations, handed over a memorandum to the naval representative of his new American ally. The memorandum showed the British and neutral shipping losses of the last months: 536 000 tons in February, 603 000 tons in March and a predicted 900 000 tons in April. The American admiral recalls what followed.

> It is expressing it mildly to say that I was surprised by this disclosure. I was fairly astounded; for I had never imagined anything so terrible. I expressed my consternation to Admiral Jellicoe.
>
> 'Yes,' he said quietly as though he was discussing the weather and not the future of the British Empire. 'It is impossible for us to go on with the war if losses like this continue ... '
>
> 'It looks as though the Germans are winning the war,' I remarked.
>
> 'They will win, unless we can stop these losses — and stop them soon,' the Admiral replied.
>
> 'Is there no solution for the problem?' I asked.
>
> 'Absolutely none that we can see now.'

(The quotation above is taken from A. J. Marder's magisterial history *From the Dreadnought to Scapa Flow* on which the whole of this chapter relies.)

The German submarines which produced this disaster were not what we would now call true submarines but were, essentially, submersible torpedo boats. Underwater they used engines powered by electric batteries which were capable of giving a range of about 50 miles [80 kilometres] at a speed of about 4 knots [7.5 kilometres per hour] or permitting a dash of about 15 miles [24 kilometres] at 8 knots [15 kilometres per hour]. The batteries had to be recharged on the surface using separate diesel engines. These diesels also gave the submarines

a surface range of, typically, 7500 miles [12 000 kilometres] at 7 knots [13 kilometres per hour] and a maximum surface speed of 16 knots [30 kilometres per hour].

Only very slow merchant ships travelled at less than 8 knots and destroyers had speeds of more than 30 knots. Once surfaced, the submarine was vulnerable even to the light gun of an armed merchant ship. The submarine was therefore effective only as a weapon of ambush, sinking its prey without warning and without allowing the chance of surrender. Since it had room only for its own crew and since the submarine was so vulnerable when surfaced, no attempt could be made to rescue the victims. The submarine, if it was to fulfill its potential as a weapon, had to break, in the most shocking manner, with the customs of the sea and the laws of war.

The effectiveness of the submarine as a commerce destroyer, provided it was allowed to sink without warning, only became clear after the outbreak of war but, from then on, the German High Command pressed for unrestricted submarine warfare against Britain. A short period of such warfare gave promising military results but included the sinking of the passenger liner *Lusitania* with the loss of 124 American lives. This incident outraged United States opinion which had before been strongly against involvement in any European conflict. Partly because of this and partly because Germany lacked enough submarines to make her submarine blockade fully effective, the experiment was terminated.

By the beginning of 1917 the German Navy had many more submarines, the German economy was deteriorating under the pressures of war and the British naval blockade, and the German Army could not promise a decisive victory on land. The chief of the German Naval Staff wrote:

> A decision must be reached in the war before the Autumn of 1917, if it is not to end in the exhaustion of all parties and consequently disastrously for us. Of our enemies, Italy and France are economically so hard hit that they are only upheld by England's energy and activity. If we can break England's back, the war will at once be decided in our favour. Now England's mainstay is her shipping, which brings to the British Isles the necessary supplies of food and materials for war industries, and ensures their solvency abroad ...
>
> I do not hesitate to assert that, as matters now stand, we can force England to make peace in five months by means of an unrestricted U-boat campaign. But this holds good only for a really unrestricted campaign ....
>
> A further condition is that the declaration and commencement of the unrestricted U-boat war should be simultaneous, so that there is no time

> for negotiations, especially between England and the neutrals. Only on these conditions will the enemy and the neutrals be inspired with ... terror ....
>
> Unrestricted U-boat warfare ..., begun early enough, [will] ensure peace before the next harvest, that is before 1 August; we have no alternative. In spite of the danger of a break with America, unrestricted submarine war, begun soon, is the right means to bring the war to a victorious end for us. Moreover it is the only way.

His advice was taken and, on 1 February 1917, German submarines once again began sinking without warning. On 6 April, the United States provoked by this resumption (and the discovery of secret attempts by Germany to draw Mexico into a war against her) declared war on Germany. If Britain could hold out long enough, the fresh American resources might settle the European conflict, but on 18 April the British Secretary of State for War wrote to his chief general: 'The situation is very bad and we have lost command of the sea.'

Since the professionals had lost control of the situation, they were bombarded with suggestions from outsiders ranging from training cormorants to land on enemy periscopes (this is said to have failed because the cormorants were too good; having been trained with British submarines they refused to use German periscopes), through filling the North Sea with barrels of Eno's Fruit Salts (the bubbles were to force the submarines to surface), to a revival of the obsolete eighteenth century practice of convoy.

In the convoy system merchant ships were only allowed to sail in large groups under the escort of warships. At first sight this seems an obvious measure but there were several cogent objections.

1. Convoy was a defensive rather than an offensive measure. The job of the navy was to patrol the sea lanes to keep them clear of hostile forces.
2. The delay involved in assembling a large number of merchant ships would reduce the total tonnage transported each month.
3. The arrival of a large convoy at a port would overtax the loading and unloading facilities. (This was a very important point. Marsden suggests that the failure of the fragmented British port and railway system to adapt to wartime conditions was almost as damaging to the economy as the German submarine offensive.)
4. A convoy can only travel as fast as its slowest ship. Not only does this again reduce the total tonnage transported each month, but it also means that the faster ships cannot use their speed as protection against attack.

5 Both merchant and navy captains believed that a large number of merchant and naval escort ships would be unable to keep in the tight formations demanded by convoy. When a group of ten masters of merchant ships was consulted, they replied that two or three ships was the maximum that 'might be able' to sail together and keep station.

6 A convoy might well prove an easier rather than a harder target for a submarine. Admiralty instructions at the beginning of 1917 made the point explicitly.

> The system of ... convoy is not recommended in any area where submarine attack is a possibility. It is evident that the larger the number of ships forming the convoy, the greater is the chance of a submarine being enabled to attack successfully and the greater the difficulty of the escort in preventing such an attack. ... A submarine [can] remain at a distance and fire her torpedo into the middle of a convoy — with every chance of success.

7 Finally, even if convoy was considered a desirable measure, where were the naval escorts to come from? Admiralty statistics (supplied by the customs authorities) showed that over 5000 ships entered or left British ports each week. To convoy numbers of that magnitude was an impossible task.

The men who commanded the British Navy were able and energetic. They and their immediate predecessors had ruthlessly modernised a dozy and old-fashioned fleet which rested on laurels half a century old. They realised that modern warfare required mastery of technology and industrial methods, and ensured that the British fleet acquired that mastery. Faced with the new threat of the submarine they sought an answer in new technology — the depth charge (a compound of 'applied chemistry, synthetic earthquake and sudden death'), the hydrophone, hunter-killer submarines, air patrols, deep mines (the British mine proved ineffective, so an exact copy of a German type was used) and other devices. Trade routes were patrolled with everything that could be spared — but whilst the Germans lost about three submarines a month they built seven a month to replace them, and British and neutral losses went on rising.

In retrospect we can identify the missing weapon in the Admiralty's armoury. In May 1917, after, but as a result of, the crisis described here, Sir Eric Geddes, a railway engineer by training, and manager of the North Eastern Railway before the war, was appointed to the Board of Admiralty (and became the first landsman since the seventeenth century

to be appointed admiral). Among his first acts was to set up a Statistical Department under one of his North Eastern Railway colleagues.

One admiral wrote

> We have been upside down here ever since the North Eastern Railway took over the management, but manage to worry along somehow doing our jobs. Geddes is mad about statistics and has forty people always making graphs and issuing balance sheets full of percentages, etc. Unfortunately worrying about what happened last month does not help the present or the future and wastes a great deal of time. It may be well enough in a Life Assurance business or a railway. We do not get anything done quicker now than this time last year and most things a good deal slower but there is more made of them on paper.

Marder comments that

> [this] inability to see that foresight must be based on sound knowledge of the past is very illuminating.

Elsewhere he states that

> [the Admiralty] had not at any time during the war made any serious study of the problem of trade protection. The Admiralty had accepted it as a principal responsibility of the Navy *without determining the precise extent of that responsibility*. 'It is as if an insurance company agreed to insure a man's life without troubling to find out his age, occupation or state of health.'

The Admiralty had fully grasped the role of scientific thought in building a modern fleet, but failed to see that similar thought was needed to employ it most effectively.

Exercise 2.1.1 *Think carefully about the arguments against convoy given above. Which seem to you valid, which invalid and which partially valid? Give your reasons. Are there any other arguments for or against which ought to have been considered?*

2.2 The coming of convoy

What were the arguments of those who favoured convoy? Convoy was a traditional form of protection, used most recently during the Napoleonic wars when, indeed, the Admiralty was given power to enforce convoy by law. But the experience of the days of sail could not, by itself, carry conviction in the age of steam. The proponents of convoy could point out that the main battle fleet was always protected by a screen of destroyers — but, again, the circumstances were very

different from those involved in the day to day escort of merchantmen. Finally, and most convincingly, they could point out that troop-ships were always convoyed and that none had been lost.

From early in 1917 convoy advocates could point to one further piece of evidence. British coal was vital for French industry which needed to import at least $1\frac{1}{2}$ million tons a month supplied by 800 colliers. By December 1916 the disruption caused by submarine warfare had reached such levels that French factories were having to shut down. Under French pressure a system of convoys was instituted which restored the regularity of supplies. Contrary to expectations the convoys enjoyed an extraordinary immunity to submarine attack. In April nearly 2600 ships sailed in the coal convoys and five were lost to submarines. Similar results followed the earlier but less remarked introduction of convoy on the Dutch route (the 'Beef Trip').

Of course, the experience of short routes close to naval bases might not apply to long ocean routes. However, the Scandinavian routes which brought iron ore from Narvik had been suffering terrible losses (one ship in four failed to survive the round trip). Once more the experimental introduction of convoy produced staggering gains. In the first month the loss rate fell more than a hundredfold to 0.24% and port congestion decreased. Initially there was a daily sailing of six merchant ships under heavy escort but, with experience, this was modified to a five day cycle with convoys of between 20 and 50 ships without an increase in escort strength and without incurring heavier losses.

In the previous section I outlined several objections to convoy. Let us see how experience answered them.

1 *Convoy is a defensive rather than an offensive measure.* It is very hard to find submarines in the immensity of the ocean and even if they are sighted by a patrol they have a very good chance of getting away. However, a submarine which does not sink merchant ships is useless. If the merchant shipping sails in convoy, then the submarine must come to the convoy and, having come, must brave the escorts to carry out its purpose. Thus convoy is an offensive measure forcing the submarine to fight rather than flee. It is no accident that many of the great battles of the era of sail and several of the surface naval battles of World War II were fought round convoys.

2 *Delays involved in assembling convoys.* In practice it turned out that independent sailings were subject to such disruption by reports of U-boats that convoys actually speeded up departure.

3 *Delays involved in unloading convoys.* It turned out that it was

the *unpredictability* of arrival of independently routed ships which disrupted the (relatively) smooth running of the ports and the railway systems which served them. The high probability that convoys would arrive and leave on schedule was a remedy for, and not a cause of, port congestion.

4 *A convoy can only travel as fast as its slowest ship.* The statistics of the two World Wars show that a ship is safer in a convoy even if the convoy's speed is substantially lower than that achievable by the ship on its own. A faster ship sailing alone will, of course, deliver more tonnage per month, but only until it is sunk.

Exercise 2.2.1 *(i) A convoy sails at the speed of its slowest ship and has to be assembled. For these and other reasons, independently sailing ships complete their voyages more quickly than those in convoy. Suppose that merchant ships sailing independently take 75% of the time to complete their voyage but lose 14% of their number to submarines on each voyage, whilst convoyed ships lose 5% per voyage. (These figures are not out of line with those experienced on the Atlantic run during the first years of the Second World War. The First World War figures are much more favourable to convoy.) We start with a given fleet of merchant ships and must decide whether to use convoy for all of them or let them all sail independently. We can produce ships quickly enough to replace all those lost in convoy. Show that in the time it takes to make three convoy voyages, an independently sailing fleet will have made more voyages than a convoyed one but the position will be reversed for the time it takes to make six. What will happen over a long time?*

(ii) The situation calls out for the use of differential equations. Suppose that we can produce merchant ships at a rate μ (ships per unit time) and that we lose merchant ships at a rate λ (ships per ship afloat per unit time). Explain briefly why, with this model, the size $x(t)$ of our fleet is governed by the differential equation

$$\dot{x} = -\lambda x + \mu,$$

and deduce that

$$x(t) = \frac{\mu}{\lambda} + \left(X - \frac{\mu}{\lambda}\right) e^{-\lambda t},$$

where X is the size of the fleet when $t = 0$. What happens to the size of our fleet when t is large?

Suppose that the ships of our fleet can make κ voyages per unit time. Show that if $T \geq 0$ our fleet will make

$$\frac{\mu\kappa}{\lambda} T + \frac{\kappa}{\lambda}\left(X - \frac{\mu}{\lambda}\right)(1 - e^{-\lambda T})$$