THE NAVAL ENGINEER IN WAR

by

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This paper was presented by Captain Maclean at the Engineers' Conference held at Caxton Hall, London, December 15th and 16th, 1945, and is reprinted with permission of the Institution of Professional Civil Servants.

The purpose of the conference was to bring to public notice the contribution made by engineers to the national effort in the war and, still more important, to afford an opportunity for eminent men and women in the engineering world to give expression to their views on the part the engineers will perform in the reconstruction of our Country and, in the broader sense, the reconstruction of the world.

This has rightly been called an engineer's war, though the contribution of the engineer is not perhaps as widely recognised as it might be. There is an engineering tradition that " the wheels always go round." This fine conception runs like a thread through all engineering activities. In my Naval career I have only once known a warship to sail late for a cause connected with the machinery and unconnected with the enemy. In that particular case jellyfish were the cause. Jellyfish and machinery do not mix well.

In peace the Royal Navy is seen in every sea. In seeking out the enemy in war, and in maintaining the vital flow of arms and food and men, the ships of the Navy and their consorts in the Merchant Navy penetrate even deeper into the remote oceans. It is the engineers who steam the ships there, and it is their craftsmanship and almost loving care which tends and repairs the machinery, keeping it running often under extremely severe and nerve-racking conditions.

20,000 Miles non-stop

Here is a recent example. Five of His Majesty's destroyers sailed from Manus Harbour on 6th July, 1945. Two months later, on 5th September, H.M.S. *Termagent* steamed into Tokyo Bay. She and the rest of her flotilla had all completed over 20,000 miles non-stop. What this bald statement implies can be well imagined. Altogether the total horse power of main fleet units operating during the war amounts to nearly 25,000,000. This compares with the 18,500,000 horse power generated in this country to which the chairman referred and gives some idea of the size of the fleets. The maintenance work in achieving this can well be imagined, since some one and a half billion revolutions of the propellers have been involved (and I am using a British billion which is a million million).

The complexity of the machinery in a modern warship is well known. Indeed, in the closely sub-divided space of a ship is packed all that is required for a fighting and living community of anything up to 2,000 souls. There are the main engines and boilers generating as much as 150,000 S.H.P. ; associated electrical machinery ; multifarious auxiliaries ; domestic machinery and what one might call hotel services ; salvage and fire-fighting arrangements ; workshops for all kinds of repair and maintenance, including that of naval aircraft.

Honours degree standards

A ship cannot move or fight without pipes—pipes for steam, for fuel, for water, for hydraulic power, and for other services already mentioned. Enough tubing to span the Atlantic has gone into the pipe systems of the main fleet units, every system containing a multitude of valves and gauges, themselves requiring maintenance. All these things and much of the hull and watertight fittings are the province of the Naval Engineer, whose training syllabus compares favourably with honours degree standards. Nor must it be forgotten that these men—officers and ratings—are above all sailors, knowing the ways of the sea and sharing its dangers and hazards as well as those of the enemy.

Naval aviation has grown from small beginnings to become one of the major offensive weapons of the Fleet. Half its personnel are engineers, and it is their function to service and inspect every part of the aircraft as well as the engines.

At the beginning of the war the Navy had only just taken over the Fleet Air Arm from the Royal Air Force, and what there was of it was manned almost entirely by the R.A.F. The number of engineer officers attached to it was not more than a dozen. The outbreak of war made it necessary for the Navy to embark on a vast expansion programme before its own air organisation had been built up, and by August, 1945 the number of officers attached to the Naval Air Arm had risen to over 1,100, of which over 900 were R.N.V.R. These officers controlled some 40,000 men. Incidentally, the Naval engineer officer who specialises in aviation, in addition to possessing the equivalent of an honours degree in aeronautical engineering, must also have flown service aircraft operationally. He is thus a new form of " giddy harumfrodite "—sailor-airman-engineer.

Complex duties

Since aircraft and carriers have become the spearhead of any naval offensive, the control of anti-aircraft guns has become of vital importance to the fleet, and a very complex system, involving radar and electronic calculating machines has been evolved. To-day it is not so much the skill of the gunner as the performance of this machine upon which safety depends. The design, production and maintenance of this and other gunnery equipment from 16 in. gun mountings downwards are also among the responsibilities of the engineering branch of the Navy.

In addition to the big ships, the engineer is concerned with the small ships. There are the craft of coastal forces ; the little ships, largely manned by the R.N.V.R., whose work has been so brilliantly described by Peter Scott ; the submarine service ; the destroyer forces, many of which have engines of 40-50,000 S.H.P., in charge of one young engineer officer, and the huge armadas of very special craft for combined operations. To propel the smaller craft, many designed for speeds of over 40 knots, more than 18,000 internal combustion engines were used.

No large-scale operations of naval or amphibious warfare can be planned without the engineer. Senior engineer officers serve, of course, on the staffs of Commanders-in-Chief and Flag Officers-in-Command. In the complex planning of a combined operation, the engineers of the services have their essential jobs, from the original detailing of the engineering requirements to the intricacies of beach repair organisation and the provision of local and distant repair facilities.

Reliability

I could quote many examples of the tradition of reliability which is so strong in the British Navy ; of last-war ships, obsolete by all the rules of war, but undauntedly kept running by their engineers. The " V " and " W " class destroyers, veterans of the last war ; the *Furious*, which became our first real aircraft carrier, laid down in 1915, still with her original machinery and more than a quarter of a million miles to her credit ; that gallant but skittish old lady in which I myself had the honour to serve until recently—the *Renown*—launched in 1916, in action in 1917. As members of the famous Force H she and the *Furious* played a large part in keeping the Mediterranean open in the dark days of the war against forces which were superior in terms of mere material. It may be of interest to note in passing that the *Renown*, re-engined in 1939, is still the fastest capital ship in the Fleet.

Salvaging damaged ships

No fleets can keep the seas, no aircraft fly the oceans, without a complex organisation for supply and repair. Aboard the ships of the Royal Navy it has been the task of the engineer not only to steam the ships but to organise that vital service, largely manned by engine-room ratings, for keeping wounded ships afloat and fighting and bringing them safely to harbour. It is called damage control, and involves an intimate knowledge of the organisation, subdivision, stability and nervous system of the ship, as well as of fire-fighting, counter flooding and salvage.

A whole great service under the Director of Dockyards exists in peace and war for servicing the Fleet. Each Royal Yard is equipped with drawing and estimating offices, foundries, smitheries, boiler shops, fitting and machine shops, dry docks and cranes, building slips and so on. In this large organisation the engineer has his place. The general work of fitting out and repairing is done by civilians—craftsmen, tradesmen and labourers, their engineering activities directed by Naval engineer officers.

As in industry, so in the Navy, women played their part in engineering both as Wrens and in repair yards, not only as operatives in machine shops but in repairs on board ships refitting in dockyards, in naval aircraft and instrument repairs and many other fields. The work of the dockyards continued, of course, under all the trials of blitz and bomb. One of the little known but none-the-less heroic achievements in the siege of Malta was the unfailing service given by the Royal dockyard. The machine shops were removed to tunnels in the rock, submarines were submerged by day and refitted by night. Throughout the whole assault on Malta the dry docks were kept in continuous operation.

Value of fleet train

The vast distances of the Pacific and the need to wage continual war on the enemy's doorstep, brought into being the fleet train, with every conceivable form of mobile repair, replenishment and amenity ship. Here, of course, the engineering branch of the Navy played a prominent part, aided by a new branch of the service recruited from trained civilian tradesmen. The Napoleonic army " marched on its stomach." The modern Navy, fighting a tropical war in the Pacific, needs beer and ice-cream. The provision of the machinery for this falls to the lot of the engineer ; and so off the drawing boards came the brewery ships and the soda fountains.

Design, production and training

There are other fields in which the engineer is vital—design, production and training.

The whole business of the design and production of the machinery in ships is handled at the Admiralty by the Department of the Engineer-in-Chief. That part of his staff, stationed at headquarters, is responsible for the design of new machinery, for its production, inspection and testing. It is, of course, also responsible for the research and development without which no virile organisation can exist. Similar work in connection with the armament of the Navy is undertaken by engineer officers under the Director of Naval Ordnance and the

Director of Torpedoes and Mining. All these officers, in peace and in war, intersperse periods ashore with periods at sea.

Confidence in the engineer is often taken for granted as this tale shows.

Shortly before the war the need was evident for some extremely fast ships for mine-laying purposes. These ships had to develop high power on small displacement. For a number of years before the war certain foreign countries had been developing light, high speed ships, building perhaps one a year, learning by experience and increasing year by year the power and the speed. For various reasons we had no such opportunity of gaining similar experience, but there was sufficient reliance on the engineer and the constructor for three of these ships, the fast minelayers, followed shortly by a fourth, each of 72,000 horse power, 3,000 tons displacement, and designed for very high speed, to be laid down and built.

These ships were destined to play an important part in the war Because of their high speed they were used to run the gauntlet to Tobruk and Malta, in fact, for many purposes not connected with their function of mine-laying The confidence was not misplaced As the first of this class to complete was about to sail for her initial machinery trials there was an urgent operational requirement ; so that in fact the first time any ship of this class developed full power and full speed was in an operation of war in the face of the enemy. The first of them in fact carried out two operations before she was able to undertake the trials which would show the engineers who designed her machinery whether or not she would fulfil their expectations.

Comparison with German machinery

It is interesting to compare these ships, produced as a result of a fairly conservative outlook, placing great emphasis on reliability and on the ability to keep the seas at all times, with the product of the German engineer The German *Narvik* Class destroyer of 69,000 horse power, has very different and very advanced machinery—a most complex design quite unsuited to a warship. The British ship operates with a steam pressure of 300 lb./sq. in. at 660°F. ; the German ship at 1,100 lb./sq. in. and over 900°F. Yet in spite of this thermodynamic advantage the fuel consumption of the German ship is higher than the British, while her machinery spaces occupy over 30 ft. more in length. The German machine is 25 per cent. heavier than the British, and on the score of reliability all is in favour of our ships, whose engine-room complements are only half those of the Germans. The German ships are, in fact, masterpieces of misapplication ; and the tale illuminates a significant feature in naval engineering, the great advantage, in fact necessity, of having machinery design in charge of seagoing engineers.

Wartime problems

It may not be out of place here to lift a corner of the veil covering some aspects of the design of the flotilla led by Peter Scott. *Grey Goose* and her class steam gun boats as they were called to distinguish them from the more usual motor gun boats, were designed to operate against the German E-boats. For this they had the advantage of comparatively silent operation, and could stalk and kill. They were equipped with water tube boilers and steam turbines developing 8,000 S.H.P., and operating with steam at 400 lb./sq. in., 750°F. Low weight was vital and the total all-in weight of the entire machinery, including water, was under 50 tons, or a little over 10 lb. per S.H.P. The machinery of these ships was a real step forward in light weight design, being only one-third the specific weight of the most highly forced destroyer machinery.

One of the first design problems of the war arose from the severe shock effect of underwater explosions near a ship but not in contact with it, particularly magnetic mine explosions and near misses by bombs. The effect was much greater than from direct hits and resulted in widespread damage to machinery. A section was set up at the Admiralty by the Engineer-in-Chief to tackle this very complicated and abstruse problem. The first method was to mount machines on specially designed rubber pads. Eventually, however, an ingenious mounting, combining resilient materials with a rigid structure was developed. At the end of the war in Europe it was discovered that the Germans, in attempting to solve the same problem, had not progressed beyond complicated and far less satisfactory spring devices.

I must mention here the war contribution made by the Civil Service staff of the Engineer-in-Chief's Department at the Admiralty, with whom I have a long association and of whom over half are engineers. Their long hours of work need no praise from me. Chronic shortage of staff, evacuation from London and their homes, Home Guard duty, fire watching and the Blitz made no easy conditions, yet the work went on unfalteringly.

I can only mention the vast work of training ; of converting butchers and bakers and candlestick makers into competent engineers ; but I well remember the great pride of the first H.O. (Hostilities Only) Stoker in my ship to be rated Leading Stoker (Acting).

The Engineering branch has exceeded quadruple expansion during the war, increasing from 1,500 officers and 28,000 ratings to 6,400 officers and 120,000 ratings. From these figures it is easier to imagine the task of training than it was to carry it out.

The Future

I have tried to show in this very brief sketch the wide scope of the duties of the Engineering branch under the Engineer-in-Chief of the Fleet, who is a Vice-Admiral. Armed with our war experience we stand on the threshold of a new engineering age. In the use of higher temperatures and pressures and the development of the marine gas turbine, the Navy will play a leading part.

As I started with the engineering tradition of keeping the wheels revolving, so I would like to end. This tradition has its dangers as well as its epics. Because the engineer continues to produce results with inadequate facilities, outworn tools and insufficient basic and applied research, there is a danger, a real danger, of losing our inherited engineering predominance. The engineer has a great part to play in the future affairs of his country and of the world. I am certain that I can rely on this afternoon's speakers to leave in no doubt the need for powerful backing for engineers and for real foresight in making sure that this country has the engineering facilities she needs. We all remember the slogan " Give us the tools." Let us see that we ourselves do not forget, nor in our post-war world neglect the engineer, the practical man who turns the dreams of scientists and research workers into the practical realms of everyday life.