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PAMPHLET FILE

Submarines

LECTURE DELIVERED BY

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I think that what is mainly desired of me concerns the future of Submarines - their strategical and particularly their tactical use and value in any future war. For a background to the remarks I shall venture to make on that subject I am taking the liberty of including the first part of a lecture given at Army General Staff College over a year ago. Apologies for so doing are due some of you who I am sure are well cognizant of most that pertained to Submarines in the World War.

"But there are many misconceptions and wrong impressions concerning the German Submarine warfare; these are not merely popular but are to be found quite extensively in the service. As they exist now, we are likely to be misled in our estimates and plans and I will attempt to clear up some of the points which seem important".

"To begin with, I should say that I shall pass over the inhumane features of the German submarine warfare with brief comment because their ways were characteristic of the race and, as best known to you, not confined to their submarines personnel. Their ruthlessness is still, to many minds, inseparable from submarine warfare and there has been great tendency to let events of recent history cloud future issues. The reason is, I think, mainly that it was done by Germans. Any nation that attempts commerce destruction by submarines will tend toward certain of the same practices that the Germans arrived at; how far it will go in that direction depends on its racial characteristics and, very likely, on how hard it is pressed. We, ourselves, are certainly never going to gun the lifeboats, dive with prisoners on the deck or do other similar tricks of the Germans that have tended to make other nations hate all submarines---including their own. Leaving out such useless brutality, it is well to point out some comparisons. If air-craft ever destroy ships at sea, they have less chance than have submarines of rescuing any personnel. The automatic mine is as bad as the German submarine was at its worst, for all bottoms are alike to it and it sinks a ship filled with women and children just as readily as it does a man-of-war. Without being understood as attempting any apology for German submarine captains, it must be pointed out that for the effect that the German submarine had on the war, they did not---as compared with their other operations---kill many people. How much they effected is quite common knowledge. The largest figure that I have seen is that their submarines' guns and torpedoes cost 12,800 lives. Many single days of the land warfare cost us a bigger loss of life than that and with far less decisive results."

"Now as to those results obtained by the German submarines, the outstanding fact is that they failed to do what they tried and expected to do. Whether or not they lost the war to their nation by bringing the United States into it, can be said by anyone who knows whether or not we should have gone in anyhow. But with us in it, they failed to win directly with their submarines by a margin the narrowness of which is sufficiently well known. The reasons in detail for that failure seem not to be known. The big reason was of course, ordinary lack of numbers. It is surprising to learn what a small proportion of the total energy of the German nation went into their submarines and to compare it with the energy expended by the Allied navies in directly combating them and in evading their attack. The high-water mark in numbers of German submarines actually operating at sea, in all waters, was about thirty; and their average for the last two years of the war, when they were strongest, was less than that. The personnel in thirty submarines would be about 10000. A fair estimate of the greatest number that the German Navy ever had in its entire submarine service would be 10,000 officers and men. There were actually hundreds of thousands of officers and men of the Allied navies, either directly engaged in combating those 10,000 Germans or employed with means intended to enable ships to evade their attack. For instance, we employed as many as 10,000 U.S. Naval personnel in laying our part of the North Sea mine barrage, and it develops that we should have had to continue to employ them in patrolling and maintaining it. Back of the actual Naval forces, the parallel between the respective industrial or manufacturing forces employed is probably quite similar. Therefore, entirely apart from the actual damage the German submarines accomplished, this use of a small part of the German manpower and resources forced the Allies to devote to strictly defensive purposes an inordinately great amount of their manpower and resources. We employed it without stint and in the end we prevailed; had we had to deal with say twice as large a force of submarines, which the Germans could have brought against us without a decisive sacrifice in their other fields of endeavor, it is not too much to say that the result would have been far different. As it was, the Allies kept barely ahead of them and were constantly menaced."

"It is said that after their greatest individual success against naval vessels, when, early in the war, one German submarine sank three British cruisers within a few minutes, the German submarine officers took the occasion to propose to Admiral Von Tirpitz that everything Naval be sacrificed to build up their force of submarines.

It was then represented that the German navy was already strong enough to control the Baltic and to do its part in keeping their enemies off their North Sea coasts; that everything else on the sea was already lost to the British navy which they could not in course of that war hope to overtake and defeat. (Although the German High-seas Fleet was possibly then nearer to being a match for the British Fleet than they knew, their estimate was correct.) It was therefore proposed that future German naval effort be confined to simple maintenance of the surface vessels they then possessed and that all available building resources be used to produce submarines. Also it was represented that it would thus become evident that the best chance of adventure and distinction would lie in submarine service; consequently the best personnel in their navy would clamor to enter it and thereby enable them to efficiently man as fast as they could build. In the light of history, that advice, if given, was correct,-- since it certainly may well have been given, there is no good ground for doubting the story. Anyhow only half-measures were followed and though the Germans did expend their submarine service rapidly, they continued to build up other naval branches, which effort never gained them much. The mistake was only one of several, any one of which can be claimed to have lost the war to the Central Power, but it was certainly their greatest naval error and the only one that had any great influence upon final results, unless it be the broader decision to adopt their "unrestricted" warfare on commerce on the estimate that the submarines they had could turn the trick. (Their estimate on that matter of course erred because they did not foresee the effect of the anti-submarine and defensive methods that the Allies developed and realize the necessity for greater numbers of submarines.) By going as far as he did in expending the German submarine service, very likely Admiral Von Tirpitz, or his advisors, encountered strong opposition on the part of the rest of the Navy; it probably was largely a matter of conservatism. No other Navy would have been any more likely to accept such a departure than was the German Navy of 1914; one case in which moderate conservatism seems to have led to a mistake."

"In the main, the German submarines operations were well-conceived and efficiently planned; also, considering their difficulties, their submarine personnel was efficient, enduring and loyal. A large force of their submarines was in the North Sea, on station and apparently ready for their part in the Naval battle planned for October, 1918, when mutines prevented the rest of the fleet from coming out. Like the rest of the nation, their morale had deteriorated in the last months of the war; they had suffered very severe losses and those of long submarine experience who remained alive were worn down by the long-endured wear and tear of the sea, with the dangers growing daily as our counter-measures increased in adequacy and efficiency."

"The Germans started the war with about forty submarines, counting all sizes. That was a small number but they had a good start in their design and development work and, since as they increased the numbers they improved their characteristics, the Allies were occasioned several surprises. The radius of action and the periods that German submarines kept the sea, even early in the war, were not previously believed possible. The guns which they installed on deck like any surface craft and fought in, fairly rough seas, constituted a novel idea. Mining from submarines was entirely a surprise and a very disagreeable one. The Germans could do little or nothing on the British and French coasts with surface vessels but their submarine mine layers, of which the British or French had no inkling until they began operating, could reach any coasts of the British Islands or France and were at it for years. They not only mined a great many ships but forced their enemies into employing an enormous force of mine sweepers. Large areas off the British and French coasts are mining waters, necessarily used by the extensive shipping and had to be swept daily. Many sweeping details did not find a mine for months but since a mine layer was likely to plant a few of her eggs any night, the sweeping had to continue."

"In all the Germans built or had building when the war ended about 430 submarines. They lost, either by our action or through accident while operating, 180 and they destroyed between 15 and 20 in Belgium and Austrian Ports, before signing the Armistice or while en route to be surrendered. They surrendered about 170, many of which were not in operating condition either not completed or damaged, and at the end of the war had building about 60 others. There was also a large additional program started by Admiral Scheer soon after he was put in charge of their entire Navy near the end of the War. The Austrians had a small submarine force which accomplished little; they lost eight boats during the war."

"There were the four following general types of German submarines:"

"Their regular U-boat, known as the middle-sized submarine and which appears to have been the best all round type."

"Their coastal type, or UB-boat, approximately half the U-boat size but which made pretty long cruises."

"Their coastal mine-layer, or UC-boat, which also has guns and torpedoes, was about the size of the UB's and also made fairly long cruises, operating against shipping after their mines were down."

"The fourth was the large overseas type, of several designs. The forerunner was the commercial submarine type and included the Deutschland which made two cargo trips to the United States; in all, seven of them were built and became men-of-war. The Deutchlands were slow, rather unwieldy and their best offensive power, for the kind of warfare they carried on, lay in their two 6-inch guns; they had great endurance, could stay out four months and had fuel for 25,000 miles. The regular "cruiser" submarines were larger and faster and had about the same endurance. Although their torpedo armament was extensive, they also carried two 6-inch guns and some of the usual submarine characteristics were sacrificed to make them "gun-fighters"; as such they were no mean opponents in that they could deliver a heavy and pretty accurate fire and, while they could not withstand a severe hit, they were so difficult to hit that they could afford to take the chances. The largest of them was 320 feet long, 2150 tons surface displacement, rated at 18 knots surface speed and could run 20,000 miles. Only three or four of the cruisers got into service but a dozen more were building with several near completion when the war ended. Finally, there was the overseas mine layer, which was undoubtedly built for the benefit of our Atlantic Coast; there were eight of the class but not all were finished. This type was not as large or fast as the cruisers but there were torpedo and gun armaments in addition to the forty-six mines and the radius was 13,000 miles."

"At the end of the war, the Germans were still building the three smaller types of submarines in spite of the fact that inshore and narrow seas work had become more dangerous and somewhat less successful. It is probable that little was done toward building the large cruiser submarines before we came into the war but at least the designs were well along by then. This type was not in the first instance intended for operations in narrow seas; not only was so great size and expense not needed for the work but the large size, and possibly slower diving with less handiness under water, made them more vulnerable to anti-submarine craft. They were all built for long radius, open sea work and even the few that did get into service greatly increased the difficulties of our trans-Atlantic shipping. Prior to their advent, the submarine danger lay only within a few hundred miles of Europe and anywhere west of that danger-zone, all was serene and with nothing to worry about except the weather. But the summer of 1918 found our shipping facing the submarine danger throughout the voyage and put quite another face on the situation; we had to maintain all possible precautions all the way. Moreover, while people in open boats had fair chances when

within, say, 200 miles of the coast, there was obviously little hope when it happened in mid-Atlantic. The effect on morale of some crews was becoming evident and while we were by no means accepting any slowing up of our shipping, other than zigzagging all the way across, we were already reinforcing ocean convoy escorts and foreseeing that we should soon have to escort with destroyers all the way across. That situation could have been met only by thinning the other destroyer escorts, near the European coasts, and consequently have given the smaller German submarines a freer hand. That is, those few large submarines were strongly tending to force us to disperse our anti-submarine forces. There were five visits of the large submarines to our coast and one other came about half-way and turned back. One of the five was the first of the large mine-layers; her grist of mines cost us five merchant ships, and nearly sank the battleship Minnesota. It rather effectively demonstrated what she and her sisters would have done to the wide areas of ideal mining waters on this coast had the war continued; we should have been hard put to it to sweep the essential lanes and channels. With guns and torpedoes, the five submarines, during the cruises that brought them to our coasts, sank about fifty vessels, counting all classes."

"It is probable that a very few of all who crossed the Atlantic in our transports experienced a real attack or even knew of the presence of enemy submarines and there is still wonder why attacks were not more frequent. Moreover, the history is that no one of our transports was successfully attacked while going east and that our only considerable loss of troops en route was in one British ship, the Tuscania. The question, in the minds of everyone, is why we did not suffer losses of troops at sea; that is, if the German submarines were so effective, why did they not do something toward stopping the flow of our troops into France. The rather common supposition is that it was plain lack of the nerve to face the risks entailed in attacking vessels escorted by destroyers plentifully supplied with depth charges. Undoubtedly that was very largely the reason; it is not easy to torpedo a zigzagging ship, particularly if she is fast, and the concentration required in it does not leave so much for looking after the submarines own safety. Therefore, in the last stages of an attack, the escorting vessels, as they were used, are quite likely to get good chances with their depth charges. However, it's not quite safe to count on lack of courage in Germans and there surely must have been some skillful German submarine captains who did have the necessary nerve; it is therefore necessary to look farther for the cause of their absolute failure against our loaded troop ships.

It has been learned, from captured instructions, from quizzing prisoners from German submarines and evidence since the armistice, that the criterion of efficiency held up to them was the amount of tonnage put on the bottom; all the promotions, decorations, etc., were based on that. They were told what kind of ships counted most from their standpoint; at the head of their list was tankers and warships did not stand high. Incidentally, although torpedoes from German submarines accounted for 62 of the 134 surface ships that the British Navy lost and eight large French and Italian ships, they seem rarely to have gone out of their way to make such attacks. It was all a matter of estimate; they reasoned that they would win the war by the destruction of merchant tonnage. Their submarines having run the gauntlet to their operating grounds, strove to put down a ship with every torpedo; they could hope to do that only with easy shots and found they could stay out long enough to get an easy shot for each torpedo. A transport coming west was an easier shot than while going east because she was not strongly escorted and they estimated that in the long run it wouldn't make much difference whether she was loaded or not, at least not enough difference to make it profitable to face extra risk. Since they were losing submarines as fast as they were building them, the German high command could have scarcely afforded to view the matter in a different light, certainly not while persisting in the estimate that our Army could not become effective in time to considerably affect the issue."

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"I shall consume a little time with the submarines of the Allies because it seems that little has been said or written on the subject. For our own submarines it was a matter, in common with some other branches, of just getting to going well when the war ended; twelve of ours were on anti-submarine work in European waters for several months and twelve others arrived at Azores, enroute, just as the Armistice was signed; when the enemy submarines appeared on our coast, the remainder of ours that were ready began hunting and the only occasion on which any of those five Germans came at all near to destruction was in an attack by one of our very small submarines which failed. The Russian, French, and Italian submarines appear to have accomplished little; they lost about thirty boats."

"But the British submarines did a great deal in the war -- and they suffered very severely, losing fifty-nine boats. A few of that number were destroyed by their own crews when the Russian Baltic ports were abandoned and in some other cases the loss of life was not complete but it has been published that the percentage loss of life was higher in the British submarine service than in any other branch of British navy, or army."



The personnel was selected, highly efficient and very adventurous; in general, their operations were more dangerous than those of German submarines. The British submarines were effective in anti-submarine work, destroyed twenty German Submarines and, moreover, bagged their share of surface warships. A small force of them went into the Baltic and very seriously hampered all German movements in that Sea. Two or three went into the sea of Marmora, successfully running very dangerous mine and net barrages, as did those that penetrated the Baltic, rather tied in knots all that shipping and were consequently of great value to the British campaign at Gallipoli. One of them went in and out of the Sea of Marmora three times and sank in all ninety-three vessels, two of them alongside piers at Constantinople; her last cruise in Marmora was for forty-eight days, hunted all the time by many enemies and she terminated it only with the evacuation of Gallipoli; that performance was certainly never surpassed by any German submarine and, in my opinion, none came near it. Probably the most valuable work done by British submarines was on the German North Sea Coast; They were over there, close in, throughout the war and were of course the only kind of craft that could do such work. Besides their usual offensive operations, they were really scouts kept close watch throughout and were the only dependable source of information from that part of the Sea. For the energy that the British Nation expended on Submarines they got at least as great results as in anything else naval and probably military undertakings could also be fairly included in that, unless an exception be the tanks. British submarines were none too good from the material standpoint, and development, prior to 1915, had been rather sacrificed to the interest of surface ships for the British Navy. But the type proved so valuable that the British built or laid down during the war several times as many submarines as they began it with."

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"The anti-submarine measures of the Allies were both defensive and offensive. Little need be said herein concerning the strictly defensive methods because they are generally known. About the only new thing that did not get into service but which is still promising is a torpedo net, based on a novel principle, which it is claimed can be carried rigged out at sea at full speed. Its effectiveness against the German torpedoes was proved in part; a technical modification in detail of design of torpedoes might defeat it. As for the defensive measures actually employed, the zigzags and high speed greatly increase the difficulties that submarines have in hitting with torpedoes. The water tight compartment subdivision, torpedo bulkheads, blisters, etc., reduce the damage done by a torpedo hit and consequently the actual loss of ships, but even so, a hit means partial disablement and long dry-dock repairs."

"Installing guns on merchant ships was necessarily a distinctly defensive step and since we kept fairly well ahead of the German submarines by equalling or exceeding their gun power it stopped most of the damage they were doing with guns and forced them to use torpedoes; the result was fewer ships destroyed per submarine per cruise. The 6-inch guns of the cruiser submarines, which were also equipped with range-finders, power ammunition hoists and carried large supplies of ammunition, were tending to reverse that situation and to make the Allies increase the strength of ocean escorts; as mentioned above, those submarines were largely designed for commerce destruction by gun-fire. The principle of the British decoy ships depended on gun-fire and their operations, based on the element of surprise and trickery, resulted in enhancing the defensive value of guns on regular merchant ships. Those decoys were not accomplishing results in actual destruction during the last months of the war but the possibility that any merchant ship might be one of them kept the German submarines wary and hampered them."

"The most effective defensive measure against torpedo attack by submarines was also offensive and its development and employment was undoubtedly what defeated the "unrestricted" submarine campaign of the Germans. That was, escorting ships by small fast vessels well equipped for depth-charge attack. In its practical operation we necessarily assembled ships into convoys. The high value of the method lay in bringing about contacts that gave opportunity for efficient attack with depth charges. The result was either in such risk of destruction that the enemy did not attack or if he did the efficiency of his attack was destroyed by the measures he had to take for his own safety. We used all available destroyers and all other light craft that were able to do the work and thus enormously increased their value over what it would have been in ordinary hunting patrol in which they were at such a disadvantage."

"The numbers of German Submarine destroyed by our main offensive agencies were approximately as follows:

By anchored mines, including those in nets-----	42
By depth charges, from all classes of vessels-----	35
By gun-fire, including those on decoy ships-----	24
By torpedoes of submarines-----	20
By ramming, including all instances-----	18
By air attack-----	7

"Mines gave results all over the world but mostly in the North Sea and British Channel. The Dover barrage was not completed, in its final effective form, until about April; it was thereafter thickly patrolled and lighted and almost completely stopped that route out of the German bases and forced their submarines to go north about.

That barrage occasioned severe losses before the Germans gave up running it. The North Sea Barrage was a stupendous undertaking, both in its length and the depths; it comprised 56,600 U.S. and 13,650 British mines. It was not completed until so near the end of the war that the data of losses do not indicate its value. A relatively small proportion of the forty-two mined submarines were destroyed by it but the Germans were becoming very seriously concerned over it. Whether or not it would have effectively and permanently closed that exist cannot be said."

"Depth charges were the next most prolific in actual results and here again numbers were high. All told, there were hundreds of craft equipped with them which used them freely. To destroy or seriously damage a submarine, the heaviest depth charges used had to explode within from fifty to one hundred feet of her. Since she might be anywhere from just under to over 200 feet down, misses could be vertical as well as lateral. Therefore, the charges were sprinkled liberally over the area in which the presence of any enemy submarine was probable. The destruction accomplished was by no means all the results; high explosive, even at quite a distance, often feels to personnel in a submarine as if it were right on top of them and the free use of depth charges badly shock the German morale. The difficulty in destroying with depth-charges lay in the inability to locate the submarine with sufficient exactness. During the war, the best inventive talent was employed and much high grade scientific ability used in developing devices through which submerged submarines could be located by sound. It was a most difficult problem and was by no means entirely solved. Apparatus of many designs was put in service on allied anti-submarine craft and proved of value; some submarines were destroyed that would have escaped had we not possessed such equipment. But it did not happen, as was so often and so freely prognosticated, that some invention of the nature would make the German submarines innocuous and "win the war". We are not likely ever to see through the water and if an unfailing submarine locator is invented, it must obviously be based on sound or some principle kindred to it. A submerged submarine can be remarkably silent; wherein has lain the difficulty and whether it will be surmounted or not is, at present, a matter of opinion. Those engaged in the attempt are enthusiastic and certain that they will eventually succeed. My own opinion is shared by some who know something on the subject. It is that by aiding depth-charge attack, the only means that in the open sea disturbs the submarines otherwise ideal defensive quality, the development of these locating devices has already damaged her defense but not sufficiently to materially detract from her war value; that further development is probable but since the best brains of the Allies, used in great numbers and at high pressure, have not solved the problem, it is unlikely that during peace a revolutionary solution will be arrived at.

Also, conditions for the use of all similar devices are more favorable in a submarine than in any other kind of vessel; it is already the case that submarines are thereby assisted in evading surface craft and if the most promising of the principles for locating devices do materialize, their use by submarines will also improve the submarine's offensive qualities. Summing up, my opinion is that the hydrophone devices have helped the submarine more than they have hampered her."

"The German submarines that were destroyed by guns were mostly either surprised, by decoy ships, in thick weather, or for some reason being no longer able to dive. Those that were rammed were also caught napping in some way. In both of those categories, the ordinary hazards of war at sea figured more than do any special feature of submarines as a type."

"In the anti-submarine work by submarines, probably the concrete result was a lower proportion of the total benefit to the allies than in the other productive methods. The strong point in their use lay in that the Germans enjoyed no advantages in visibility. Normally, they always saw a surface enemy first; as against an allied submarine, the chances were even. If submarines had not hunted them, they could always stay on the surface in good weather, unless a surface enemy came along in which case they would simply dive until the danger passed and then come up again, to rest, charge batteries or perhaps to make a fast surface run and cut off ships which otherwise would get by. In the face of possible submarine enemies, patrolling submerged, the German did not dare stay up in good weather---or took chances if he did--and instead charged batteries, etc., in thick weather or at night and thus his chances of being surprised or run down were increased. That condition wore them out and permitted them to intercept fewer ships; several that were done in by submarines had simply gotten tired and decided to take their chances, come up and get some sun and air."

"With air attack also, the concrete results are probably not the true measure of benefit. Like the allied submarines, aircraft sighted the Germans and attacked them often. But it proved too difficult to do the very accurate bomb-dropping that was essential to destroy them and aircraft are not credited with high results for the energy expended. For the close-in work and guarding convoys while forming up and starting, aircraft were very useful."

"Summing up, no one of our several methods beat the German submarines. It was a case of every little helps. We were able to bring large forces against them, under circumstances that might not hold in another war, and kept our end up by continuous persistent work. Little of it was strictly fighting, for the peril in the offensive anti-submarine part of the war mainly lay in the hazards of the sea."

Now for the future. In order to estimate the usefulness of Submarines to us I divide the factors that constitute their strategical and tactical value into four heads:-

Defensive power.  
Fuel-radius  
Sea-endurance  
Offensive power.

Before enlarging upon those factors I will mention another which is not strictly germane to the study of war. That is the question of costs; those who appropriate the money are interested in that factor. As Naval Officers we cannot disregard the costs of the various kinds of weapons we demand and still claim to be the best advisors of the men who appropriate for our National defense. In the long run we will spend just about so much upon it. I therefore believe we also need to think of the dollars.

In the past the first cost of all classes of surface ships and of Submarines has been approximately the same per ton. Submarines wear fully as well as capital ships and have much longer life than light fast vessels. Their maintenance, fuel, personnel and other running costs are much lower than anything else - whether reckoned per ton or for potential war value.

The Submarine's defensive power does not get out of date; our oldest boats are defensively as strong as our newest ones. Their defense depends neither upon speed or the offensive power of self or other vessels. This unique defense by simple concealment is inherent in the type and is the quality which make the submarine able to act unsupported and to play a lone hand. No other ship can unless with long-sustained speed sufficient to get away from everything that is stronger.

It is no doubt believed by many that hydrophone or kindred devices have entirely compromised the Submarine's defense. We have used these devices as extensively in Submarines as in anything else. They are at their best in a submerged Submarine and such use is most favorable for estimating their value. While diving we do hear and locate each other at some distance if the conditions are favorable; otherwise we don't. When it comes to dependance upon hearing an extremely faint noise through hydrophones used from among the loud and numerous noises of a formation of surface ships running at usual speed, its quite another matter. Its true that we followed and destroyed some German Submarines by use of hydrophones. But our average was not high and I'm sure you will find that the Captain of any well-conditioned Submarine will bet you to his last dollar, and give you big odds, that he can get away from any hydrophone pursuit which we can now organize. Possibly the listening devices will improve

but no advance since the armistice or even any projected device threatens the Submarine very much. It is to be remembered that since the Submarine is the ideal listening vessel, his use of those devices is a great aid in out-manceuvring anti-submarine craft. I will mention later certain advantages in the tactical offensive operations of Submarines that are derived from their own hydrophones.

The fuel-radius of Submarines is higher than in any other class of vessels. Even small ones run long distances and a large one could make a non-stop run around the earth. Their Diesel engines are more than twice as economical as any steam plant. Their fuel and ballast tanks hold large stocks of fuel which is carried without sacrifice other than sluggishness in a sea-way and some reduction in speed. Since their defense is independent of speed its entirely safe to thus load them down with fuel.

By sea-endurance I mean habitability and capacity for consumable supplies, including ammunition. Long periods of living in a Submarine is none too pleasant but it has been and can be endured. In fact if a boat is properly designed, particularly with a view to minimum requirements in number of personnel, it is not so bad. We are able to work out the capacity for supplies without difficulty and it can be safely said that if we design properly, a sea-endurance can be obtained which balances the fuel-radius.

These factors give a vessel which can keep the sea for long periods, cover long distances and operate unsupported. They alone provide a most valuable agency for scouting and it is upon those qualities that we have to build for direct offensive power.

Any valid criticism of war-value seems to question the Submarine's powers of offense against surface war vessels. At present development we have seen that they were powerful enough to lay mines secretly and where they liked; their guns, which during that war were only patched on, at least worried us; while their torpedoes, husbanded for safe shots only, caused heavy losses in men-of-war. Aside from the direct results, were the restrictions that their menace placed upon the allies. It was a nuisance to have to zigzag, etc. Escorting vessels used up a lot of our resources and energy; for instance, Destroyers had to be specialized in armament and tactics at the expense of their value in the missions for which they were built. I can't concur with anyone who thinks that what the German Submarines did against allied men-of-war alone did not most amply repay them for their total effort.

However, the direct offensive power of the Submarine is still developing. I won't hazard a guess as to what will be done about guns. As you know, one British boat carries a 12-inch gun; from the technical standpoint it operates successfully but how it now appears to them tactically is not known. It is easy to mount powerful guns, up to 8-inch; and to provide ammunition supply and fire control. Personally, I am inclined to the belief that guns on Submarines are only auxiliary weapons and that under-water attack is still their main job. In that variety of attack the latest developments are toward the use of hydrophones instead of periscopes, both for manoeuvring and for actually directing torpedoes; this substitution to be whenever use of periscope is likely to defeat the attack through early discovery, or the counter-attack of escorting vessels. With standard hydrophone equipment our results have been promising and any advance in hydrophones will improve this method - thereby increasing the powers of offense by means of devices invented to defeat the Submarine. There are also means other than torpedoes for attacking under-water. These new weapons are mainly in the paper stage only; if successful they will surely destroy any ship built or building. I'm certain that a vast improvement in offensive power, - certainly all that needs to be added to present-day Submarines is practicable. I hope we, will be the ones to effect the development and not have to learn it from another nation.

The tactics of a Submarine attacking singly I'll dismiss with a tribute to the Submarine Captains who are good at it. A simple attack is none too easy for many. While not more than average aptitude and ability is required of all other individuals in a Submarine, for a good Captain they are rather special. I've had poor success in prognosticating who would be good and who wouldn't - frequently have been wrong both ways. Unless the Captain is an efficient attacker the boat is not dangerous. In any other craft we know that a good ship doesn't necessarily mean a good Captain but thus far that's not been the case with Submarines.

In collective tactics with Submarines singly or in groups working with and against all other kinds of war ships in Fleet actions, there has been scant experience and little or no development. In planning for a Fleet action in November 1918, the Germans only planted their Submarines in certain localities. The British seem not to have gone farther than the doctrine of getting their Submarines between the enemy fleet and his base. From a lot of study and a little experience we have a few general and tentative principles:-

- (a) Tactical units to be sections of from three to five submarines.
- (b) At least part of the sections to be well advanced beyond own Fleet and make earliest contact - if the stronger Fleet, all of the sections advanced.
- (c) Much freedom of movement to be allowed section commanders and to continuously inform them of the situation as concerns the main Fleets.
- (d) With several sections, to considerably disperse the advanced sections.

It is wrong to conceive Submarines running in close formation with capital ships and its also wrong and most misleading to regard them only as an intelligent mine field to be planted in one exact place under directions of the Flag. Even fairly slow Submarines handled on the principles given above give good chance of one or more sections getting in for close attack - and that's enough to do the business. Also it should not be assumed that once a section, or a boat, dives it is to stay submerged throughout the action; if unable to get in while submerged it can quickly surface and run on the surface to a more favorable position. General-purpose submarines with all the best strategical qualities are not fast. The principles given above are meant to apply to that type. With efficient leaders kept in touch with the Commander-in-Chief's intentions, I think there is decidedly a use for even medium speed Submarines in a Fleet action.

The tendency to specialize in designs appears in Submarines as in other types. A design intended primarily for Fleet work would be such a specialty and certain qualities would have to be sacrificed. A project to that end was put forward some months ago. It involves old principles in new applications by doing away with the present dual power plant. In it the single power plant gives high power on surface or while diving, - promising at least fleet speed on the surface and somewhere near it while submerged. Several engineers who have studied the proposition are optimistic and think it practicable from the technical standpoint. But the Navy Department's organizations which have power to act did not see fit to undertake any development of it.

Finally, I would say that the Submarine Officers think our next national emergency will find them fighting on our most advanced front from the day hostilities begin. Its conceivable, and to many probable, that there will be a long period of hostilities before a Fleet action occurs. Many Submarine Officers think that if our Submarines and Submarine Service in general receives the necessary attention and development, in conjunction with air service and fast light surface craft, the Fleet action will never occur.