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THE EMPLOYMENT OF AVIATION IN NAVAL WARFARE

DECLASSIFIED IAW DOD MEMO OF 3 MAY 1972, SUBJ:
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Naval War College
Newport, R. I.
September, 1937

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R E S T R I C T E D.

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THE EMPLOYMENT OF AVIATION IN NAVAL WARFARE.

I

THE NATURE OF AIRCRAFT AS A MEANS OF ACTION.

During the World War the development of aviation as a means of military action was tremendous. From almost nothing it gradually absorbed the energies of a large proportion both of the military personnel and also those employed in manufacture. As an illustration of the rapid rise of this new arm, we find that at the beginning of the war the British Royal Flying Corps was a rather unimportant part of the army, with 1844 officers and men, and only about 150 airplanes fit for war use. At the finish, all British aviation had been combined into an entirely separate branch of the armed forces, with a personnel of 300,000 and the enormous total of 22,000 airplanes in actual commission.

Aviation almost from the first affected the strategy and tactics of land warfare because along certain lines it exhibited capabilities far surpassing those of the older military arms. It failed to exert so great an influence upon sea warfare because technical conditions were more difficult, and because the problems on land seemed so much more immediate that every possible resource was devoted to their solution. Even so, at the end of the war many large seaplanes were operating in various theatres, blimps were in use for patrol, several battleships had been outfitted with planes, a seaplane tender was attached to the British Fleet, and the first airplane carrier was under construction.

Those familiar with naval aviation as it exists today are generally in agreement that, in future warfare, aircraft will doubtless affect naval operations to a least the same extent that in the past they have affected land operations. In our estimates as to the influence of aircraft, and as to the numbers that we are likely to need during war, it is therefore well to remember the impressive figures applying to British military aviation, and also

the fact that our present naval aviation has been principally developed during peace, and not under the spur of a life-and-death struggle. Though aeronautical engineering and manufacturing methods have made great strides since the war, they doubtless will develop even faster and further during future hostilities. If engaged in a prolonged war, it does not seem at all unlikely that the United States will be able to produce and maintain in commission a total of at least 50,000 naval and military airplanes, together with the necessary operating personnel.

It is important that members of the military profession make an effort to evaluate all material means of military action, in order that they may plan in advance the most effective offensive and defensive methods of using them. The first step in such a study properly seems to be to obtain a comprehension of their inherent limitations and capabilities, considered not with respect to details, but with a broad view of their underlying nature. With this purpose in mind, we may first consider the special limitations of aircraft, and then their particular capabilities.

In this study we will say little concerning lighter-than-air aviation. Nevertheless, it will have many important uses in war. Balloons and blimps are vulnerable to airplane attack and this fact may reduce their future value in active areas, but in quiet areas where enemy action is intermittent, they will continue to be used for observation and patrol. Rigid airships will have their uses if we possess any of them, but, so far as we can now foresee, the major burden of the effort in the air will be borne by airplanes.

Aviation, more than any other arm, is hampered by unfavorable weather, although we are bound to admit that this disability has recently become appreciably reduced. While neither the army nor the navy is likely to accomplish tactical results in a dense fog or heavy storm, unexpected bad weather will not be actually disastrous to ships or troops to the same degree it will to airplanes

in flight. Furthermore, at times seaplanes will be unable to land safely in the open sea, and thus may be available for only a single flight, and that a dangerous one.

Airplanes and engines are intricate and delicate machines that need expert attention. Trained and skillful personnel in large numbers are therefore necessary for their manufacture and operation to an even greater extent than for other technically complicated material.

Aircraft can be manufactured in quantity more rapidly than can ships or even much of the material means of action employed by other parts of the armed forces. But they require periodical renewal and overhaul, and their rate of obsolescence is rapid. For their operation they must receive a steady stream of replacement parts and bulky supplies. As they are capable of carrying only a small percentage of their own stores themselves, we must recognize that the maintenance in the field of large numbers of airplanes will impose great additional burdens upon all available means of transport.

Compared with most naval craft the cruising range of airplanes is small, and the time that they can remain away from base is restricted to a few hours. Radius is especially small in the case of airplanes designed for offensive use: for bombers, the bomb replaces the fuel that would sustain long flights; fighters, to be fast and highly maneuverable, must remain small and can therefore carry only small amounts of gasoline. Any one group of airplanes therefore can act at a given point for only a short time, and if the effort must be continuous, must then be replaced by another group. Thus the field of operation of aviation as regards radius and duration of effort is limited.

The effectiveness of a single airplane is not very great. It takes 108 planes to carry as many torpedoes as one squadron of destroyers, and 1200 planes to carry in one flight as many large bombs as the allowance of large projectiles of one battleship,

whose crew numbers only half as many men as that of 1200 planes. Furthermore, the aviation ground organization must be large if we are to keep a high percentage of the planes in the air for long periods.

Except in minor warfare and raids into the interior of enemy territory, aviation produces its maximum effects when employed in supporting the aims of naval or military strategy. It is unable alone to conquer or to hold territory, as it must depend upon the other arms for the security of its bases, and for consolidation of the gains that it may make possible. It cannot permanently occupy even its own medium, the air, in the sense that it is possible for a fleet to deny an enemy the use of a sea area, or an army to suppress effective hostile military activity in a given district. We must therefore reject the idea that aviation alone can achieve unlimited results against well-organized and well-trained military or naval forces.

On the other hand, the time factor as regards the speed of application of effort is all in favor of aviation. Its mobility permits it to be brought into action far more rapidly than any other weapon. Even when units are widely deployed they can be concentrated for the execution of common tasks in a very short time, and be used at distances much greater than is possible in the case of tactical units that are constrained to act on the surface of the earth. For this reason aviation is especially valuable as a means of speedy action for the counter-balancing of unexpected adverse events, or the prompt exploitation of favorable situations.

Aircraft also have a freedom in space limited only by their ceiling and the weather. It is difficult for an enemy to intercept and destroy them in the air even when superior. So long as their bases are secure, aviation forces quite inferior to the enemy can seldom be prevented from accomplishing many important missions.

Finally, to compensate for the relative ineffectiveness of single airplanes, it is possible to bring large numbers of them into action in a small area within a short period of time. No other military force can concentrate its effort against a single point so thoroughly and with so little dissipation of effort.

Thus the great technical advantages of aviation as a means of action are those concerned with time, space and mass.

Few nations can afford to maintain large fleets of airplanes during peace. After the outbreak of war, it will doubtless take most industrial countries about one year to expand their aircraft factories to the point where they can offset losses and begin to increase their peace complements. Roughly, we would not be far in error to consider the aviation aspect of war in three phases: the first year, during which the peace complements will be maintained but not increased; the second year, when numbers are growing rapidly but the operating personnel are still inexperienced; and the third and later years, when improved airplanes are available in large numbers, and they are manned by well-trained and skillful crews. In the consideration of the major strategical movements of a war, the probable state of the development of the war aviation programs might well be taken into account.

The next step in our evaluation would seem to be a consideration of the character of the probable future employment of aviation in naval operations, with respect to its larger aspects. We should examine the fields into which aviation may project its activities, and also the measures that we are likely to find most useful for defense against hostile aircraft.

Airplanes can fly long distances and are our most rapid form of transportation. In the air they can operate close to overwhelmingly superior enemy ground forces, and the latter can't do much to prevent it without strong air forces of their own. But even in possession of such forces, the air space is so great, and airplanes are so small that even numerous defensive planes find

great difficulty in locating individual scouts and driving them off. Speed, long radius, ability to employ radio, and comparative immunity in the penetration of hostile lines will always give to aircraft a special importance in the service of information.

The same qualities that make aircraft valuable in the collection of information and also permit their rapid concentration, make them valuable for counter-attack and for preventing surprise. Thus we can expect to find them extensively employed as a means for increasing the security of surface forces.

Nearly every existing weapon has been converted to the use of aviation. Its importance in the field of major and minor attack must therefore be taken for granted. One advantage peculiar to aviation is that its heavy attack elements can usually reach objectives well to the rear of the enemy lines, no matter how formidable may be his defense against surface forces.

Thus aviation can be counted upon for the execution of important tasks in the three fields of information, security and attack.

Objectives whose destruction might reduce naval effectiveness, and thus may be considered suitable targets for attack by naval aircraft, include not only ships and aircraft, but also naval bases, harbor works, factories, storehouses, means of transport and communication, and sometimes troops, airdromes, and shore artillery.

Although not directly concerned with naval or military strategy, the raids on the centers of civil population during the World War and the Italo-Ethiopian War were valuable for undermining a nation's war spirit, and reducing its general military resources. Regardless of individual aversion to such methods, we must recognize the fact that in the military opinion of Europe and Asia the next war will, from the beginning, see a determined aerial offensive against civilian support of military effort.

During the World War it became of great importance to defend vulnerable surface targets against air attack, and many men and much

material were devoted exclusively to this activity. Defensive measures included the concealment and camouflage of important objectives, the use of defensive fighting planes, and anti-aircraft gunfire. All of these were valuable, but they had only moderate success in reducing the effectiveness of aircraft attack. During the period since the war the material of defense has greatly improved, both as to local gunfire and the more active defense by fighters. Two new defense methods have also received serious attention: the removal of the more vulnerable attack objectives to positions either underground or beyond the range of hostile bombers, and the training of civil populations in minimizing the effects of hostile air raids.

No one of the available measures of defense is likely to be entirely effective by itself. The best method is to use a combination of all measures so that each can contribute its part. We should also remember that even if several attacks get home, we may, by continuing to inflict loss on the hostile air units, finally discourage them from further effort. Thus the German Zeppelins, which were effective bombers at first, ultimately gave up their raids and for a time England remained comparatively free from air attacks until the Germans developed the long range Gotha airplanes, against which the British defense was much less effective. The present defense system consists of placing around the more important and vulnerable objectives a heavy concentration of anti-aircraft guns, and deploying lookout stations and defensive fighters to a considerable distance in all directions. Because aircraft can pass behind the lines of surface forces and penetrate the back areas rapidly, the defense, to have its maximum effectiveness, must be organized in great depth, so that hostile aircraft will continue to encounter successive lines of resistance no matter how far they penetrate.

Even with the most careful organization and the best equipment, we are not justified in assuming that the balance has in-

clined more in favor of the defense than it was at the end of the World War. The offensive qualities of aviation -- speed, range, reliability, bombing accuracy and bomb sizes -- have improved in a like degree. We are therefore bound to conclude that, even when all means of defense are employed, attack by hostile aircraft constitutes a serious threat against naval objectives within range of the enemy.

After a full consideration of the nature of aviation as a means of naval action, its fields of activity, and the measures of defense that may be employed against it, we are at length able to isolate one particular feature which characterizes aviation effort as distinguished from surface military effort.

We speak of the "front" of an army, which delimits the sphere of that army's influence; if the army is to advance or even to continue to remain in position, it must be able to suppress enemy operations behind that front. A fleet does not require secure communications in quite the same sense as does an army; nevertheless, around its operating area it maintains what amounts to a "front" somewhat similar to that of an army, and unless it is able to control the area within this front, it will doubtless be forced to retire its lines to prevent undue loss. Therefore either an army or a fleet has under its control an area within which hostile influence is a minimum: our own and the enemy areas may touch at many points and action may occur at these points of contact, but there is little overlapping. The zones of operation of surface forces are therefore exclusive of important enemy activity.

No such exclusive zones exist in the case of aviation. The active hostile zones overlap each other. The "front" is formed by the limits of possible aircraft flight, but within aircraft range, nothing behind the enemy front is entirely secure from observation and attack. In fact, to be effective, most of the activities of aircraft (information, security, and attack), will of necessity take place within the hostile zone. In the case of land and naval

forces, raids into territory under enemy control are sporadic, but with aviation this reaching out into the enemy zone is the normal state of affairs.

In concluding this portion of our study of the employment of aviation in naval warfare, we may summarize our findings as follows:

THE GENERAL NATURE OF AVIATION AS A MEANS OF NAVAL ACTION.

LIMITATIONS.

1. HAMPERED BY UNFAVORABLE WEATHER.
2. REQUIRES HIGHLY TRAINED PERSONNEL.
3. UPKEEP IN FIELD REQUIRES LARGE TRANSPORT TONNAGE.
4. SPHERE OF OPERATION LIMITED IN RADIUS AND DURATION OF EFFORT.
5. SMALL EFFECTIVENESS OF SINGLE UNITS.
6. UNABLE ALONE TO ACCOMPLISH UNLIMITED MILITARY RESULTS.

CAPABILITIES.

1. TIME: CAN ACT QUICKLY AT GREAT DISTANCES.
2. SPACE: CAN NOT BE DENIED USE OF AIR BY DIRECT ATTACK.
3. MASS: LARGE NUMBERS CAN BE EMPLOYED AT A SINGLE POINT.

NUMBERS OF AIRCRAFT AVAILABLE DURING WAR.

- FIRST YEAR: NUMBERS THE SAME AS IN THE PEACE ESTABLISHMENT.
- SECOND YEAR: NUMBERS RAPIDLY INCREASING, BUT PERSONNEL INEXPERIENCED.
- THIRD YEAR: LARGE NUMBERS OF IMPROVED AIRPLANES, MANNED BY SKILLFUL CREWS.

THE PRINCIPAL FIELDS OF ACTIVITY OF AVIATION.

1. INFORMATION: SPEED, RANGE, RADIO, FREEDOM OF SPACE.
2. SECURITY: INFORMATION, RAPID CONCENTRATION, ATTACK VALUE.

THE PRINCIPAL FIELDS OF ACTIVITY OF AVIATION (cont'd)

3. ATTACK: MAY EMPLOY PRACTICALLY ANY WEAPON AGAINST OBJECTIVES EVEN BEHIND THE ENEMY FRONT.

(a) OBJECTIVES: SHIPS, NAVAL BASES, HARBOR WORKS, FACTORIES, STOREHOUSES, TRANSPORT, COMMUNICATIONS, TROOPS, AIRDROMES, ARTILLERY, CENTERS OF POPULATION.

(b) OFFENSIVE QUALITIES CONTINUE TO IMPROVE RAPIDLY.

DEFENSE AGAINST AIRCRAFT.

1. MEASURES OF DEFENSE: GUNFIRE, AIRCRAFT, CONCEALMENT, CAMOUFLAGE, REMOVAL BEYOND RANGE, MINIMIZING EFFECTS THROUGH TRAINING.

2. TO BE MOST EFFECTIVE, ORGANIZATION IN DEPTH IS NECESSARY.

3. UNSAFE TO ASSUME DEFENSE HAS IMPROVED RELATIVE TO THE OFFENSE.

FINALLY:

THE CHARACTERISTIC WHICH ESPECIALLY DISTINGUISHES AVIATION FROM OTHER MEANS OF MILITARY OR NAVAL ACTION IS THE EXISTENCE OF OVERLAPPING ZONES OF HOSTILE ACTIVITY. THE MOST IMPORTANT OF OUR AIRCRAFT OPERATIONS TEND TO OCCUR WITHIN THE ENEMY ZONE, RATHER THAN ALONG THE ENEMY FRONT.

II.

AVIATION AND NAVAL STRATEGY.

With a comprehension of the nature of a means of naval action, it becomes easier to deduce the effects it is likely to produce during war. The probable effects that follow the sound use of the various means form in turn one of the principal determinants of the strategy that will be most useful in attaining the objectives of the war. For instance, before the beginning of the World War the submarine was evaluated as being one of the minor means of naval action, and the full results of its use were altogether unforeseen. The British were much embarrassed during the first part of the war because German submarine activity forced them to move their main fleet north to new bases not previously prepared during peace. They finally almost lost the war because their inadequate strategic conception delayed until almost too late the evolution of an effective counter to submarine attacks upon sea-borne commerce.

It therefore is important to bring an open mind to the evaluation of the probable future effects of another new form of naval warfare, viz., aviation. We may thus be enabled to develop a strategic method that will more surely accomplish our war tasks.

We have mentioned the fact that aviation has an unusual freedom of movement as compared with the other arms. Even the deep defenses established by Great Britain, France and Germany during the World War were ineffective in preventing hostile bombers from penetrating to the hearts of those countries. It has become clear that it is impossible to deny the use of the air through direct action against aircraft themselves, and therefore the only sure way through which we can attain "Command of the Air" in a region is by putting the nearby air bases out of commission. The destruction of land air bases is a far more difficult task than is the destruction of floating air bases. In the case of a fleet distant

from its own shores, we can attain a virtual command of the air around it by destroying all its carrier decks. For us to attain command of the air around a hostile fleet in its own home waters we must not only destroy its carrier decks, but also all the air-dromes or land-based aviation in its vicinity.

Therefore, aircraft based on shore, as compared with ship-based aircraft, must be considered as having a strength much greater than would be indicated by an evaluation of numbers and types alone.

Thus we may expect that a nation with strong air power can create zones along its coasts and around its outlying fortified positions within which its shore-based aircraft are likely to have practically continuous freedom of action, and in which their activities in the fields of information, security and attack will exert an important influence upon nearby naval operations. Before undertaking operations near hostile coasts, a naval commander must therefore seriously consider this aircraft influence, and decide whether or not he can afford the losses that are certain to ensue. To continue for extended periods to operate, or even to base, within the reach of strong hostile aviation it would seem to be necessary either to render the enemy air bases untenable, or to establish a deep and very superior defense around the fleet, neither of which is very easy of accomplishment.

The growth of the influence of defensive air power upon hostile naval operations close to shore has been strikingly demonstrated in the recent history of the Mediterranean. Great Britain is distant a thousand miles from the western entrance to that sea, but for 200 years has completely dominated it through her navy alone. Her positions at Gibraltar, Malta and Egypt, although far from home, have been satisfactory for the maintenance of her fleet. In continuation of this policy of naval domination, and apparently without an adequate appreciation of present conditions, two years ago she moved the major portion of her fleet to the Mediterranean in

order to halt the Italian conquest of Ethiopia. Italy estimated the situation accurately and defied Britain. Two significant events at once occurred: 1st, the British moved their naval forces to Gibraltar and Suez; and 2nd, they then called upon France to assist them if they were attacked by Italy. Even though Italy was weakened through having to send her expeditionary forces through the Suez Canal directly past a large part of the British navy, this much superior naval force was constrained to abdicate control of the Central Mediterranean. Without doubt, Italian submarines and motor torpedo craft menaced the British Fleet, but in the World War the German submarines were an even greater menace. There was one element of opposing strength, however, which the British apparently had under-estimated until the arrival of the crisis, and that was the Italian air power.

To be able to nullify this power, England required at least an equal air power in positions which she could defend and supply, and so located as to be within flying range of objectives whose destruction would seriously injure Italy. England had no such positions. Her aircraft carriers were too vulnerable, and had to be moved away with the rest of the fleet. Neither the harbors nor the terrain of Gibraltar and Malta are suitable for maintaining large numbers of aircraft. Air bases at Cyprus or Alexandria would have been cut off from direct supply via Gibraltar, and are out of easy reach of vulnerable Italian positions. Hence Britain's call for help to France, which has a well-based air establishment even stronger than the Italian. Great Britain did not need the French navy, but she sorely needed the French air force and its bases.

The characteristics of existing shore-based airplanes are such that, in good weather, they can scout 1000 miles to sea or drop bombs within 500 miles of their bases. Of course they can not do these things every day, nor be in great strength at many points at once. It would be a mistake to assume that aircraft

alone can at all times defend a long coast line in such a way as to prevent incursions by hostile naval forces. The influence that aircraft will exert in the coastal zone depends upon many factors in addition to that of performance characteristics. Among the more important factors are the extent of the coast that is to be guarded, the character and duration of enemy activity, the numbers of planes available, prevailing weather, and the distribution and security of supporting air bases.

Each of these features has variations and might be discussed at length. But it will be sufficient for our present purposes merely to record our opinion that shore-based aviation will greatly increase the defensive power of a maritime nation against hostile naval pressure in contiguous waters. Such a nation will possess a more or less secure zone along its coast, which an enemy with even very superior naval forces will find it hazardous to attempt to penetrate and control. As a consequence, the strategy of the future may tend to require that the principal naval operations of a war between opponents with strong air power be transferred to waters distant from the home territories of both belligerents.

This principle seems applicable not only where the opponents are separated by a broad expanse of sea, as in the case of Great Britain and Italy, but also where they are close together.

Before aviation attained its present importance, Italy developed a great naval base at Spezia, within one hundred miles of the French border. But with a growing realization of the power of the French air force, Italy has in the past few years neglected Spezia and has concentrated attention upon building up Taranto as her chief naval base. She has also pushed the development of various other ports in the south for commercial and naval use. It is clear enough that the future Italian naval effort will be directed toward the control of the central, rather than the northern portion of the Mediterranean.

An indication that even Great Britain entertains doubts as to her future ability to operate heavy vessels near the shores of a hostile Continent may be seen in the present agitation to move the fleet bases away from the south of England and around to the Irish Sea and the west coast of Scotland. Against the bases on the Channel and the North Sea, air attack from the Continent could develop with little warning, and be successfully completed before any but a small portion of the defense forces could be brought into action. To attack the new positions, distant about 350 miles from France and 500 from Germany, aircraft would be forced to cross the entire breadth of England under conditions greatly favoring the defense. If the main fleet bases are moved so far to the north and west, we may expect that the British Fleet must in the future cover its Channel operations from these more distant positions, or else employ new methods that do not involve the direct use of its larger and more valuable units in those waters.

So much for the defensive role of shore-based aviation in national naval strategy. It may also have an important part in offensive strategy.

In support of a naval offensive, shore-based aviation may be conceived as having two distinct missions. The first is the direct defense of its own fleet by covering its movement and attacking hostile forces that threaten it. The second is purely offensive, is tactically independent of fleet operations and involves the weakening of the enemy's defense by air attack upon objectives in the particular locality which is proposed for occupation. These attacks may be made against naval vessels and bases, airdromes, and other elements likely to be of assistance in resisting the invading fleet's advance. Since aviation will itself be subject to counter-attack both in the air and at its bases, it is obvious that relative superiority will probably be required to accomplish tasks of an offensive nature.

We may cite an imaginary example to illustrate air operations

in support of a fleet acting on the offensive.

If France last year had agreed to support Great Britain against Italy, it is conceivable that both nations together might have concentrated enough aviation in Tunis to have driven the major part of the Italian air and naval forces out of Sardinia and Southern Italy, and thus have permitted the British Fleet to have regained control of the Central Mediterranean. The air preponderance of the allies would have been at least two to one, and doubtless such a superiority would have been necessary.

Therefore our second principle with regard to shore-based aviation is that it will increase the offensive power of a fleet, provided it is based close to the theatre of operations, and has sufficient superiority to weaken seriously the enemy's air and naval defense systems.

Ship aviation differs from shore aviation in that its bases are mobile, much more vulnerable, and its aircraft are more limited in range and power. However, its general fields of operation are the same. If it were possible for a fleet always to operate close to shore, there would be little necessity for much ship-based aviation. It is when a fleet leaves its own coasts that its aircraft become valuable. Thus Italy, whose naval ambitions are now confined to the Adriatic and that part of the Mediterranean which lies between Africa and Sicily, rightly sees no need for aircraft carriers. But the United States, Great Britain and Japan, whose interests may require their fleets to operate far at sea, rightly consider the development of fleet aviation to be of great importance.

When outside the range of coastal aircraft, the presence of ship-based aviation permits a commander to establish a zone around his fleet within which his aircraft may maintain their usual services of information, security, and attack. The mobility of these floating air bases permits this zone to accompany the fleet, and also enables the commander to set up auxiliary zones detached from

his main force. Where two hostile zones overlap, each fleet is able to exert pressure upon the other through air operations.

The natural desire of each commander to extend his own knowledge, to restrict that of his opponent, and to give special protection to certain portions of his fleet, will create a tendency toward enlarging these zones and effecting the early destruction of the adversary's air power. We may thus expect to see cruising fleets establish strong advanced and flank forces composed of both air and surface units having the double duty of scouting and offensive screening.

The establishment of these enlarged zones within which both belligerents have reasonably accurate knowledge of the other will reduce the chances of surprise, and make it more difficult than ever for a strong fleet to bring a weaker to action, unless the latter can first be "fixed", or slowed down, by subsidiary attack. With this wide deployment of possibly the greater part of a fleet, and the ability of aviation to attack rapidly from long range, we may expect to see an increase in the employment of attrition until it may even become the principal method of inflicting damage upon the enemy.

If we accept this view, it follows that the relative strengths of two hostile air contingents will have great strategic importance, because if one fleet is able to destroy all of the opposing air force, and yet keep a portion of its own, it will gain the ability to conceal itself and yet retain the advantage of knowing what the enemy is doing. Such a fleet will then have a power out of all proportion to its apparent material strength. As a general proposition, therefore, we may say that a fleet which lacks aviation has, in comparison with an opponent in possession of aircraft, a serious weakness which even greatly superior strength in other types may not counterbalance.

It has been pointed out by Corbett that the Clausewitz ideal of absolute war is not applicable to nations which do not have

common frontiers, and whose home territories have a large degree of security against direct overseas attack. Wars between separated nations therefore tend to take the limited form; strategic objectives are then most likely to involve the seizure of important outlying territory, or the reduction of the enemy through the slow strangulation of his sea-borne commerce, or a combination of the two methods. In either case, control of vital portions of the sea is usually necessary for success, either in offense or defense.

Major naval missions of any war therefore are properly concerned with the exercise of control of some part of the sea, whether for protecting or destroying trade, or for protecting or preventing the overseas transport of military forces. Aviation will in the future play an important part in the control of the sea. Some of the sea areas in dispute during war may lie within the zones of the shore-based aircraft of one or both belligerents, and some important areas may lie entirely outside these zones. In the various conceivable combinations of vital areas, either shore or ship aviation may be the more important as a fleet reinforcement. In some cases, aviation may even become so important as to be able to relieve the main fleet almost altogether of its responsibilities in a particular area.

An example of the potentialities of aviation in the control of a sea area may be found in the Caribbean. This case is unique in that the United States is the only strong air and naval power having its home territory close to this sea.

Before the World War, in spite of our comparatively strong navy, we had serious misgivings as to the defense of the Panama Canal and still believed that in war a strong naval power might be able to establish itself in the Caribbean. Today there seems little need to apprehend danger in that direction. A fairly good air base exists in the Canal Zone and one is to be constructed in

St. Thomas, while the mainland, Guantanamo and Puerto Rico are well located for setting up others. The territories of foreign naval powers in that region are comparatively vulnerable to amphibious attack. All outlying positions are within flying distance of the continent, and all shipping and supply lines lie within the scope of air influence. It is inconceivable that any foreign naval force, however strong, should at present feel itself able to establish its fleet in position to dispute this area with the United States. The strategic effect of a sound use of aircraft in the Caribbean, once it has been properly consolidated for defense may well be to remove it almost entirely from the active theatre of any future war in the Atlantic, and thus, by reducing the former burden of its defense, enable our fleet to employ its principal strength elsewhere.

Another example may be found in the western portion of the Pacific Ocean. To the South, East, and West, Japan through her aviation is secure to almost the same degree as is the United States in the Caribbean, but to the North the growing air power of Russia has introduced an element of uncertainty. If the Philippines were to fall into the hands of Japan, aviation would gain an increased potential influence in the defense of Japan's control of the China Sea and the Western Pacific. However, it is about as far from the Kurile Islands to Tawi-Tawi as it is from Unalaska to San Diego. While many intervening islands would serve as stepping stones for the concentration of aircraft at any particular point, transportation difficulties and the fact that the main positions are not mutually supporting would make the system difficult to consolidate for defense. It is obvious that the full exploitation of the potentialities of aviation in this extended area would require numerous airplanes and many well-defended air and military bases.

With the Philippines in the possession of Japan and requiring protection, she would then have a serious task if she should under-

take to stretch her defensive system further and make an effort to include in this system the central portion of the Pacific.

The Mandates have few natural resources and no industrial importance. Distances to industrial and military centers are great, and difficulties would exist in the protection of lines of communication. None of the islands can be held long unless continuously supplied from the outside. Though many could be converted into subsidiary bases, none seems suitable for development into a major fleet or air base. Shore-based aviation might in time become very influential, but no large contingents are now established in the area, and any such force would require strong support from both naval and military forces. The Mandates seem now to be debatable ground; both their defense and capture would require great efforts; in these efforts ship-based aviation might well play a very important part, particularly at the beginning of hostilities.

The employment of aviation in the attack upon, or in the support of military expeditions lies within the field of tactics; its employment in connection with the direct control of sea-borne trade seems, however, to have a strategic character.

During the next war we will doubtless see a clarification of the question of an acceptable relationship between belligerent aircraft and the merchant marine. There has been much speculation on the subject, though, like similar problems, it will eventually be settled from the practical viewpoint of how much can be done without too great objection from neutrals. Probably all will agree that aircraft may be employed freely in the control and defense of such of our own merchant vessels as pass within our aircraft zones. But in the control of neutral shipping and the capture of vessels of enemy nationality, we do not now seem justified in counting upon doing much more than to use aircraft to scout for surface warships, which themselves will make the necessary visits. These airplanes may be based either on the ships themselves or up-

on nearby airdromes or harbors. With the assistance of scouting aircraft a given naval force can effectively control the shipping in a much greater area than can the ships alone; or, conversely, fewer and weaker warships detailed to a certain area may still accomplish the desired results.

Strategically, this matter is important not only because of the saving in warship tonnage that would otherwise be devoted to commerce duty, but also because of the increased value that aircraft will give to widely distributed bases for the protection of friendly shipping and the destruction of enemy trade. Because of this increased importance, there will also be an increased incentive to capture outlying enemy positions that might prove useful in the trade war.

Though the power of the British fleet has now diminished in the sea areas near adversaries having strong air forces, its own aviation should greatly enhance the value of its more distant positions near trade routes^{such} as Gibraltar, the Cape of Good Hope, Aden, Ceylon, Singapore, etc. Scouting and bombing squadrons should be of great assistance in preventing enemy raids on their sea-borne trade, because the aircraft zones that can be established around these bases will cover the major portion of British shipping routes throughout the world. Cooperation between airplanes and small naval vessels located at these points should at the same time practically insure to the British the prompt destruction of enemy trade.

We have endeavored to touch upon the principal strategic effects that aviation may have in the naval sphere, and have avoided referring to its connection with military strategy. But our study even of this aspect of naval strategy would be incomplete if we did not mention an important part that aviation may play in a sphere entirely separate from those of either the army or the navy.

It is ^agenerally accepted ^{view} that the ultimate aim of the nation-

al war effort is the destruction of the enemy's "will to fight". Experience has shown that, aside from the direct effects of operations against the hostile armed forces, this "will to fight" may be shaken by the employment, external to enemy territory, of financial, economic, and diplomatic weapons, and also by naval blockade and by air raids against its internal civil organization. Before the World War, a nation's citizens well removed from the front were reasonably secure from direct military pressure. Today its whole territory may lie within the aircraft zones of the enemy. In these zones, hostile aircraft will, of course, operate on purely naval or military missions, but they may also operate with the sole purpose of disrupting the nation's internal structure. An indirect offensive of this character consisting of sustained raids upon the areas behind the enemy front for the purpose of undermining civilian morale, destroying a nation's general resources, and forcing it to maintain heavy local defenses at the expense of man power and material that could otherwise be sent into the field, does not seem to be a direct concern of either the army or navy. While the successful performance of such a task will doubtless indirectly assist the other arms, essentially it lies entirely outside the purview of normal naval and military strategy. As a feature of national strategy, however, it may closely concern the government and may even appear to offer the only hope of a successful issue of the war. It seems to be a task for aviation alone, and in this one field we may say that aviation may legitimately be considered independent of either the army or the navy. There is also, the defensive air effort that must be made against hostile aircraft which attack our own centers of population.

The special conditions involved in any particular conflict will determine the importance and the extent of this independent strategic field, but we may commit a grave error if we fail to recognize its existence. When called upon, we should be prepared to contribute such part of the total naval aviation as the needs of this independent effort require. It has often been said that it was the unwillingness of the leaders of the British Army and Navy to place a part of their aviation at the disposition of the

government for use in this separate sphere that constituted the one valid reason for the original organization of the Royal Air Force.

In closing this portion of our study, we may make the following summary of the principal effects aviation may cause in the field of naval strategy:

1. Augmentation of both defensive and offensive naval power within the zone of strong shore-based aviation.
2. Relative increase in the employment of attrition as a chief means of inflicting damage.
3. As between two naval adversaries, the disproportionate lack of power of the one without adequate aviation.
4. Increase in the effectiveness of control of sea areas.
5. Increase in the strategic importance of outlying positions.

It may also be well to reiterate that a sustained air offensive against an enemy's internal organization will usually be a task for aviation strategy which will lie entirely outside the spheres of normal naval and military activity.

III

THE PART OF AIRCRAFT IN NAVAL TACTICS.

An exposition of the tactical employment of aircraft should start with consideration of the weapons they use and the classification and organization of the airplanes themselves. One should then survey possible methods of bringing special capabilities to bear upon practical situations, and finally attempt to evaluate the effects that may be produced upon an enemy. As with the tactics of other forms of military effort, we must necessarily consider these matters in some detail.

With regard to weapons, we find that airplanes employ machine guns for combat with other airplanes. For attack, the fixed gun is used; for defense, the free machine gun. Little progress has been made in the development of other weapons, although bombs, gas, and, in the case of the Japanese, even silk nets released in the air have been tried out.

Against military personnel on the open ground the best aircraft weapons seem to be machine guns and small fragmentation bombs, while large demolition bombs, gas bombs, and gas spray may be used against personnel in fixed positions or embarked in various forms of mechanical transport.

Torpedoes and large bombs are available for attack on ships and shore artillery and structures. 100 pound bombs and .50 caliber machine guns are effective against the structure of destroyers and smaller craft. Incendiary bombs have proved useful against various inflammable objectives. If civil populations are to be attacked, it seems rather more likely that incendiary bombs and the intermediate demolition bombs of from 300 to 500 pounds will be used rather than smaller bombs, machine guns, or gas.

Our demolition bombs for the most part have light cases in which about 75% of the total weight is devoted to the explosive. We formerly believed that armor-piercing bombs would be the most

effective against ships, and there now seems to be a tendency to try them again, in spite of the doubt felt by many persons that they will penetrate more than one or two decks without detonating. The present bombs have selective fuses that function when about half-way through one deck, or, if they strike the water, will delay until the bombs are about thirty feet below the surface.

Under-water detonations of 500 pound and 1000 pound bombs will damage heavy ships up to a distance of possibly 25 feet from the side. If they explode within two or three feet the 400 pounds of explosive carried by the 500 pound bomb will do ^{about} as much damage as the average torpedo, while the 750 pounds carried in the 1000 pound bomb will do considerably more. One 1000 pound bomb deck hit may be expected to blow a hole through three decks of a heavy ship, the upper hole being about ten or fifteen feet in diameter. The effect of the explosion on the surrounding structure, wiring, and pipe leads is likely to be quite severe.

Some foreign torpedoes weigh as little as 1000 pounds and have a range of only 2000 yards. Our own torpedoes weigh about 1800 pounds, and have a range of 6000 yards, and carry 325 to 600 pounds of explosive in the warhead. If dropped more than about 1500 yards from a target a spread must be used similar to that fired by a squadron of destroyers. Naturally, a torpedo plane is in a dangerous situation when within 1500 yards of a heavily-armed vessel.

The airplanes that have been developed for tactical use in the U.S. Navy are classified as fighters, observation planes, scouts, bombers, torpedo planes, and patrol planes.

Fighters are usually small single-seaters, fast and highly maneuverable. They carry two fixed machine guns of which one may be a .50 caliber; in addition to these fixed guns, two-seater fighters also carry one free machine gun. The Navy has added two 100 pound fragmentation bombs to the fighter's weapons, and proposes to employ these planes in the so-called strafing attack

against exposed personnel, principally for the purpose of driving them to cover, and thus to prepare the way for attack by heavy bombers, or for the landing of troops on a beach.

Observation planes and scouts are small two-seaters, and may be either landplanes or seaplanes. They carry one .50 caliber machine gun for attack, and one free gun for defense. The smaller planes of these two categories may also carry two 100 pound bombs, while the later and larger scouts attached to carriers are designed to carry one 500 pound bomb so that they may be used on occasion as intermediate bombers.

Naval bombing and torpedo planes include the medium-sized landplanes attached to carriers, and the same or larger planes on floats. The large, long range flying boats known as patrol planes are also used as bombers. Large seaplanes are all based on shore or on tenders, and to move with the fleet must proceed under their own power or be completely disassembled and shipped in crates. Carrier bombers carry from one to three 500 pound bombs or one 1000 pound bomb, or one torpedo. The flying boats may carry four 500 pound bombs or two 1000 pound bombs, and are now being developed to carry an alternative load of two torpedoes. The larger dive-bombing planes are two-seaters; they carry one 1000 pound bomb and one fixed and one free machine gun; we also have an intermediate dive-bomber that carries one 500 pound bomb. The high altitude, or sight bombers, are three-seaters, and carry from two to three machine guns. Patrol planes have a crew of five or six men, and mount three or four machine guns.

In addition to naval planes, we must not forget to mention the planes that friendly or hostile land forces may be able to employ. Those most likely to concern the Navy are bombing planes. They may be of an intermediate size carrying bomb loads up to 1000 pounds, or the large size carrying bomb loads up to 4000 pounds. Individual demolition bombs used by these planes vary in weight from 300 to 2000 pounds; some are armor piercing and some are

light-case. The navies of the United States and Japan are said to be the only services that employ the method of dive bombing; the United States Army and most of the foreign services generally employ high altitude, or sight bombing.

The naval aeronautical organization during peace comprises several tactical categories.

As part of their own organization battleships carry observation seaplanes and cruisers carry scouting seaplanes. These are launched from catapults, but must land on the water and be picked up by the ships' cranes. These planes are placed on board not for independent use, but to increase the effectiveness with which battleships and cruisers can perform their regular tasks.

The airplanes of the aircraft carriers, on the other hand, form in the fleet a separate combatant category of the Battle Force. Their tasks are always to assist in the execution of fleet tasks. They sometimes form the major element of a task force, and may be assisted by cruisers, destroyers, submarines, and patrol planes. Sometimes they are only minor elements. The usual complement of carriers is one squadron of fighters, one of scout-bombers, one of intermediate bombers, and one of heavy dive bombers or combined sight bombers and torpedo planes. All of them are landplanes. At first there was some tendency to segregate on one carrier all of the planes of a particular class, but we now recognize that the carrier is likely to be more useful if she is capable of performing several different kinds of tasks in the same area. Furthermore, on account of the question of officers' quarters, it is better to have about the same number of pilots on each vessel. Although the number and diversity of class of its planes fit a carrier for the performance of various duties, the one outstanding feature is their attack power against all kinds of objectives. This category is especially well adapted for the tactical offensive.

The patrol plane squadrons are all composed of planes of one class, and are at present a part of the Base Force, and independent of the carrier squadrons, in spite of the fact that cooperation between the two categories may

often prove to be of the greatest importance. Originally, they were thought to be especially important for base defense. But with their recent increase in range and offensive power, they have become of great value to the mobile Fleet. While some of the flying boats are based on tenders and some at shore bases, as an organization they are less mobile than the carrier group because when they accompany the fleet, they can go only via routes that take them from one regular base to another, or from one tender to another. Tasks assigned to the patrol planes are usually long range scouting, off-shore patrol, and bombing.

The final naval tactical category consists of the airplanes attached to the Fleet Marine Force; these are of the classes considered most suitable for expeditionary duty. In this organization are several squadrons of observation planes for local scouting and for spotting gunfire, several fighter squadrons for repelling air attack, and several squadrons of medium-sized bombers for use against troops or ships.

The only important modification of the aeronautical organization that may be expected during war is that patrol squadrons will be added to the naval districts to assist the local naval forces in the control of merchant shipping, and in detecting and driving off raiding submarines and surface vessels. Probably these will be augmented with numerous non-rigid blimps. It is to be expected, however, that in the Fleet Zone, whether at home or overseas, the Navy will endeavor not only to increase its ship-based aircraft to a maximum, but also will organize a large force of shore-based aircraft of all the classes and types that might prove useful for reinforcing the Fleet's operations against the naval forces and the sea-borne trade of the enemy. The proper distinction between Army and Navy aircraft has nothing whatever to do with type or class of airplanes, or the character or location of their bases, but is one of function. That is, is the airplane required primarily to assist the Army in its usual tasks on shore, or is it primarily designed to assist the Navy in its usual tasks at sea? The answer will determine whether the plane should belong to the Army or the Navy. For the independent field of aviation

strategy, either Army or Navy airplanes, or a joint force of both, should be employed, depending entirely upon the situation, and the practical conditions as to which category of planes can best be spared, or is most likely to be effective.

One may believe it a mistake to be too literal or too doctrinaire as to whether, in a particular case, an operation is one in which one service or the other has paramount interest, or is to occupy the subordinate position. One of the most effective units afloat during the Civil War was Foote's Flotilla, which was a gunboat force not under the Navy at all, but directly under the Army for assisting in the accomplishment of purely Army tasks. This case is unusual, because ordinarily ships cannot do much in land operations, nor troops be very effective in naval tactics. But in the case of aviation this sharp distinction does not exist at all. The zones of effectiveness of Army aviation can extend over the sea as well as over the land, and the zones of naval aviation can be just as broad over the land as the sea. Each branch, at times can and should assist the other in its tasks. In the air the spheres of interest of the Army and the Navy come in contact, and even overlap, in a way that is quite impossible with ships and troops. It is especially in aviation that there is a real opportunity to promote effective cooperation between the two branches of the national defense forces.

It has previously been pointed out that the activities of naval aircraft are chiefly concerned with matters of information, security, and attack. All of these fields have great tactical importance.

Scouting is, of course, the airplane's principal method of obtaining information. Somewhat less important are such matters as the transfer of spies to positions behind the enemy front, raids for interrupting means of communication, and the rapid transportation of despatches and persons. Under this heading we may also mention the employment of aircraft for distributing propa-

ganda.

The details of aircraft search and reconnaissance may be found in various official publications available here at the War College. These must be studied if one is to be thoroughly grounded in this subject, but they will not be repeated here. But there are several features pertaining to scouting that have interesting tactical aspects, and therefore we will consider them here.

Shore-based flying boats are the best for search of extensive sea areas because of their greater endurance and the higher accuracy of their navigation. But they can be seen at long ranges and are vulnerable to anti-aircraft fire and to attack by fighters; thus, while they are suitable for search and tracking, they are less effective for tactical scouting.

In areas well out to sea where patrol planes are not available air scouting must be done by ship-based aviation. The question at once arises as to whether to use cruiser or carrier planes. On the one hand cruiser planes are rather slow and have a limited range, and if we deploy our cruisers widely enough for effective scouting it will not only take considerable time to concentrate them again, but also they incur the danger of destruction one at a time. On the other hand, carriers in advanced tactical positions are also exposed to attack, and if they are destroyed we will at once lose one of the most mobile and powerful attack elements in the fleet. Some of the commanders in the fleet depend almost entirely on scouting by planes from the carriers, while others go so far as to say never to use them in this way, but save them for use in the attack. It seems to be a mistake to make any hard-and-fast rule on the subject. Available forces and other conditions should be considered before reaching a decision in any particular case; however, both fleet and War College experience indicate that many scouting problems can best be solved by an advanced force which includes both carriers and cruisers. Planes from each may do a part of the scouting; if the cruisers are dis-

posed in an advanced line they will be in a position to scout ahead and also to provide the carrier with some protection against enemy light forces, while the carrier, in rear may scout the flanks and be available for driving off enemy groups that may attempt to roll up the cruiser line.

The proper sequence of aircraft scouting is, 1st, thorough search of the whole of an area and location of all enemy forces in it; 2d, tracking of all individual groups, contact being made frequently enough to determine their composition and the speed and direction of movement; and 3d, as soon as tactical action appears imminent, continuous contact for the purpose of insuring complete knowledge of all enemy operations.

For close and continuous tactical scouting, quite naturally it is desirable to employ very fast planes that can evade attack without being driven off. It will be found that several pairs or sections of planes will be required for scouting large dispositions, because it will seldom be possible for one scout to view and to develop more than a small portion of the enemy forces. A careful organization of the tactical plot on board ship, and coordinated training of plotters and plane pilots is essential if good results are to ensue. Otherwise, with the many fragmentary and apparently contradictory reports that will come in from the planes, it will be impossible to draw a true picture of rapidly changing situations. Various methods or plans for tactical scouting may be found useful: for instance, one section might be assigned to watch all the forces on the enemy's right flank, one to watch all those on his left flank, one his battle line, etc. Or, one section could watch the area in the van of our own fleet, one the area in the rear, and one the area on each flank. It is also desirable that tactical scouts be available to work exclusively with special attack groups such as aircraft, destroyers, and submarines. In any case, the planes should be so disposed as to insure obtaining a knowledge of the movements of all known enemy forces in the

area, and also to guard against the surprise appearance of undisclosed forces, particularly submarines and aircraft. An important detail is that all tactical information should be picked up direct by the radio services of the O.T.C. and all force commanders.

The only aircraft that are entirely suitable for work of this character are the fast carrier scouts. However, since these may not always be available, some of the cruisers should reserve planes to take over this duty if it becomes necessary.

It may be that tactical scouting will extend over a considerable period -- several days, in fact, when conditions require continued operations in one area. This will require a carefully worked out scheme of reliefs if scouting is not to be interrupted. It would sometimes be important, if night destroyer, gun, or bombing attacks are to be undertaken, or if a fleet engagement is projected at dawn, that aircraft gain contact with the enemy before dark and maintain it throughout the night, guiding their reliefs and the attack units by means of radio transmissions. Aircraft can maintain contact with large ships at sea on fairly clear, moonlight nights.

In the field of security we will find a wide variety of useful aircraft operations. First we may have the observation of a line or area through which the passage of our fleet is projected. Then we may establish protective screens or picket lines of planes to give warning of the approach of enemy vessels or aircraft. We may also maintain a continuous patrol in an area for the purpose of detecting and attacking hostile forces that enter it. We may employ protective escorts for surface vessels and aircraft, and finally may have planes in readiness to lay aerial smoke curtains or clouds to permit our ships to evade attack.

In aircraft screens or picket lines the planes must be close enough together, and be disposed at such altitudes as will surely lead to the discovery of hostile forces that pass, whether air-

craft or surface. The picket line must also be far enough away from the force screened to give ample time to develop our full defensive strength (ships, guns, planes, smoke) before the enemy can attain an attack position.

Aircraft patrols may be used for a number of purposes. For the detection of mines ahead of the fleet we may employ a number of low-flying planes along the fleet course. When the fleet is in submarine waters a continuous anti-submarine patrol is very useful during daylight hours. An outer anti-submarine patrol may operate from 20 to 40 miles entirely around the fleet in order to detect submarines while still on the surface and then drive them down until our disposition has evaded them and is finally clear. We may also be able to employ an inner patrol in the van within about ten miles to mark and to bomb submarines approaching submerged to attack. We often assign small planes to the inner anti-submarine patrol, but it is better to use machines that carry 500 pound bombs if we have them available. Probably best of all for the inner patrol are flying boats armed with 4-500 pound bombs, not only because of their greater attack value, but also because there are more men in the crew, and so we will have more eyes for keeping a lookout. It is more important to have an outer anti-submarine patrol of aircraft than of destroyers, because the planes can usually see the submarines on the surface before they are seen themselves, while the submarines can always see destroyers first, and by diving may escape detection. The best arrangement of all is to use aircraft for the patrol, and also to have one or two divisions of destroyers at hand which may proceed to the reported positions of the submarines and attack with depth charges.

Patrols may also be run from shore bases against submarines and surface raiders which may enter coastal waters. As it is unlikely that we are ever likely to have enough planes to cover these areas continuously, probably the best we can do is to search important areas once daily, and, if enemies are found, to call out

attack groups of aircraft or surface vessels.

Airplane escorts are sometimes provided for ships and also for airplane formations to protect them against hostile air or surface attack. If bombing attacks upon a fleet appear imminent, an outer aircraft picket line might be established, and an escort of fighters kept overhead to engage the bombers before they come within range of anti-aircraft batteries. Unless some system is employed that will insure some advance warning, the bombers are likely to get home their attack. Even in this case, they should be engaged by our fighters as soon as they again pass beyond anti-aircraft range, in order to reduce the power of subsequent attacks. Where important convoys are to move through dangerous waters, it may sometimes be practicable to maintain a squadron of bombers in the air near the convoy to act as an escort, or to reinforce the regular escort of surface ships for protection against surface attack.

Fighting squadrons may also be employed to escort bombers, spotting groups, and scouts to protect them against hostile fighters.

If aerial smoke curtains or clouds are desired, considerable advance notice must be given, because it takes some time to rig the tanks on the smoking planes. Once the planes have been equipped with tanks and are in the battle area, curtains can be laid quickly and accurately. If the screen is to be laid at a considerable distance from the enemy, as would be the case when a retirement of the battle line is to be covered, it is practicable to use heavy smokers, which are slow but carry large tanks of liquid and can lay very long screens. For other purposes, such as isolating a part of the enemy battle line, and for protecting the advance or retirement of destroyers and torpedo planes, it may be better to lay the curtain close to the enemy. For these cases, light smokers may lay a curtain without any particular hazard within 1000 or 2000 yards of the hostile line by diving rapid-

ly in succession from high altitudes, laying their smoke in succession at high speed and withdrawing promptly. You may be inclined to question this statement. However, a plane flying at 200 knots speed will lay a screen 1000 yards long in nine seconds. Obviously, anti-aircraft gunfire isn't likely to be accurate when directed at a target that is changing its range and bearing very rapidly, and is in sight for only nine seconds. Experiments have been made in order to develop the technique of laying horizontal aerial smoke cloud a few hundred feet directly over objectives that are threatened with bombing attacks, but the scheme doesn't seem very practicable in the case of a moving fleet. The greatest drawback to the use of aerial smoke curtains is that probably it will never be available in an emergency that has not been anticipated.

Turning now to the field of attack, we find that action against shore targets may often be a task for naval aviation. But conditions will vary so much between different situations that it would be difficult to arrive at any general conclusions regarding such attacks except that, whenever possible, the aircraft should be based on shore, because at an air station they are less vulnerable than aboard ship. However, we can be more specific with regard to air attack upon ships.

Considering first the means of defense available to ships against aircraft we may list: gunfire; armor and ruggedness of construction; under-water subdivision; maneuverability; concealment by smoke; protective fighters; and, in the case of submarines, submergence. The concentration of many vessels in one disposition, and the arrangement of the ships having heavy anti-aircraft batteries in such a manner that hostile bombers must fly over several lines of gunfire before reaching the attack objective, should contribute to the effectiveness of the gunfire defense. The present circular cruising dispositions designed primarily to protect a train against attack by submarines and

destroyers does not seem entirely suitable for defense against airplanes, because the ships are so close together that the anti-aircraft fire of the various parts of the force will result in interference and inaccuracy. It may be said that unless we are able to effect satisfactory coordination, anti-aircraft gunfire from a large number of ships will cause a great deal of confusion and probably numerous personnel injuries on board the ships themselves. Furthermore, the close formation of many ships will reduce the chances for effective maneuver; therefore it would seem preferable to spread our ships over a somewhat greater area, to place the most vulnerable at the center, to surround these with several circles composed of divisions of ships with strong batteries, and to leave a certain amount of maneuvering room between divisions. We have done little toward the development of using protective smoke from surface ships, but the method has some possibilities, particularly when ships are anchored.

Vessels may possess these means of defense in varying degree. Thus, battleships have excellent gunfire and structural defense, and fair maneuverability. Cruisers have fair gunfire and construction, and excellent maneuverability; the principal defense of destroyers is through maneuver; and auxiliaries have poor defenses of any character.

From the standpoint of the attack, the conditions that may favor the aircraft are their own high speed and maneuverability, broken clouds, a high sun, protective smoke curtains, and sometimes night or low visibility. The airplane's best answer to heavy defensive gunfire may be high altitude, simultaneous attacks by many planes, the use of cloud, sun, and smoke concealment, attacks when a vessel is heavily engaged, or preparatory strafing by fast, highly maneuverable planes carrying small bombs and machine guns in order to drive guns' crews to cover. Against great structural strength we should concentrate many planes carrying the heaviest bombs. The advantage of a vessel's maneuverability may be reduced if the

attacking planes can effect surprise while the vessel is at anchor, or is making low speed, or is not free to change course, as possibly when in action, or in a close formation, or in narrow waters. To prevent being driven off by defending fighters, bombers themselves will wish to have an escort of fighters, ^{and} will fly in a compact formation to give a good defensive fire in every direction; and to effect surprise by attacking from an unexpected direction.

Aircraft have three methods of damaging ships: sight bombing, dive bombing, and the use of torpedoes. Each one of these has certain special advantages.

The effectiveness of sight bombing will be favored when there is a high ceiling so they can bomb from high altitudes, and also when ships are anchored, or are moving at slow speed, or are unable to maneuver radically.

Dive bombing will be better when there are numerous rather low, broken clouds. Anti-aircraft gunfire from the larger guns is not likely to be very effective if the planes maneuver radically and approach at high altitudes or behind clouds, nor while they are in the dive. Machine gunfire will probably be the best defense against this form of attack. After the dive has been completed, however, all gunfire may be dangerous to dive bombers if the retreat must be made past several lines of ships, as in the case of a large disposition. Maneuvering by ships is rather less effective in the case of dive than sight bombing, and therefore dive bombers should be favored for the attack on fast vessels.

A special form of diving attack has been developed for use against destroyers or other small craft which have little structural strength. Small bombs and .50 caliber machine gun bullets will penetrate light decks or side plating, and will wreck machinery and pipe lines, and cause leaks in the hull. One squadron of very fast, small planes can do considerable damage to a division or squadron of destroyers by making repeated attacks at low altitudes, and yet they are unlikely to suffer serious losses themselves.

Torpedo planes will have their best chances when the ceiling is low, visibility poor, and if their attack can be made during battle in coordination with surface torpedo attack. But this coordination is not easy to attain, because most torpedo planes have a very limited endurance, and it may be that they will not be able to wait until the destroyers are ready. Torpedo planes must have protective smoke to be successful, as they are highly vulnerable to gunfire while approaching close to the surface.

It may be venturesome to attempt to draw too many general conclusions concerning night aircraft attacks on ships, because this field has not been very well explored. But we can say, 1st, that while flares are of little use in general search, once the target has been located they can illuminate ships sufficiently to permit effective bombing; 2d, that low flying planes can locate surface vessels on bright moonlight nights, and can maintain contact with a fair amount of moonlight; and 3rd, that anti-aircraft/gunfire from ships will be ineffective at night unless searchlights are employed.

Aircraft spotting for the gunfire of surface vessels, may be considered as an activity in the nature of attack, while air offensives by fighters against enemy spotters or defensive patrols lie also within the same field.

We now have mentioned all the principal elements that enter into the tactical employment of aircraft.

WEAPONS EMPLOYED BY AIRPLANES AGAINST:

Other airplanes: machine guns.

Military personnel in the open: machine guns and fragmentation bombs.

Military personnel in position or embarked: demolition bombs, gas bombs, gas spray.

Large ships: large demolition bombs and torpedoes.

Destroyers and other small craft: fragmentation bombs and .50 caliber machine guns.

Shore artillery and structures: demolition and incendiary bombs.

Civil Population: intermediate demolition bombs and incendiary bombs.

CLASSIFICATION OF TACTICAL AIRPLANES OF THE NAVY

Fighters, observation planes, scouts, bombers, torpedo planes, patrol planes.

TACTICAL CATEGORIES OF NAVAL AIRPLANES

Observation seaplanes of battleships.

Scouting seaplanes of cruisers.

Carrier airplanes: fighters, scouts, bombers, torpedo planes.

Patrol squadrons of flying boats.

Marine Expeditionary airplanes: fighters, observation planes, bombers.

In war add: Naval District aircraft, and shore-based planes in the Fleet Zone.

TASKS OF NAVAL AIRPLANES.

Information:

Scouting: search, tracking, tactical scouting, observation, reconnaissance.

Transfer of spies.

Destruction of hostile means of information.

Transportation of despatches and persons.

Distribution of propaganda.

Security:

Observation of lines or areas.

Lookout screens (picket lines) to detect approaching vessels & aircraft.

Fleet patrols: mine, outer-antisubmarine, inner-antisubmarine.

Coastal patrols against raiders and mines.

Escorts: defensive fighters over formations of ships or aircraft, bombers over convoys.

Protective smoke screens and clouds.

Attack:

Against aircraft: fighters.

Spotting planes to increase effectiveness of surface gunfire.

Against shore objectives: various conditions require special arrangements; preferable to base aircraft on shore.

Against ships:

Defensive means that reduce effectiveness of attack:
gunfire, structural strength and subdivision,
maneuverability, concealment, submergence, escort
by fighting planes.

Means that increase the effectiveness of air attack:
plane speed and maneuverability, concentration of
many airplanes carrying large bombs, preparatory
strafing, target under fire, broken clouds, bright
sunshine, protective smoke, sometimes low visibil-
ity or darkness.

Sight bombing effective with high ceiling, low speed,
lack of maneuverability of target.

Dive bombing more effective with low, broken clouds,
and when enemy can maneuver radically.

Torpedo attacks better than others with low ceiling and
poor visibility, and in coordination with surface
torpedo attack.

Having these various elements in mind, as well as the special advantages of aircraft with respect to time, space, and mass, and the handicap as regards the vulnerability of aircraft carriers, our problem is to put them together in such a manner as best to meet any particular tactical situation.

We may expect to find in most cases that we haven't as many aircraft as we would like to have, and therefore in allocating tasks to our air force we will be forced to neglect some of these tasks, so as to be able to accomplish those having the greater importance. If we try to do too much we may end by accomplishing

very little. It may seem unnecessary to emphasize so obvious a point, but here at the War College and also in the Fleet we frequently see an operation order which assigns to the Air Force such a multitude of tasks that their Commander, unable to perform all of them, is at a loss to comprehend what effect his Commander-in-Chief really wishes him to produce. Furthermore, during long-continued operations, we should not forget the fatigue factors of pilots and machines, nor the losses of material and morale that are certain to be incurred through crashes and action with the enemy.

Enough has probably been said concerning activities in the fields of information and security. The War Instructions, U.S. Fleet Tactical Orders and Doctrine for Aircraft, and the Aircraft Search Diagrams, among them rather thoroughly cover these fields. But a few additional words concerning attack methods may be in order.

Whenever we have an attack mission to perform, we should, as with other means of action, be sure to employ a concentration of enough airplanes to produce the desired effect. For instance, if we contemplate the reduction of the strength of a battle line, we will surely get better results by concentrating our entire air strength in attacking a few units rather than by attempting to do a small amount of damage to all battleships. On the other hand, if we wish to slow his fleet speed, to "fix" him in position, we should attack as many of his slowest units as will accomplish this result, so that he will then feel too weak to divide his force and push on with the fast vessels. If we believe that we are strong enough in the air to effect a satisfactory reduction of only one element of his fleet, then, so far as possible, we should concentrate our air effort on that one element. Making many small, scattered, uncoordinated efforts against a large number of targets will fritter away our strength without accomplishing much.

We must repeat that, particularly in the case of air operations at sea, "Command of the Air" can practically never be attained through direct action against aircraft in the air, but is only possible through destruction of aircraft bases. From the tactical standpoint, therefore, airplanes have an essentially offensive, rather than a defensive nature. Since the nullification of the enemy air power, while maintaining our own, has a tactical importance out of all proportion to the mere strength of the arm itself, then among the primary tactical objectives of air operations are the early destruction of the aircraft carriers or bases of the adversary, and the continuous preservation of at least some of our own. The accomplishment of these two objectives is worth the expenditure of considerable effort by surface as well as air units.

Because of the ability of airplanes to deliver hard blows against the enemy quickly and often while he is still at a distance, the attacking power of carriers should usually be considered as constituting their chief value. If we have several carriers, certainly some of them will be employed in the forward areas of a deep deployment in order to strike the enemy carriers as soon as possible. But in these areas they are themselves subject to attack, and so may not be available at later stages to shift their attacks to other tactically important units.

There seems to be no one best place to locate our carriers to prevent the enemy from destroying them. If they are with the main body, their early discovery is certain. Nevertheless, at times it may seem best to keep them near the fleet center, with a defense of as many lines of anti-aircraft gunfire around them as possible, supplemented by an outlying air screen and air escort of fighters. At others, it may seem best to operate them at a considerable distance from the main body, in the hope of evading early discovery. We might even hold some of the carriers in reserve in a position well to the rear, and bring them forward only

after we have been able to destroy most of the hostile carriers, or in time to assist in accomplishing some mission which would fail if aircraft were not available.

The ability of aircraft to inflict attrition through repeated attacks will certainly increase the tendency to act during preliminary and final phases of a naval battle between surface forces. In fact, the success or failure of preparatory air operations may be the determining element of a commander's decision as to whether or not to engage. In these operations the principal task may be either to reduce certain specified portions of the enemy strength, or to "fix" him by slowing him down so that we can keep hold of him with our surface vessels; or, on the other hand, to slow him so that we can avoid action altogether. In the phase following battle, aircraft may prove important in preventing the escape of the enemy, or for covering our own retreat. It is in this "fixing" of an enemy that aviation, possibly in combination with submarines or destroyers, may find one of its principal uses. But we should recognize the probability that we may lose most of our carriers before the battle begins, and so plan to use shore-based aircraft, or else to be ready to continue our operations without further air assistance.

Without doubt, the same number of aircraft will produce greater damage, if they can attack while the enemy is being heavily engaged, as then the effectiveness of his anti-aircraft gunfire and maneuverability will be much reduced. We may thus have to decide whether to try for several successive attacks preliminary to the action, which may also reduce our own air strength rapidly, or to make but one or two attacks during the engagement itself, when the effect will be greater than for any similar numbers of preliminary attacks.

Destroyers and submarines, so far as regards their value for attack upon the stronger elements of a fleet, are important largely for inflicting attrition at times other than during a main action.

As a general proposition, to be successful in such enterprises, these vessels must be able to employ stealth and surprise. If they are discovered at a sufficient distance from their objective, an alert commander should be able to evade or to frustrate their attacks. With aircraft at his disposal, he will often be able to detect their approach through his surrounding zone of information, and be able to drive them off by means of a vigorous air or surface offensive. Thus the advent of aviation will tend to reduce the former tactical effectiveness of destroyers and submarines for making surprise attacks. On the other hand, against forces which do not possess aviation, we will find that if the attacking units use aircraft for tracking, their tactical effectiveness will be increased in the same manner as that of other classes of ships.

In attempting finally to evaluate the tactical effects likely to be produced through the use of aviation, it is unnecessary to open the controversial subject as to just how much damage one or two squadrons of airplanes may be able to inflict upon a strong vessel such as a battleship, and what will be their own losses from anti-aircraft fire. Very frankly, no one knows the answer. Our Maneuver Rules give certain figures as to probable percentages of hits, probable average damage made by one bomb, and probable effects of anti-aircraft fire. These rules, though made up after a study of target practice records, really are only a rough average of estimates made by a number of officers. We are not interested in discussing such questions as to whether or not the advent of the airplane will destroy the value of battleships or any other class of naval vessel. We do feel that, as a naval tactical weapon, the airplane is here to stay, that it will modify tactics and thus influence construction. The objective study of its field of action, and an intensive development of its tactics, is therefore desirable as a basis for an early and accurate evaluation of its usefulness.

For the present, therefore, we may confine our evaluation to listing the following special tactical effects likely to be produced by aviation:

1. The enlargement of the area of tactical contact and action.
2. Within the aircraft zone, an important augmentation of the tactical means of information, security, and attack.
3. Through the addition of carrier aviation, the availability of a new weapon effective, to a greater or less degree, in the tactical offensive - against all classes of vessels.
4. A relative reduction in the importance of destroyers and submarines as means for inflicting attrition.
5. The expenditure of considerable strength and effort toward the early destruction of enemy air power, and the continuous protection of our own.
6. An increase in the importance of the preliminary and the final phases of a naval action.
7. A merging, along the coast line, of the spheres of influence of the military and the naval forces.