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The effectiveness of the German and United States submarine campaigns during World War II is compared by analyzing the genesis of each campaign, the commitment to each and the effort to overcome the losses imposed by submarine warfare. This comparison highlights one aspect of the strategic and operational consequences of conflict with an adversary able to build and maintain a superior industrial base in support of the military effort. This analysis places primary focus on German U-boat efforts in the Battle of the Atlantic and the U.S. submarine efforts in the Western Pacific. Ultimately, the overriding factor in the outcomes of both campaigns was the ability of the United States to produce more ships than the Germans could sink, to build more submarines than the Japanese could sink, and to sink

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more Japanese ships than the Japanese could build. As a result, the United States was able to sustain its' total military effort against Germany; Japan was not able to sustain its efforts in the Pacific.

With the present U.S. requirement for trans-oceanic logistics for force projection, the lessons of WWII should remind us not to downplay the threat of adversarial submarines or to continue to lose the ability to muster a credible shipbuilding industry in the event of mobilization.

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NAVAL WAR COLLEGE
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**THE EFFECTS OF THE WORLD WAR II SUBMARINE CAMPAIGNS
OF GERMANY AND THE UNITED STATES-
A COMPARATIVE ANALYSIS**

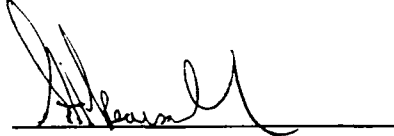
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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Operations.


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With the present U.S. requirement for trans-oceanic logistics for force projection, the lessons of WWII should remind us not to downplay the threat of adversarial submarines or to continue to lose the ability to muster a credible shipbuilding industry in the event of mobilization.

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**THE EFFECTS OF THE WORLD WAR II SUBMARINE CAMPAIGNS
OF GERMANY AND THE UNITED STATES-
A COMPARATIVE ANALYSIS**

CHAPTER I

INTRODUCTION

Before commencing a military operation, War College doctrine advises review of four basic questions. First, what military condition must be produced in the theater of war or operations to achieve the strategic goal; Second, what sequence of actions is most likely to achieve that condition; Third, how should the resources of the force be applied to accomplish that sequence of actions and; finally, what is the likely cost or risk to the joint force in performing that sequence of operations.

Both Germany and Japan needed to ask these questions as they sought to expand their empires through regional conflicts prior to United States' entry into World War II. Both recognized the criticality of sea lines of communications to achieve their strategic goals-- Germany to defeat Britain and Japan to sustain its' own war effort and economy. Both also recognized the risks of provoking the United States into entering the war against them, yet both, when war with the United States did occur, had done little to overcome those risks. Once the United States entered the war, neither Germany of Japan could counter the U.S. industrial might economically or through direct or indirect military efforts. The submarine campaign that the United States carried out in the Pacific against Japan was instrumental in

bringing Japan to defeat. Germany's U-boat campaign in the Atlantic against U.S. and Allied shipping was thwarted. Numerous reasons, including leadership, tactics, and technology have all been cited as causes of respective success and failure. These are all valid. Ultimately, however, both campaigns came down to wars of attrition. When the final counts are analyzed, the U.S. simply built more merchant ships than the German U-boats could sink; U.S. submarines sank more merchant ships than the Japanese could build and built more submarines than the Japanese could sink.

The Second World War, with multiple campaigns and phases, is much too complex to make finite statements on one decisive outcome. Even the U-boat campaign contained other significant chapters, e.g., the Mediterranean, interruption of imports to Russia and North America, etc.--each worthy of research and comment but omitted from this paper. The changing missions of submarines, the development of anti-submarine tactics and implementation of countermeasures and Britain's contribution to the Allied war effort, however significant, are also not addressed in detail. This paper focuses solely on the aspect of attrition and the success or failure in overcoming losses in merchant shipping as a result of submarine warfare in the Atlantic and Pacific theaters of operations.

As the United States becomes increasingly dependent upon sea lines of communication to move military supplies to distant theaters of operations, as additional bases and shipyards are closed and U.S. shipbuilding capacity continues to shrink, the lessons of World War II remain valid for U.S. planners.

CHAPTER II

THE U-BOAT CAMPAIGN

Germany

German U-boats had been the most serious menace to Great Britain in the First World War, posing a constant threat to the Atlantic supply lines of the Allies and, despite advances in anti-submarine tactics and countermeasures, had been a significant factor in the German war effort. Within two months of Germany's declaration of unrestricted submarine warfare in WWI, Admiral Jellicoe, First Sea Lord of the Admiralty, had declared, "they will win unless we stop these losses and stop them soon."¹ Post war technical developments had further increased the submarine threat.

None-the-less, when Hitler invaded Poland in September 1939, Germany was not ready for a major war at sea and no preparations had been made for a prolonged U-boat campaign. In the mid-to-late nineteen thirties, Hitler's war aims had remained on the continent and he steadfastly denied intentions to engage in conflict with England. The German Navy Commander-in-Chief, Admiral Erich Raeder, was guided in his ship construction planning by Hitler's early guidance that "war would not take place with England until at least 1944 or 1945, though trouble with France, Poland, or Russia might be expected sooner."²

Commodore Donitz (to become Flag Officer, Submarines) and his staff had always

known that, in the event of war with Britain, their chief hope of blockading the island nation lay in the U-boats which could sink the ships that were bringing supplies and troops across the Atlantic from the United States. "The U-boat", he reiterated in a memorandum, "will always be the backbone of warfare against England and of political pressure on her."³ Donitz's pleas for a large submarine fleet were ignored in favor of the German Army and the Luftwaffe. German planners held firm in their belief that only large capital ships would penetrate the shipping lanes of the Atlantic. If war did come, Donitz's submarine tactics would be found deficient under war conditions. The submarine was considered to be an outdated and obsolete weapon.⁴ Thus, only 57 German U-boats had been built by 1939 and only 26 of these were suitable for Atlantic operations.⁵

Following Hitler's invasion of Poland and England's entry into the war, the German Naval Staff renewed its' demands for a large U-boat fleet. Following two months of directed restraint*, German U-boats were once again conducting unrestricted submarine warfare on Allied shipping in the war zone and Raeder was arguing: "No threat by other countries, especially the United States, to come into the war--which can certainly be expected the conflict continues for a long time--must lead to a relaxation of economic warfare once it is begun. The more ruthlessly economic is waged, the earlier it will show results and the sooner the war will end."⁶ From the Navy's perspective, the aims and sequence of actions to get there were well understood.

* Hitler firmly believed that war could be avoided with Britain and imposed restraints on his U-boat commanders to avoid additional provocation. Such restraints were often hazardous to U-boat crews and were ultimately lifted.

Donitz gave his minimum requirement for a successful blockade of Great Britain as a total force of 300 U-boats, a number which would enable him to keep at least 90 at sea at all times in the vital area of the North Atlantic.⁷ This was not overwhelming force. It was a realistic appraisal of what would be required to defeat England. In spite of Donitz's projections, there were never more than seven or eight U-boats at sea during the first year of the war. Never-the-less, U-boat successes against Allied shipping mounted throughout 1940. The issue of additional U-boats remained "back burner" while Hitler focused on the invasion of France, then Russia, then England itself. Even as the United States increased support to England and mobilization of its industrial base, Germany remained skeptical that U.S. support would be sufficient to sustain England's war efforts. In September 1940, Raeder issued a report to Hitler stating, "In the present significant events, i.e., agreement between the U.S.A., Great Britain, and Canada, the Naval Staff sees the beginnings of a situation which will necessarily lead to closer co-operation between Britain and the U.S.A. The course of events will be accelerated by the dangerous plight in which Britain finds herself. Britain will probably relinquish her leading position in favor of co-operation with the U.S.A. In the interest of her own position, the United States will hardly support the British motherland with significant amounts of material and personnel"⁸ Increasingly, Germany reacted to anticipated U.S. intentions, not capabilities.

The sequence of events necessary to defeat England remained the same--to isolate the island nation economically--and that required full attention to the U-boat campaign. The drive to bring England to its' knees economically was not seriously started until early 1941 when Hitler's attention shifted to the objective of defeating Britain. He wrote, "Contrary

to all our previous conceptions the strongest blow to the British war economy has been the high figure of losses in merchant ships A further considerable increase can be expected when our U-boat operations are intensified during the course of this year. The object of our future war efforts must be to concentrate every means of waging war by sea and air on enemy supplies"⁹

It was at this time that Hitler began to pay for his earlier mistakes. He had begun the war in Europe expecting no conflict with Great Britain. Even after Britain's entry, Hitler expected that economic and military pressure would force an early settlement. When these plans failed, he did not abandon the aim of an early end to the war, nor did he concentrate on the Battle of the Atlantic, and on U-boat construction in particular. In March 1941, Admiral Raeder stressed, "Shipping is Great Britain's vulnerable spot She will be done for if, over a period of little more than six months, the tonnage sunk approximates to the highest rates of sinking achieved during the [First] World War."¹⁰ Hitler's increased interest in the Battle of the Atlantic was more than canceled out by the decision to divert resources to the invasion of Russia (Operation Barbarossa). This was despite Admiral Raeder's argument that "the greatest task of the hour is the concentration of all our power against Britain All demands not absolutely necessary for the defeat of Britain must be deliberately set aside". Raeder continued, "There are serious doubts as to the advisability of operation Barbarossa before the overthrow of Britain In particular, there is the greatest need to concentrate on the British supply lines What is being done for U-boats and naval air construction is much too little Britain's ability to maintain her supply lines is definitely the decisive factor for the outcome of the war." For this effort, the

Naval Staff is firmly convinced that U-boats, as in the World War, are the decisive weapons."¹¹

The previous lack of emphasis on U-boat construction was resulting in a maximum monthly output of U-boats only half that reached in the [First] World War. For Raeder, U-boat construction was "one of the most urgent demands submitted by the Naval Staff to the Armed Forces and the Government"; if it was not granted, "all hope for the decisive effect of this important weapon against Britain will have to be relinquished."¹² This was a critical time for the German U-boat campaign--possibly the culminating point--although it was not realized at the time. In early 1941, Britain's Prime Minister Churchill and his War Cabinet recognized that the "cumulative effect of the monthly losses was a 'mortal danger' to [Britain's] life-lines. They were losing ships at the rate of over 7 million tons a year, more than three times as fast as the shipyards could build them"¹³ and shipyards were overwhelmed with repairs. As British imports continued to dwindle, Churchill wrote to President Roosevelt, "It is in shipping and in the power to transport across the oceans that in 1941 the crunch of the whole war will be felt."¹⁴

The Germans were close to producing the military condition (economic starvation) to achieve their strategic goal (defeat of England) yet they failed to capitalize". Despite Hitler's stated intent in his Barbarossa directive of December 1940 to keep the pressure on Britain, he did not hesitate to give priority to the Russian campaign and then he insisted in

^{**} Churchill was to write of this period, "Battles might be won or lost, enterprises succeed or miscarry, territories might be gained or quitted, but dominating all our power to carry on the war, or even keep ourselves alive, was our mastery of the ocean routes and the free approach and entry to our ports . . . the only thing that ever really frightened me during the war was the U-boat peril."

the second half of 1941 that U-boats should be transferred from the Atlantic in a effort to save North Africa. In December 1941, thirty U-boats--a half of the number that could then be kept at sea at a time, and a quarter of the total operational force available--were diverted to the Mediterranean in support of the North African campaign. This splitting of forces was undoubtedly an important factor in the relief which Great Britain obtained in the Atlantic in the last three months of 1941. The opportunity for serious, if not decisive, damage to British shipping was lost. U-boats could not be built overnight and the number of U-boats on active patrol was increasing at only a moderate rate. At the same time, anti-submarine tactics and countermeasures were slowly improving. Individually, U-boats at the height of the Battle of the Atlantic in 1942 sank ten times less tonnage than did each of the few available at the outbreak of war, or built in time to operate before the spring of 1941. In the meantime, the United State entered into the war and the full wartime mobilization of the U.S. shipbuilding industry was concentrated on overcoming the U-boat campaign.

The objective of the U-boat command shifted significantly in a defensive direction from the moment the U.S. entered the war. Impressive totals of ships sunk in the first months of 1942 were a result of American unpreparedness, carelessness, and non-adherence to the lessons learned from previous convoy operations. Success of U-boats aside, Germany's initial war aim in the U-boat campaign, to defeat England in war and to force her to ask for terms by cutting off her imports, was being thwarted. By the spring of 1942 Hitler was declaring, "Victory depends on destroying the greatest amount of Allied tonnage possible," but his caveat that "all offensive operations of the enemy can thus be slowed down or even stopped entirely"¹⁵ insinuated instead that defeat might thereby be avoided. By late

spring 1942, convoys from the United States were well escorted while the increasing numbers and range of Allied aircraft was steadily reducing the areas in which they could operate without loss.¹⁶ Hitler's delay in fully utilizing U-boats against Britain had given them, and the U.S., almost two years in which to improve their tactics and countermeasures and mobilize the shipbuilding industry. These gains had kept pace with the increased number of U-boats. The number of U-boats was still not great enough for their work to be decisive and by 1942, Germany began to lose ground in the war of attrition of the U.S. merchant fleet.¹⁷

Merchant Ship Construction vs Losses - United States

The United States merchant fleet was in poor condition in two decades following World War I. Recognizing this, the United States Congress passed the Merchant Marine Act of 1936 establishing a Maritime Commission and programming the construction of new tonnage at the envisaged rate of fifty ships a year for ten years.¹⁸ As the possibility of war in Europe grew, this number appeared inadequate. The original building schedule was doubled in 1939 and doubled yet again, in 1940¹⁹ when the U.S. had begun preparations to build a larger merchant fleet under Lend-Lease. British yards were freed to construct warships; American shipyards began concentrating on the assembly-line construction of merchant vessels which gained the name "liberty ships." In 1939-1940, only 102 sea-going ships were constructed in the U.S..²⁰ At the same time, German U-boats were sending 438 merchant ships to the bottom. As the German U-boat offensive gained momentum and the

rate of sinkings of Allied merchant vessels increased, the Maritime Commission implemented a new schedule accelerating and expanding deliveries so that in June 1941 the total of liberty ships planned for delivery in 1941 was raised from 1 to 19 and the total for 1942 was raised from 234 to 267.²¹ Just before the attack on Pearl Harbor, the Maritime Commission scheduled 5 million deadweight tons for 1942 and 7 million for 1943. These goals assumed that the yards would speed up production from two ships per way a year, as planned for their first year to four ships per way a year. With the declaration of war, the Commission's schedules on January 1, 1942 were up to about 6 million in 1942 and 8 million in 1943.²² This number, while considerably straining the rapidly expanding maritime shipbuilding industry, was still not viewed with dismay by the German Naval Staff. In early 1942, Admiral Raeder calculated that total Allied shipbuilding in 1942 would be 7 million tons and that the U-boats need only sink 600,000 tons a month to keep level. On 14 May, Admiral Donitz concluded his survey with the words: "I do not believe that the race between enemy shipbuilding and U-boat sinkings is in any way hopeless."²³ This did, in fact, become a race and the shipbuilders under the Maritime Commission were tasked to build merchant ships faster than they were being sunk (Table I). Merchant shipping was critical for the United States to project its' will across the Atlantic but in 1941 and 1942 shipping losses exceeded new construction. Germany was still winning the war at sea and succeeding in cutting the Allied lines of supply. In September 42 Hitler reiterated that "the monthly rate of sinkings will continue to be so high that the enemy will not be able to replace his losses by new construction." He though it "impossible that the increase in production in enemy shipyards comes anywhere near what propaganda would have us believe."²⁴ This underestimation of

American shipbuilding capability was a fatal error. In October 1942, the American shipbuilding capacity had expanded more than six percent over the 1937 figure and there

TABLE I

**GAINS BY NEW CONSTRUCTION VS LOSSES
of U.S. Merchant Ships of 1,600 gross tons and over
1939-1945
(thousands of gross tons)**

Year	Losses	New Construction	Net Change
1939 (4 months)	810	101	- 709
1940	4,407	439	- 4,358
1941	4,398	815	- 3,968
1942	8,245	5,339	- 3,583
1943	3,611	12,384	- 2,906
1944	1,422	11,639	+ 8,744
1945 (4 months)	458	3,551	+ 3,093
Total	23,351	34,368	+11,017

Source: Terry Hughes and John Costello, The Battle of the Atlantic (New York: The Dial Press/James Wade, 1977), p. 304.

were more than sixty shipyards producing various types of ships for the maritime commission.²⁵ The building time of Liberty ships delivered in 1941 was about 250 days, but they were the first in the ways; Contracts called for the completion of later ships in 150 days. In January 1942, the shipbuilders were called on to contract for new Liberty ships on the basis of a building time of 105 days. Allowing for 60 days on the ways, 45 days in

outfitting, this would produce six ships per way per year.²⁶ The total construction time from keel laying to delivery for all yards building Liberty ships was 41-42 days in Sept-Dec 1943.²⁷ By the end of 1942, 646 freighters had been completed, 597 of them Liberties and launchings outnumbered sinkings in the Atlantic for the first time since the war began. At the peak of the wartime effort, workers were able to construct one ship in 80 hours and 30 minutes²⁸ and by September 1942, American shipyards reached their promised goal of three ships a day by delivering ninety three ships into service.²⁹ By 1943, 140 Liberty ships were being launched each month.³⁰

A total of 3,148 Liberty hull numbers were allocated between different shipyards, but a total of only 2,710 ships were constructed, the balance of the numbers being either not used or the contracts canceled³¹ as the Germans, unable to keep pace at sea, withdrew to safer waters.

Submarine Construction vs Losses - Germany

Even as the German navy was drawing its plans for eventual war in Europe, the immediate need for submarines was downplayed as war with Great Britain was neither expected nor desired. It was with utmost concern and surprise that Hitler advanced his timetable for war. Plan "Z"--ship construction plans for 1938 to 1948--called for 57 submarines to be under construction at the start of the war with 241 to be built by 1948.³² Thus, U-boat construction was not emphasized at the critical time in which England was most vulnerable and the war of attrition began with only a slight advantage to the Germans.

In the whole of the first year of the War, only 35 Atlantic going U-boats were completed while 28 were lost at sea.³³ It was not until the latter part of 1940 when Hitler agreed that the existing building output of twelve to eighteen U-boats a month was not enough and that he wished "the greatest possible progress in U-boat construction."³⁴ As noted earlier, in spite of Hitler's renewed interest in U-boat construction, an immediate improvement in Germany's U-boat situation was not possible. The neglect of the U-boat construction program in 1940 resulted in shortages of necessary materials in 1941. The submarine program was faced not only with an immediate shortage of materials but a shortage of skilled workers as well. Unlike the United States, which had begun to mobilize its' submarine building industry before the war broke out, the German shipbuilding industry had concentrated on the building of warships. In addition, German submarine designers continued to plan new, improved platforms--all of which delayed production.^{***}

As the war progressed, German U-boat production exceeded sinkings (Appendix I) in spite of increased success with ASW tactics and the loss of German shipbuilding facilities. This is partly explained by the fact that U-boats were forced out into the central Atlantic where surface ASW platforms and anti-submarine aircraft were less prevalent.

Lack of submarines was not a problem for Germany. The problem was that they were not available at the time needed to be decisive. Even more critical to the German U-boat effort in the later years was the shortage of qualified crews which reduced effective operations.

^{***} Throughout the war, the Germans developed and built no less than thirty new submarine designs. In contrast, the United States settled on one design and stayed with that design throughout war construction.

CHAPTER III

PACIFIC SUBMARINE CAMPAIGN

Japan

"No major power in the world was more dependent upon ocean shipping than Japan. Her entire economy in peace, and even more so in war, depended upon shipping to provide the basic materials for industry and to fill out the supply of staples required to feed and clothe her population.¹ In spite of this total dependance on shipping, Japanese naval leaders did not foresee use of submarines against Japan's commerce as a major mission of U.S. submarines.² Thus, Japan approached war footing with the United States with little attention paid to anti-submarine tactics or counter measures. Naval shipbuilding concentrated on large fleet warships necessary to project seapower--not anti-submarine vessels and convoy escorts. The apathy to the submarine threat was expressed in the 1930's by Japanese Foreign Minister Kijuro Shidehara when he declared, "The number of submarines possessed by the United States is of no concern to the Japanese inasmuch as Japan can never be attacked by American submarines."³ Japanese neglect was perhaps reinforced as late as March 1941 in a discussion between the Japanese Foreign Minister and German Foreign Minister Ribbontrop in which the German official repeated that the ". . .U.S. submarines were so bad that Japan need not bother about them at all America could do nothing against Japan."⁴ When the Japanese attacked Pearl Harbor in December 1941, submarines were secondary targets and

were not damaged.

Even more noteworthy than Japan's disregard for U.S. submarine capability was the lack of early emphasis on its' merchant shipping--the arteries of the nation's (and military's) lifeblood. For an island nation dependent on imports of raw materials, and to support a military force in an expanding theater of operations, the Japanese shipping situation was remarkably tight and little was done to ensure that shipping would be adequate for the task.

TABLE II

ANNUAL MERCHANT SHIP CONSTRUCTION
PRE-WAR JAPAN
(Gross Tons)

Year	Cargo Ships	Tankers
1938	294	43
1939	214	56
1940	194	14
1941	156	13

Source: The United States Strategic Bombing Survey, Overall Economic Effects Division, The Effects of Strategic Bombing on Japan's War Economy, (Washington, D.C., U.S. Govt Printing Office: Dec 1946), p. 180.

As shown in Table II, merchant ship construction actually decreased in the four years prior to Japan's attack on Pearl Harbor. Japan expected early success in the South Pacific to provide ample resources to see them through any possible U.S. siege of their defensive perimeter. Critical raw materials such as oil and bauxite would remain available in large quantities from captured territories in Southeast Asia. Although Japanese merchant shipping

was acknowledged to be barely sufficient to sustain import requirements, Japanese planners expected to alleviate this situation with captured merchant vessels and double duty--vessels that carried military materials from Japan to support the war effort could return to Japan with raw materials and cargoes for civilian use.

Fully aware of the history of submarine warfare and its' near strangulation of Britain in World War I--a situation potentially not unlike its' own--and the shortfalls of their own merchant fleet, Japanese leaders none-the-less initiated military conflict with the United States. Firmly believing that U.S. will would not sustain a prolonged battle of attrition, Japanese leaders also acted on what they thought the U.S. would do--not what the U.S. was capable of doing.

Almost immediately after entering war with the U.S., merchant ship losses to submarines demonstrated a flaw in Japan's pre-war preparations and assessments. Despite these losses in the first year of war, Japanese anti-submarine warfare improved very little. Weak and ineffective escort forces left Japanese merchant ships frequently on their own on the high seas, depending only on diverse routing, their own guns, and zigzagging for anti-submarine protection.⁵ Japanese convoys, when utilized, were small, generally about five ships with one or two escorts. In response to increased losses to U.S. submarines, the Japanese Navy became convinced that it was futile to sail important convoys with a single escort. Since few escort vessels were available, it was necessary to increase the size of convoys to as many as fifteen ships with three or more escorts.⁶ This simply led to the introduction of wolfpack techniques by U.S. submariners. Slowness to react to the submarine threat at the outset placed Japan's economy and logistics tail in a downward spiral

from which it did not ever recover.

Merchant Ship Construction vs Losses - Japan

Attrition of the Japanese merchant fleet as a result of U.S. submarine activity probably was not what Admiral Yamamoto had in mind when he stated, "If I am told to fight regardless of the consequences, I shall run wild for the first six months or a year but I have utterly no confidence for the second or third year."⁷ However, the loss of the Japanese merchant fleet was reflective of the accuracy of this statement. At the beginning of the war,

TABLE III
JAPANESE MERCHANT SHIP CONSTRUCTION VS. SINKING
1941-1945
(Thousands of tons)

	Sunk (All Sources)	Sunk (Submarines)	Built
Dec 41 - Oct 42	793	480	212
Nov 42 - Oct 43	1530	1188	609
Nov 43 - Aug 44	2891	2150	1299
Sep 44 - Aug 45	3083	1043	1091
Total	8299	4861	3211

Sources: The United States Strategic Bombing Survey, Transportation Division, The War Against Japanese Transportation, 1941-1945 (Washington, D.C.: U.S. Govt Print. Off., May 1947), p. 47.

The United States Strategic Bombing Survey, Overall Economic Effects Division, The Effects of Strategic Bombing on Japan's War Economy (Washington, D.C.: U.S. Govt Print. Off., Dec 1946), pp. 116-118.

the emphasis of the Japanese shipbuilding industry was on naval construction. Combatant ships had top priority through 1941 and well into 1942. Merchant ship construction was dependent upon the Navy's unused shipyard capacity.⁸ The fleet of ocean-going steel ships had still expanded by this time to some 6 million tons but nearly 4.1 million of these were assigned to the military in separate Army and Navy pools. Only 1.9 million tons were

TABLE IV

**JAPANESE SHIPPING LOSSES VS CONSTRUCTION
(TONS)**

Year	Losses	Construction	% of Losses
1942	952,965	260,059	27
1943	1,803,409	769,085	43
1st Half 1944	1,776,248	877,372	49
3rd Qtr 1944	959,900	393,721	41
4th Qtr 1944	1,098,229	428,110	39
1st Qtr 1945	805,332	380,520	47
2nd Qtr 1945	802,346	122,642	15

Source: The United States Strategic Bombing Survey, Transportation Division, The War Against Japanese Transportation 1941-1945, (Washington, D.C., U.S. Government Printing Office: May 1947), p. 55.

allocated to the civilian shipping pool.⁹

The impact of the U.S. submarine campaign was felt almost immediately with losses

of merchant ships exceeding construction from the outset (Appendix III). This pattern was never to change. Japanese planners had estimated that they would lose 800,000 tons of shipping during the first year of the war. Actual losses from all causes were closer to a million tons. Japanese planners had also estimated that after the first year the situation would be under control and the rate of loss would decrease.¹⁰ This was not the case. The rate of sinkings increased and shipbuilders could not keep up with the losses. Japan began making an all out effort to adjust her replacement effort to match her losses in 1943. However, it was a losing battle. Replacement was less than 45 percent of losses (TABLE IV). By late 1943, the Japanese had nearly a million tons less than the minimum required to run their economy and the Japanese Army began to urge a reduction of the Pacific defense perimeter.¹¹ Facing growing shortages of critical war materials as a result of the U.S. submarine campaign, the War Ministry was faced with trade-offs between ship and aircraft construction requirements. Japan needed to produce four thousand planes a month to check the rising tide of defeat in the air. Her best production record was less than half that. Increased imports of raw material, particularly oil and bauxite, were needed and this required more shipping rather than less. An Imperial Conference agreed to reduce the defensive perimeter, to increase the military's shipping capability to build up its inner defense line and to boost plane production to forty thousand planes per year. The Navy would reduce shipping losses from sinkings and damages to below a million tons a year and it would improve the turn-around period for cargo ships by providing more escorts.¹² None of these agreements were executable nor did they have any impact on Japan's ability to offset shipping losses. Additionally, of all the raw materials necessary to run the Japanese war

machine, oil was the most critical and, alarmed at the severe threat to their oil supply, the Japanese made drastic changes in their shipbuilding program, converting many dry cargo ships to tankers while on the building ways.¹³ Although they were able to construct more tankers than they lost, this gain was at the expense of other shipping.

By 1944, losses by U.S. submarines began to diminish, both as a result of a growing scarcity of targets and by the increased role of U.S. airpower in the western Pacific. Nonetheless, submarines alone sank almost eighty percent of all ships built that year. Ultimately, the Japanese built 1,226 cargo ships, passenger ships and tankers in the period 1941 to 1945. In that same period, losses to sources other than U.S. submarines totaled 1,108-1/2 ships. If Japan had, in fact, been able to minimize the impact of U.S. submarines, construction of merchant ships may have kept up with losses.* However, U.S. submarines alone sank 1,150-1/2 merchantmen--almost a one for one construction to loss ratio. Given other conflicting national priorities (warships, aircraft, etc.) for limited raw materials, Japan was doomed from the moment the U.S. submarine force embarked on unrestricted submarine warfare.

Japanese planners had known that adequate shipping and a short war were necessary conditions to achieve Japan's strategic goals. However, there was no serious commitment to achieve the shipping required to sustain its war effort. This was compounded exponentially when the U.S. became committed to a protracted war of attrition. An aggressive ship construction program was necessary to achieve that condition. Given the

* This is speculative since increased emphasis on construction in 1943 was a result of losses to submarines. Without this impetus, new construction may not have begun until later in the war.

many conflicting requirements and priorities for the Japanese war effort, the allocation of resources to accomplish that sequence of actions was difficult. However, when it was evident that U.S. submarines could disrupt the Japanese economy and war effort, immediate steps should have been taken to improve the survivability of its' merchant fleet--constructing additional escorts and improving ASW tactics and countermeasures. Finally, what was the likely cost or risk? Obviously, the risk of war with the United States had been considered. As noted earlier, Admiral Yamamoto recognized the risks of a war of attrition with the United States. The risk of a war of attrition was eventual annihilation. All of this considered, Japan attacked the United States.

United States

U.S. prewar plans for a war against Japan, including Plan Orange, failed to consider the use of submarines for waging a slow, strangling war of attrition against Japanese merchant shipping. World War I had demonstrated the effectiveness of the submarine for such a purpose but the "uncivilized" use of unrestricted submarine warfare by German U-boats was morally opposed by most Americans and had encouraged U.S. entry into that war. Submarines were to provide a supporting role in fleet operations and were bound to ethical rules and tactics in the conduct of their duties. Within hours of the destruction of a significant part of the Pacific Fleet at Pearl Harbor, the rules were discarded and the fifty-one American submarines in the Pacific submarine force were themselves ordered to commence unrestricted submarine warfare. "Converted by a directive into commerce

raiders. American submarines in the Pacific went to war to sink everything that floated under a Japanese flag."¹⁴

Submarine Construction vs Losses - United States

Fully a year and a half before the Japanese attack on Pearl Harbor, the United States had begun an enormous effort to build boats and train men for the undersea navy. Congress, alarmed by the fall of France in June 1940, voted to add 67 submarines to the six already authorized under its normal naval building program for fiscal 1941. This initial effort served to "prime the pump" of U.S. submarine builders. The U.S. had only three submarine-building yards with only a dozen construction ways among them.¹⁵ Immediately following the Japanese attack on Pearl Harbor, these yards initiated a crash program to add more ways, and the U.S. Navy's Bureau of Ships pressed into service two firms that had never built submarines before.¹⁶

The first of the boats authorized by Congress in 1940 started arriving with their new crews at PH in early 1942. By midyear, the new fleet boats were going into combat at the rate of four a month.¹⁷ Table V shows compares the rate of submarine construction versus the loss of submarines in the Pacific. The significant growth of construction capability was due, in part to assembly-line efficiencies made possible when Navy experts became convinced that the fleet boat had reached a sufficient level of development in 1942 to freeze the design at that point, prohibiting any major alterations. As workers repeatedly built boats to the same plans, they increased their speed throughout the process. "Within three years,

the average man-hours needed to construct a submarine had been reduced from more than two million to less than 650,000.¹⁸ By June 43, Portsmouth Navy Yard was turning out a new submarine every month. USS Cisco was built from keel laying to launch in just 56 days.¹⁹ The submarine program's net construction gains over wartime losses were sufficiently adequate that as early as the middle of 1944, the Bureau of Ships proposed a reduction in the submarine building program. As recalled by Rear Admiral Charles

TABLE V

**SUBMARINE CONSTRUCTION VS LOSSES
1941-1945**

YEAR	BUILT	SUNK	NET GAIN/LOSS
1941 (Dec)	2	1	+1
1942	35	6	+29
1943	66	15	+51
1944	68	19	+49
1945	39	8	+31
TOTAL	210	49	+161

Source: Theodore Roscoe, United States Submarine Operations in World War II (Annapolis: U.S. Naval Institute Press, 1949), pp. 188, 300, 434-435, 496, 498

Lockwood, Commander, Submarine Forces Pacific, "... At first consideration, this seemed a blow but realistic examination of this further indication of the healthy state of our armament production showed we could take a cut without curtailing our ever-increasing

activities. With the submarines then in the Pacific--approximately 140--we had the situation well in hand, and dozens more were so far along in construction that they would have to be completed and sent out to us."²⁰

The fact that U.S. submarines played a decisive role in the Pacific is particularly remarkable in that war planning had not assigned them a key role. The submarine campaign was essentially won in the first year when Japan failed to render a credible response to the threat. This enabled the submarine force to expand, train and improve tactics and weaponry. At the same time, critical war materials were kept from the factories and the military in the field.

CHAPTER IV

CONCLUSION

The Second World War was not precipitated by a single event. By 1939 (Germany) and 1941 (Japan), the possibility for world-wide conflict in which United States would be an adversary certainly existed and was apparent to the leadership and planners of these respective nations. There is sufficient evidence to support that both were aware of the industrial potential of the United States. Yet neither Germany nor Japan fully appreciated the magnitude of the American mobilization capacity nor anticipated its sustained will once provoked. There is ample evidence that German Naval leaders addressed the four operational questions. They were, however, ignored by their command authority. For German planners (in 1939) to expect that Britain would remain out of a European fray that would threaten Britain's national interest was extremely short-sighted. To fail to plan and carry out a dedicated campaign to remove that obstacle was disastrous to the German war effort. To win in Europe, Germany had to defeat Britain. To defeat Britain, Germany had to force Britain to its' knees economically before the United States could mobilize and enter the war in active support to Britain. Once the United States entered the war, Germany needed to do everything in its' power to keep the U.S. war effort from reaching European shores. To do all of this, Germany had to concentrate its' efforts on the U-boat campaign in the Atlantic. Yet the U-boat effort was a case of too little, too late. By failing to mass against England, Germany failed in its' other endeavors.

In the Pacific, Japan's unfathomable neglect of the submarine threat and lack of attention to the merchant fleet on which the nation survived placed them in a no-win situation from the outset. The euphoria of empire building caused them to ignore the four basic questions until it was too late.

Despite downsizing, the United States can still present a significant submarine threat-- yet few potential conflicts involve interdiction of sea lines of communication of our adversaries. On the other hand, the emergence of no-traditional naval powers as submarine threats presents a significant challenge to U.S. planners. The U.S. can ill-afford wholesale losses of its' merchant shipping to submarines and the ability to replace such losses expeditiously is rapidly waning.

APPENDIX I

GERMAN U-BOAT OPERATIONS 1939-1945 Construction vs Losses

Year	Quarter	Commissioned	Sunk
1939	Sept - Dec	2	9
1940	Jan-Mar	4	6
	Apr-Jun	9	8
	Jul-Sept	15	5
	Oct-Dec	26	3
1941	Jan-Mar	31	5
	Apr-Jun	53	7
	Jul-Sept	70	6
	Oct-Dec	70	17
1942	Jan-Mar	49	11
	Apr-Jun	58	10
	Jul-Sept	61	32
	Oct-Dec	70	34
1943	Jan-Mar	70	40
	Apr-Jun	69	73
	Jul-Sept	68	71
	Oct-Dec	83	53
1944	Jan-Mar	62	60
	Apr-Jun	53	68
	Jul-Sept	50	79
	Oct-Dec	67	32
1945	Jan-May	93	153
Totals		1,133	782

Source: Terry Hughes and John Costello, The Battle of the Atlantic, New York, The Dial Press/James Wade: 1977, p. 304.

APPENDIX II

**JAPANESE MERCHANT SHIP CONSTRUCTION
1941-1945**

Year and Month	Cargo, Passenger & Misc.	Tankers	Total
1941/42			
December	3	1	4
January	4	—	4
February	7	—	7
March	8	—	8
April	3	1	4
May	6	—	6
June	6	—	6
July	5	—	5
August	5	2	7
September	8	—	8
October	5	1	6
November	3	—	3
December	10	3	13
Total	73	8	81
1943			
January	5	1	6
February	12	4	16
March	24	4	28
April	8	—	8
May	5	4	9
June	14	3	17
July	12	3	15
August	19	3	22
September	19	8	27
October	23	4	27
November	22	9	31
December	37	11	48
Total	200	54	254

Source: The United States Strategic Bombing Survey, Overall Economic Effects Division, The Effects of Strategic Bombing on Japan's War Economy, (Washington, D.C., U.S. Govt Printing Office: Dec 1946), pp. 180-181.

JAPANESE MERCHANT SHIP CONSTRUCTION
1941-1945
(continued)

Year and Month	Cargo, Passenger & Misc.	Tankers	Total
1944			
January	45	10	55
February	39	14	53
March	67	22	89
April	31	4	35
May	40	23	63
June	38	18	56
July	33	17	50
August	36	18	54
September	44	22	66
October	42	18	60
November	43	21	64
December	41	17	58
Total	499	204	703
1945			
January	33	14	47
February	35	11	46
March	34	3	37
April	14	-	14
May	21	-	21
June	5	-	5
July	13	-	13
August	5	-	5
Total	160	28	188
Grand Total	932	294	1226

Source: The United States Strategic Bombing Survey, Overall Economic Effects Division, The Effects of Strategic Bombing on Japan's War Economy, (Washington, D.C., U.S. Govt Printing Office: Dec 1946), pp. 180-181.

APPENDIX III

**LOSSES OF JAPANESE MERCHANT SHIPPING
1941-1945**

Year and Month	Built	Submarine Sinkings	Total Sinking
1941-42 December	4	6	12
January	4	7	17
February	7	5	9
March	8	7	15
April	4	5	7
May	6	20	22
June	6	6	8
July	5	8	12
August	7	17.5	20
September	8	11	12
October	6	25	32
November	3	8	27
December	13	14	21
Total	81	139.5	
1943 January	6	18	28
February	16	10.5	19
March	28	26	38
April	8	19	27
May	9	29	35
June	17	25	28
July	15	20	25
August	22	19	23
September	27	38	47
October	27	27	38
November	31	44.5	68
December	48	32	61
Total	254	308	

Sources: The United States Strategic Bombing Survey, Transportation Division, The War Against Japanese Transportation 1941-1945, (Washington, D.C., U.S. Government Printing Office: May 1947) p. 47.

The United States Strategic Bombing Survey, Overall Economic Effects Division, The Effects of Strategic Bombing on Japan's War Economy, (Washington, D.C., U.S. Govt Printing Office: Dec 1946), pp. 180-181.

LOSSES OF JAPANESE MERCHANT SHIPPING
1941-1945
(Continued)

Year and Month	Built	Submarine Sinkings	Total Sinking
1944 January	55	50	87
February	53	54	115
March	89	26	61
April	35	23	37
May	63	63.5	69
June	56	48	75
July	50	48	63
August	54	49	65
September	66	47	121
October	60	68.5	134
November	64	53.5	97
December	58	18	45
Total	703	548.5	
1945 January	47	22	125
February	46	15	29
March	37	23.5	73
April	14	18	51
May	21	17	116
June	5	43	108
July	160	12	111
August	0	4	26
Total	330	154.5	

Source: The United States Strategic Bombing Survey, Transportation Division, The War Against Japanese Transportation 1941-1945, (Washington, D.C., U.S. Government Printing Office: May 1947) p. 47.

The United States Strategic Bombing Survey, Overall Economic Effects Division, The Effects of Strategic Bombing on Japan's War Economy, (Washington, D.C., U.S. Govt Printing Office: Dec 1946), pp. 180-181.

APPENDIX IV

JAPANESE MERCHANT SHIP SINKINGS BY ALLIED ACTION
1941-1945
(thousands of tons)

	Subs	Air	Mines
Dec. 41 - Oct 42	480	123	68
Nov. 42 - Oct. 43	1,188	374	41
Nov. 43 - Aug. 44	2,150	846	51
Sept. 44 - Aug. 45	1,043	1,379	353

Source: The United States Strategic Bombing Survey, Transportation Division, The War Against Japanese Transportation 1941-1945, (Washington, D.C., U.S. Government Printing Office: May 1947) p. 47.

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