Amateur's rudimentary WW2 Military Encyclopedia--for some Terms

Alternately, a Dictionary listing of some WW2 terms and a discussion of military air power, may be found at: http://www.ww2guide.com/

((My miniature descriptive **Military Encyclopedia**, below, may be helpful for my article: "*Brief History of the World, and of World War 2—Part III*", (7-31-2005), and for other parts, too. It may have some errors, and readers' comments are invited. It is provided for amateurs, including myself. (Apologies that some war descriptions in it may seem gruesome.) --Carl R. Littmann))

"Index Tab" Procedure: To speed up finding things in my ~27 page alphabetic index---use the 'scroll' tab on your screen and scroll down as follows:
To **C** (as in Conversions or Costs): --------about 1/3th way down.
To **L** (as in Lend-lease or Liberty ship):---a little over 1/2 of the way down.
To **R** (as in Railroading, Rank or Rifle):---2/3rd way down.
To **S** (as in Ships, or beyond S):-------------7/8th way down.

AIRPLANES and Tactics: Many important advances in engine and airplane designs were made between WW1 and WW2. To name a few: Good turbochargers were developed so that piston engines could have the same air pressure which served them at sea level also serving them at high altitudes. Also developed was adjustable propeller pitch, so that airplanes could take off using efficient, high engine speeds and high propeller speeds, adjusted for "fine pitch". And after take-off, cruse efficiently at faster speed, using "course pitch". Better air-cooled "radial" engines were designed to give off their waste heat without the engine running too hot, so they would last longer between extensive "overhauls". I can only wildly guess at the likely varied times between overhauls, say 1000 hours, (but probably many finely built engines went 2000 hours.)

Many battles in WW2 were often severely lost, because various information was not promptly shared, or not acted upon when shared. And many were won because information was promptly shared, important codes broken, and also because some competent spies provided information. Although the subject of air combat tactics is beyond the scope of this article; obviously it is a subtle and complex subject. Avoiding the Sun's glare, and knowing the capabilities, strengths, and weaknesses of the opponents' airplanes, as well as one's own, were very important. Historically, it was very helpful for a pilot to have had even a small taste of air combat, compared to being recently out of fighter-training school and 'green'. Many potential Aces were killed or almost killed during their first too hasty attempt to take off for their mission, or during their first combat encounter. The better squadron leaders would update a "rookie" and give them some extra pre-combat practice before their first missions. (Also see "**F**LYING TIGERS").

Almost all WW2 airplanes were greatly limited by not having jet engines or turboprops--which modern airplanes have. WW2 airplane piston engines were less powerful, and had generally less altitude capability than today. Thus, there were severe limits to the weight of fuel, bombs, and torpedoes that WW2 airplanes could carry; and their ranges and speeds were also limited. Guided missiles were non-existent or extremely limited. Fighter planes did have machine guns and often “cannons”. Those cannons could fire shells of about 1 inch diameter, and the cannon’s shells would explode if they hit enemy airplanes in the air, or hit vehicles, etc., on the ground. During the last few years of WW2; some airplanes also carried *non*-guided “rockets” (i.e., rockets--with their own fuel, oxidizing agents, and explosives) which would explode when they hit enemy bombers or ground targets.

A typical large (4-engine) bomber might carry a load that consisted of ~2/3 fuel, ~1/3 bombs, and 8-10 crew with special suits, oxygen equipment, and some supplies. And that entire load would have to be limited in weight, and would be significantly less than the weight of the airplane when empty. When rather fully loaded with fuel and weapons; such heavy bomber might cruise along at ~200 mph; and would be typically limited to a ~2000 mile range (distance traveled) and ~10 hours maximum flying time. Each of its four ~1500 hp engines might burn ~50 gallons of gasoline per hour, and the airplane carried about 2100 gallons of gasoline. ((A typical single-engine torpedo plane or dive-bombing plane might be limited to ~ 1000 miles; and most escorting fighter planes (in the early war years and if provided) were limited to much less than 1000 miles. WW2 two-engine bombers seem to me not well suited for much, but had some successful specialized usage. The astute British soon switched their priorities away from their (two-engine) “Manchester” bomber, and wisely placed their priorities on their good, versatile, four-engine “Lancaster”, instead.))

Near the last two years of the war; the fighter and bomber paradigm began to change some. Special releasable fuel tanks were provided on “Mustangs” and some other fighter planes for longer escort service. (A releasable, disposable, fuel tank is visually distinguishable from a bomb by its lack of tail fins.) A special long-range bomber (the famous B29) was developed which (like some fighters) stretched piston engine design and usage to its near limit. The very large B-29 bomber had a range of ~4000 miles, and could carry a combined fuel and bomb load that was approximately equal the B-29’s empty weight. Bomber weight limitations were still quite severe; so that on some special missions--even a defensive gun turret might be deleted (saving a ~600 pound weight) to make possible a little more fuel or bomb load.

Some high-horsepower piston aircraft engines had to use a 4-blade propeller instead of a 3-blade to more efficiently deliver their horsepower. In the case of the “Corsair’s” initial design; it landing gear did not raise the plane high enough to prevent the long propeller from scraping the ground; so that was corrected by giving the wing region a downward slant near the landing gear to increase the propeller “standoff”. (I.e., even though that looked silly.) And the B29 was carefully designed so that no propeller region exceeded the velocity of sound, while rotating with great power and speed.

America’s pre-WW2 concentration on bombers, and other problems, resulted in the U.S. not having a “fighter” that competed very well against the Japanese “Zero”, until about a year or longer into the war. And the U.S. did not have a fighter that competed very well against the very fine German ME109 and extra fine FW190 until nearly 2 years into the war. By that time the British had finally helped the U.S. develop the "*Merlin-engine* powered Mustang". Shortly, thereafter, the British also showed us how to overcome some of the Corsair's imperfections.

Optional: Even the large, fully loaded, B-29 of WW2 weighed somewhat less than *half the weight* of a very large, fully loaded, commercial aircraft today (2004). For example; each of the "767's" that hit the Trade Towers 9-11-2001 had somewhat over twice the mass of a loaded B29, in WW2; and somewhat over four times their fuel capacity. Yet, even those very large modern jets had only ~ half the mass of so-called "Jumbo" jets, which, of course, existed before the "Towers" were begun. (And I leave that subject, now--also because nothing I have read about it makes any rational sense to me, anyway!)

The point to all the above is just that modern super-powerful jet engines make it possible to fly far greater distances and at far faster speeds—than WW2 airplanes ever did, and that must be remembered to understand WW2 strategies and limitations. Although new developments occurred, near-end of WW2, such as the "V2" rocket and the ME262 jet fighter, (and gave us a little glimpse into the future); they did not come in time or were not used smartly to play a decisive role in WW2.

Cruisers and Battleships also carried "Seaplanes", which they could launch to carry out "reconnaissance" far beyond the horizon. These planes could help report the locations of enemy ships, even if the enemy put up a "smoke screen" to hide their ships from the attackers, or even if there were other visual problems.

Even before WW2; the U.S. had several giant "Seaplanes", which could luxuriously transport travelers while they slept in beds, dined, played cards, etc. Some were called "Pacific Clippers". These could go ~4200 miles nonstop. It is likely that Japan greatly feared the possibility that these could easily be converted to bombers (although "slow" ones) which could still humiliate them early in the war. It is possible that the Japanese over-reactions to that fear--helped lead to their defeat. Thus, we may have defeated Japan, in part, by a "weapon" which we never discovered that we had, and never used!

ARMOR:

The old Confederate iron-clad ship, "Virginia", had two layers of iron plating for armor, each layer 2-inches thick, for a total of 4-inches. And that was backed by one or two foot thick timber on the ship's inside. One layer of iron was laid horizontally and the other vertically; and thus the result was laminar, in a sense. It was sloped like a roof from the water to the top of the ship. Those concepts (i.e., different laminar layered armor, and sloped to partly deflect an enemy's hit)--seem to me remarkably advanced, and were sometimes used, in a sense, in WW2. The fronts of WW2 Tanks were made sloped; and the medium-sized tanks had about 3-inch steel thickness used in their crucial areas.

The under-water sides of more modern WW2 Battleships had 3 steel layers spaced apart from one another. The first (thin) layer was to explode the enemy torpedo at some distance from the other layers; and was called a bubble, budge, or blister. The second layer was very thick, to hopefully prevent the explosion from puncturing all the way through it; and a third (last) thinner layer was to catch "splinters" flying off the back surface of that second layer. (Even that somewhat failed against the best torpedos.)

Decks of some battleships were ~6 inch thick steel to give them some protection against a 1000 pound armor piercing bomb dropped from ~16,000 feet or less. And some had ~13 inch thick (or more) steel sides to give them some protection against a 14 inch diameter armor piercing shell, if not fired from too close of range. Obviously, the subject of armor involves a lot of thought, subtlety, planning, and scientific testing. (Some WW2 U.S. tank men, put sandbags on the fronts of their somewhat inadequately armored tanks to dissipate some of an enemy shell's energy before the tank armor was contacted.)

Older WW2 battleships had an extra "bubble-like" layer added to them, somewhat before WW2, in the below-water regions. Concrete, or even water, was used as a cushion between steel layers. (But I have read that 10 inches of strong steel will contain an explosion at least as effectively as 120 inches of reinforced concrete.) Some poorly designed old WW2 battleships sometimes purposely flooded the empty spaces between the armor layers and the ship's "bubbled" side, to cause the ship to tilt to their flooded side somewhat, to give the main guns a greater firing angle, and a longer range.

The armor on the front of a gun turret of a WW2 battleship is about 18 inches thick, since that section becomes very exposed to the enemy during sea battles. The turret is a crucial part for the battleship's operation. Since there is ammunition and sailors in the turret and immediately below it; that area must be greatly protected. (The main innovation of the Civil War's Monitor was its "rotating gun turret". The Monitor's turret armor consisted of ~8 to 11 inches total thickness of layered iron sheeting. It was significantly dented in a number of battles, but not pierced.)

Aircraft carriers relied upon many isolated large compartments, instead of thick armor, to hopefully protect them against total destruction, if hit by only one or a few torpedoes. Their "thin" armor allowed them to be light and 'sail' faster. The carrier's fast speed was helpful for launching planes, and allowed the aircraft carrier to be fast enough to sometimes dodge bombs and torpedoes. Thus, it was accepted that an explosion would cause flooding of some compartments of a large carrier, but hopefully not too many. The U.S. had to build aircraft carriers so fast during WW2 that many small U.S. "escort" carriers were powered by triple expansion reciprocating steam engines and had their decks made of wood—no joke; that's what I've read. And that wood made them more vulnerable to Japanese bombs and kamikazes than the British carriers. However, it seems to me that all Countries' battleships and other large ships were at least somewhat vulnerable to bombs in WW2, historically. Some WW2 Battleships had a layer of wood covering their steel decks, but that was for the benefit of the sailors' footing.

The U.S. generally chose to design more armor protection in its fighter planes, near its pilots, compared to most other countries' designs. But that added weight, resulted in slightly less maneuverability and climbing rate. Incidentally, the troops' steel helmets and airmen's flak jackets were helpful against shrapnel and flak; but, of course, were not expected to stop a direct, short-range bullet hit.

ARTILLERY: (Also see headings: **R**OCKETS and **A**IRPLANES)

During early U.S. wars (and often during the Civil War); cannons fired iron cannon balls which, by their inertia, severed or fractured tree trunks, ship's sides, fort walls, and other structures. If, for example, a cannon with ~5 inch "diameter bore" fired a ~5 inch diameter solid iron ball, that ball would weigh about 18 pounds; so that the cannon was known as an "18-pounder". Actually, the cannon, itself, (which fired such "18-pounder" ball) generally weighed about 2 tons, due to the thickness of cannon barrel's wall, that was required. That great thickness was about as thick as the cannon ball's diameter, itself, near the back of the cannon. There a gunpowder explosion was detonated, to propel the cannon ball. The thickness could taper off some, near the open end of the cannon. Such great thickness was needed to confine the explosion of the gunpowder and the resulting expanding hot gases. That caused the very high pressures which would expel the cannon ball from the gun's open end, at a very high velocity, toward the enemy.

That speed, for such "18 pounder" ball, in those days, was a little less than the speed of sound. (The cannon's very thick barrel wall, which I refer to, is the distance from the cannon's inside 'bore' diameter and its outside diameter.) The weight of the propelling gunpowder, used in such old cannons, was typically about one-tenth to one-third of the weight of the ball propelled. (I've read various figures on that, and it probably depended on a lot of things.) A bag of gunpowder was rammed down the far (open) end of the barrel and then cannon ball pushed down against that. Then, through a "touch hole" at the cannon's near end (fat end) top surface, the bag was broken, and a little fine powder inserted through the "touch hole", and then ignited. Incidentally, despite a big gun's huge mass, compared to the small ball or shell fired; the gun has a significant recoil speed and energy; and thus people should not be standing where they will be hit by that gun's recoil. (Optional: The "momentum" of the gun's recoil is about equal to the forward "momentum" of the projectile fired. But the speed and "energy" of the massive gun's recoil is much less than the ball's. However, not trivial! Math and details skipped here.)

Not surprisingly, the penetrating capabilities of a shell and its destructive potential--increases with the speed of the shell. And lengthening the gun's barrel results in more time for a given explosive propellant to transfer more energy to the shell, and thus greater shell velocity. So in many cases, the effectiveness of a WW2 gun was increased by increasing the barrel's length, i.e., without increasing the shell's diameter, nor its weight, nor the gun's diameter. (A gun crew, manning a naval Civil War gun, might be ~ 6 men.) A gun crew, manning a WW2 modest-size anti-aircraft gun, might be ~ 8 men. A decent sized anti-aircraft gun in WW2 could fire shells with an adjustable timed fuse, set to explode at the distance near where a hostile airplane was flying. That distance had to be “ranged” rather accurately; and an anti-aircraft crew was specially trained for its work. The most useful anti-aircraft guns were versatile, and could be adjusted to fire horizontally at hostile infantry and tanks, also. And the guns that Germany used for that were probably the most effective, (especially those with about 3-in bore). Many people consider Germany’s anti-aircraft guns to be the most effective of those used in the war.

Compared to Civil War cannons, the WW1 and WW2 shells were propelled out of their guns much faster: (at 2 to 3 times the speed of sound). At such high speeds, *prolonged* air resistance would greatly decrease the destructive and penetrating capability of a shell of “*modest-mass*” or less. Another words, even though one shell from such gun might have a range of many miles, it might not be able to totally destroy a well-armored tank at that great range. Yet, that same shell might likely totally destroy that tank at a half mile range or less.

Most large bombs or shells that exploded on impact cause a great momentary “*pressure*”; for example, between the deck surface of an enemy ship and the surrounding *air*. That would generally cause damage, indeed; but less than, say, an underwater exploding torpedo or shell, where the “pressure” is created between the side of the ship and the dense, nearly incompressible *water*. And similarly, with regard to an underwater explosion between the underwater portion of a Dam and adjacent water—very damaging! Where as bombs were not very effective on a thick, high dam, if they exploded above the water.

(As mentioned, WW1 & WW2 bullets and shells traveled several times faster than sound. That made post-WW2 airplane and rocket designers confidant that man could also fly faster than sound!)

By WW2, large shells and airplane bombs had already been developed for “specialized” uses. For the destruction of enemy ships, commanders preferred to load naval guns and airplanes with “armor piercing” shells and bombs, if time allowed; although less-specialized shells and bombs could also do much damage and often penetrate. For use against ground troop or burnable structures and cities; “napalm” bombs, or the like, were technically “improved” during WW1, using ultra-hot, sticky, long-burning materials, with a jelly-like consistency.

The old term “cannon”; generally designates a cannon with a smooth bore. Thus the cannon ball it fires will not have significantly spin. But by the time of the U.S. Civil War, many guns were being made of the “rifled” type, which meant that the bore was “grooved” spirally, so that the gun’s projectile would leave the gun “spinning”. It would thus spin in route to the enemy. This would give the projectile more stability, like a gyro; so that it would not wander far away from its expected path. I believe that, generally, the gun’s length and “grooving” is such as to give the projectile one full rotation before it leaves the end of the gun. The practice seems to have, thus, arisen of describing a big gun’s length in terms of the number “shell diameters” required to equal that length. That is generally also the length necessary to give its fired projectile its one full turn. Thus, if a battleship has a gun with a 16-inch ‘bore’ diameter; and is 800-inches long, the gun is said “of 16 inch Calibr**e** and to be “50 Calibre**s**” long!” I.e., that is: a 16 inch calibr**e** times 50 Calibre**s** = 800 inches long. (That is about 67 feet.)

So the term “Calibr**e**” should be used (and is usually used) to describe the diameter of the gun ‘bore’ or diameter of the shell or bullet fired, regardless of the gun barrel length. Still there might sometimes be confusion, and if someone tells you that a ship has a “50 Calibre” gun; you might make sure he is referring just to the gun barrel’s ‘bore diameter’ instead of the gun’s length? And if he is referring to the bore diameter only; does he mean in millimeters or inches or what units? (If a *big* gun is said to be “*50 calibre**s***”, that generally means that the projectile receives *one full spin* (or rotation) after going forward *50 times the width of the gun’s “bore diameter”*. For a big naval WW2 gun, that would mean that if it fired a 16-inch diameter shell—the gun barrel would typically be about 67 feet long, and not much longer, to achieve that one full projectile spin—I believe.)

Although I have used the “slang”, 16 inch “bore” diameter, to describe a big 16 calibr**e** WW2 naval gun, I don’t mean that any iron was actually machine bored at 16 inch diameters to make it. Instead, thick-walled cylinders, hollowed out to **greater** that 16 inches diameter had replaceable “liners” fitted into them, reducing the inside diameter to about 16 inches. These would be replaced with new liners every 300 shots, or so, so that tolerances and accuracy in hitting targets was maintained. (The firing of long range, heavy shells, required many powder bags, often amounting to ~ 600 pounds of total propellant per firing. Naturally, the resulting great wear necessitated periodic liner replacement, in those days, without the great lubricants and tricks now available.)

Even in earlier times, many American “rebels” were using “muskets” with grooved bores (i.e., rifled ‘muskets’) even during their Revolutionary War. Even the “ball” they shot out, in those old days, came out spinning; and that helped its successful and consistent trajectory—according a “PBS” TV program.

The longest range of big Civil War cannons was about 3 miles. The longest range of very big WW2 guns was a little over 20 miles. Almost all rifles and guns in the Civil War had to be awkwardly loaded from the far end of the barrel (i.e., “barrel-loaded). Sometimes that is termed “muzzle loaded”. Of course, guns in WW1 & 2 were loaded from the near end, close to the person firing it, (i.e., breech-loaded or loaded inside the gun turret or the like). In a ship, the large shells, to be fired, were raised from a storage area, down inside the ship, directly upward into the gun turret. If a threatening fire broke out near that storage area, the crew was supposed to “flood” that area with water to help prevent an explosion, and to get out soon, if possible. During battle, different sections of a ship were isolated from one other by closed bulkhead doors, to prevent water leaking from one damaged area into an adjacent area, and flooding it too. And, sometimes not everyone could get out of such isolated areas if the ship began to sink.

“Light” anti-aircraft guns were generally more powerful than army machine guns and army “automatic” guns. Light anti-aircraft gun, of even only ~1.5 inch bore, fired shells that could explode on contact with, or just after breaking into, an enemy aircraft. And such anti-aircraft guns could also fire tracers, and shells with other options.

By the time of the Civil War; very large "guns" had been developed; and some had 13-inch diameter bores for firing ~200 pound cannon balls or heavier. Some ~ 200 pound balls contained about 20 pound of gunpowder so that such ball would explode on impact against the enemy position. Heavy guns began to be described generally by their bore diameters; not by the weight of what they fired--which might vary, depending on the specialize type of projectile chosen to be fired. That seems very logical!

Optional: But it seems unfortunate (in a sense) that the confusing practice arose and continues--of designating even a modern gun by the typical weight of the projectile which it fires--even though no longer an iron ball! Thus, a ~3 inch "bore diameter" tank gun apparently continues to be called an "17 pounder" because the heavy *cylindrical* shell it fired, indeed, weighs ~17 pounds. But an old Civil War gun, which fired a ~ 17 or 18 pound *spherical* iron ball, would have had about a 5 inches "bore diameter", not 3 inches. Thus, I think the glib term "17 pounder" is totally insufficient to describe which gun is being referred too: i.e., a ~5 inch diameter gun of 1850's vintage, or a 3-inch diameter gun of the 1950's vintage? Thus, I prefer a term like "3 inch" or "5 inch" gun, which is more specific!   I.e., Does a 16-inch old battleship gun suddenly shrink to become a "1,900 pounder" instead of "2700 pounder" if they decide to fire a lighter, longer range shell, instead of an armor piercing style? Of course not! ((And, unfortunately; military reference books and magazines are littered with various seemingly inconsistent or confusing terms and practices—in my opinion.))

BLIMPS, Balloons, and Dirigables: Benjamin Franklin witnessed the first manned hot-air balloon lift in Paris about 1783, and urged his countrymen to consider its military potential. Later, hydrogen balloons were used by the North and hot-air balloons by the South, in the U.S. civil war, for observation and spying. In WW2, "blimps" were used for locating enemy submarines (if on or near the surface). And balloons, with cables hanging from them to the ground, were used to "clip" low flying enemy airplanes. An especially "clever" high-altitude, unmanned balloon was designed by the Japanese to drift from Japan to the U.S. and to automatically drop little "fire bombs" and start forest fires in the N.E. (But the forests proved too damp and the season and hit-locations "non-ideal".)

CAMOUFLAGE: That is the art of making something important hard to see by using colors, patterns, or the like, so that it visually blends into the background. I once heard that the simple expediency of painting WW2 ships so that they were rather camouflaged—resulted in cutting WW2 shipping losses by about 33% or better. And that technique was often also be used on soldiers, their clothes, and their equipment. (Of course, natural camouflage existed in the "animal" kingdom millions of years before human military use. Similarly, with the concept of animal "herds" before the "Naval Convoy" system. And it is interesting that about every fancy "animal" defense and offensive "trait" was eventually, in effect, copied by humans. ((I.e. the swordfish, octopus dye or smoke screen, skunk (i.e., gas), spider web (barbed wire and traps that prey fall into), porcupines throwing their quilts, etc., etc.))

__**C**ARBINE__**—**see “__**R**__IFLES”

__**CIVIL AIR PATROL**__: Quite a few Americans knew how to fly their “private”, small airplanes before WW2. But because of age and/or other miscellaneous reasons, most of these civilian pilots would not have made good candidates to train as fighter pilots. With the sinking of American merchant ships by German submarines reaching drastic proportions; many of these private pilots organized into a volunteer group to try to help.

They helpfully became “spotters”; to locate German submarines, and to locate and direct rescue of any torpedoed U.S. ships and their sailors. Often the Civil Patrol’s airplanes would be seen through the periscope of an underwater enemy U-boat, which would not surface, until the airplane went away. Sometimes these airplanes would begin to swoop down toward a surfaced U-boat, forcing the scared boat to submerge immediately. Although it was rare that such little airplanes could carry such explosive as to sink the U-boat or get quick help to its location to sink it; German U-boats could not be sure of that. So the menace to the U-boats by these Civil Air Patrol planes played a major role in Germany’s decision to withdraw most of its U-boat from near U.S. shores; and try to find “happier hunting grounds” further away. And that helped the Allied cause “some”, when even a little was very helpful.

__**CONVERSION**__ __of various units making comparison__**:** (The below are approximations)

….__Areas__: 1 Acre = 43,560 square feet; A square-shape lot ~206 ft. by ~206 ft.=1 Acre

….__Lengths__: 1 meter = 3**.**28 feet; 1000 meters = 3280 feet; 1 mile = 5280 feet;
25**.**4 mm (millimeter) = 1**.**00 inch (useful for gun bore conversions)
(A 75mm or a 76 mm gun has approximately a 3 inch “bore” diameter.)

Optional: Regarding depths of oceans and rivers: 1 league = 3 miles; 1 fathom = 6 ft.; and a river measuring-stick depth “call” of “Mark *__Twain__*” is *__2 fathoms__* or *12 ft*. deep.

….__Power__: 1 horsepower = 550 foot pounds per sec. = ~0**.**75 kilowatts = ~35**.**5 Btu/hr.; 1 joule/sec. = 1 watt; 1000 watts = 1 kilowatt; Also see heading: “….”__**W**__ork”.

….__Speeds__: 1mph = ~ ~1**.**5 ft./sec.; 1 mile per min. = 60 mph = 88 ft./sec.;
l**.**00 knots (k) = ~1**.**15 miles per hour (mph);
The speed of Sound at sea level is ~1085 ft/sec. or ~ 740 mph. or a mile in ~4 seconds.

The speed of Light is ~186,000 miles per second. The escape speed (neglecting friction, of a rocket or a theoretical bullet fired vertically, i.e., never to return to earth) is 7**.**0 miles per second. But to just circle the earth slightly above our atmosphere; about 2/3 of that velocity will suffice, i.e., ~26,000 feet/sec. (In WW2, some shells were fired at ~3,000 ft/sec., but the weight of firing powder itself was about 1/3 the weight of that shell fired.)

….Weights and Volumes: 16 ounces = 1 pound; 2000 pounds = 1 ton (U.S.);
1 "U.S. regular liq. barrel" = 31**.**5 "U.S. reg. liq. gallons"
1 U.S. gallon of water weighs ~ 8**.**35 pounds, (a little less than 10 lbs).
1 cu.ft. of water weighs ~ 62**.**6 pounds
1 "Brit. Imperial gallon = ~1**.**2 "U.S. liq. gallon";
Oil is about 9/10th the weight of Water.
1 "Oil barrel" = 42 "Oil gallons" (no misprint, probably pioneered by British);
1cu.ft. = ~7**.**5 "U.S. gallons" = ~60 "U.S. pints" = ~30 "U.S. quarts" = 28 liters;
thus 2 pints = 1 quarts; 4 quart = 1 gallon; (roughly 1 "U.S. quart" = ~1 liter)
1 bushel = ~1**.**25 cu.ft.; A 1 kilogram mass weighs ~2**.**2 pound on the earth.

….Work (i.e., Energy) 1 calorie = 4**.**18 joules; 1 foot pound = 1**.**36 joules;
….for the subject of "power", see heading "….**P**ower", above.

Water pressure increases at the rate of ~ 0**.**43 lb per sq.in., for each foot below water. Atmospheric pressure is ~ 14**.**7 pounds/sq.in.; and decreases with altitude; but we don't feel that unless we suddenly are raised or lowered in altitude, or the like.

High-density weights fall at an increasing rate of 32 ft. per sec. for each passing second. That is, when dropped from a super-high building (if a weight has high density and we can neglect the air resistance); then, in 10 seconds, will reach a speed of 320 ft. per sec.(i.e., ~ 214 mph); and will have fallen ~1600 feet downward in that 10 sec. time.

The propelling capability of early German *Jet* planes and the like was expressed in amount of "*Thrust*", (thus in units of "force"), for example "4000 Pounds of Thrust". But the propelling capability of conventional Allied ***piston engine*** fighters was expressed in "**Horse*power***", (in other words, units of "power"), for example "3000 Horsepower". A very rough rule to compare subsonic jet thrust and piston airplane horsepower is:

(English "**Horsepower** equivalent") = ~ **0.75** times ("Thrust") expressed in lbs of force.

For example, a subsonic Jet with 4000 Pounds of Thrust capability might behave somewhat like an airplane piston engine with power of *3000 Horsepower* capability. The above rule has very limited usage, partly because it violates something called "dimensional analyses". And a piston engine's "horsepower" capability is much more impaired at high speeds and high altitudes--than a jet engine's "thrust" performance.

With the advent of turbine engines, the power delivered began being expressed in "shaft horsepower" (shp); but we disregard that distinction here.

For "Currency Conversions" somewhat before WW2, scroll down to "**MONEY**" below.

COSTS--<u>of mostly WW2 Military related Equipment, Vehicles, Ships, Airplanes etc</u>.**:**

What follows is just an estimate (~); or a likely poor estimate (~~); or rough guess (~~~). One problem is that I don't know the U.S.'s official costs, even though they are probably on record, somewhere. Another problem is that even when a war-directing bureaucracy puts down figures, they may not be as meaningful as they think. I partly agree with the economists, Bastiat and Hayek, that only in a rather <u>free</u> economy <u>can one know</u> rather accurately the "<u>true costs</u>" of labor and goods. Otherwise, a System can fool itself. ((<u>Suppose</u>, for example; that the U.S. made a decision--that since our 13,000 soldiers in the Philippines were only paid a few bucks each per day (i.e., only worth ~$4000 each for an estimated <u>4-year long war</u>)—that we may as well let the Japanese capture them, and not attempt a rescue. We see, obviously, that superficial judgments based upon the "economics" of conscription, may be catastrophically <u>wrong</u>!! (That is because a "draft", even by a "well-meaning" society, still constitutes "<u>un</u>free", artificially maintained wage).)) But, if judgments are made with circumspection and with the above in mind; then cost statistics may be helpful in determining wise war priorities.

Remember, around the year 1939, silver prices were only ~ $0.50/ounce; and gold ~ $35/ounce; and especially keep that in mind when attempting any modern relative comparisons. So here are some of my ~ 1939 year estimates:

…Airplane—good quality, small "fighter" ~$50,000
…Airplane—2 eng. PBY seaplane, or DC3~$110,000 (a tad more for 2 engine bomber)
…Airplane—4 engine heavy bomber ~~$330,000
…Airplane <u>Engine</u> (~1000 Horsepower) ~$25,000 (i.e., the Engine, only)
…Aluminum ~$l.60 per pound

…Coal (from cheap labor and worked horribly) ~$2.00 per ton
(or about $<u>0.01 per 10 lb</u>. weight; incidentally, a gallon of water weighs 8.3 lb.; and oil is a little lighter than water, i.e., ~0.90 times water's specific gravity) See "…<u>O</u>il" below. (Price varied depending on bulk, location, and even strong-arm political tactics.)

…Copper $0.10 per pound (~2/3 cents/<u>oz</u>.)
(Even though the amount of copper in a melted-down penny, was far below the purchasing power of the intact penny; still the U.S. Treasury <u>switched to zinc plated steel pennies in 1943</u>. Any copper thus saved was deemed helpful, since the Allies military situation was still extremely pressing. A typical U.S. penny weighs about one tenth ounce.)

…Food; grocery store (retail sticker) prices:
…………………………..…Apples: ~~~$0.38 per 5lb. bag (~2 apples/lb.?)
…………………………..….Cocoa: ~~~$0.20 per 3lb. of it
……………………...………..Eggs: ~~~$0.22 per dozen (some sites say $0.39)
………………………...Grapefruits: ~~$0.25 per pack of 5 grapefruits
……………………………Oatmeal: ~~~$0.25 per 5lb. of it
…………………..……………Pork: ~$0.35 per 1lb.

……………………..…………Rice: ~$0.07 per 1lb. of it
……………………….…Salmon: ~~$0.20 per ~14 oz. can
…………………… "Peanut butter": ~~~$0.25 per 24 oz. Jar
…………"Wheaties" (cereal flakes): ~~~$0.11 per ~ 1lb. package

See separate heading: "…Wheat", below; for discussion of wheat, meats, and miscellany. Over all, I get the impression (from many important consumer items and the income of average semi-skilled workers) —that we are somewhat better off today (mid 2004), but not much). The entire "cost" subject is very complicated, and depends on many things, such as retail location and bulk buying. Also, in many regions of the country, products like "lumber" has *no* value during some of the worst "Depression" years.

…Gold: ~~~$35/ounce
…Guns (also see …**R**ifles, for small arms)
…Guns….Anti-aircraft type, ~3inch bore ~~$25,000
………….large howitzer, ~3.9inch bore ~~$28,000
…………"bofors" artillery ~1.5inch bore ~~$4,300 (defense against very light tanks)
(I think that ~~$4,300 cost also applied to a single barrel anti-aircraft "bofors", based on labor estimates I have read—at least until production short cuts were found. Although the U.S. had many "light" anti-aircraft guns at the beginning of WW2; their quality and performance was horrible, and within a year or so, most were replaced.)

…Hog (young sow, likely 300-400lb weight) ~~$20 per hog ("wholesale")

…Jeep—(small 4-wheel drive, tough vehicle)~~$750 (jeep weighed ~ 2400 lb.)

…Labor—modern factory, semi-skilled work ~$8 per 8-hour day. (~$2000/year)
...(Labor-to make a 15 th Century Knight's Armor ~1 full year of skilled medieval labor)

…Labor—Army low-ranked "Private" ~$2 per day (I consider skilled labor)
May have been paid more under combat condition—I'm unsure. Also, received "benefits" if injured or killed, if on "winning" side. Incidentally, the official "Minimum Wage" in 1938 was $0.25/hour and in 1940 was $0.30 per hour, but there were large numbers of jobs, as usual, for which these minimums did not apply.

…Liberty Ship –7000 ton cargo ship ~$1,600,000 (fast welded and mass produced)

…Locomotive—big 160 ton, 275psi steam ~$50,000 (a tender included in cost)
…Locomotive—1000HP Diesel, then large ~$85,000
Well over 90% of the locomotives in the U.S. during WW2 were steam locomotives. Almost all steam locomotives were coal-powered; and all Diesels were oil-powered. U.S. diesel locomotive production was halted during the WW2; because of the military's own growing need for diesel-powered ships, tanks, etc., and the increased oil that that required. Gasoline was rationed. Also, the enemy was capturing many oil producing areas and threatening others. (Readers are reminded that big steam locomotives were about 4 times more powerful than big diesel locomotives, in those days. But Diesels

would gradually replace them after WW2, anyway. (See "**R**ailroading" below, for the reasons.) I roughly guess that large baggage and mail cars cost about $8,000 each; and smaller railcars, such as freight cars, about $2,500 each. Of course, that varied with the type of freight car. And one might get a "used" railcar for 1/3 rd that much. Automobiles and truck use was on the rise in the late 1930s.

…Oil (Crude oil, wholesale, just before war!)   ~~$0**.**03 per gallon wholesale (The price of gasoline in a non-oil producing State in a rural region might be ~$0**.**16 per gallon.) The oil price was very erratic, and had been about half that in the early 1930s; reader may wish to also see "…**C**oal" .

…Potatoes—for 10 pound weight, in England   ~$0**.**20 (~20 U.S. cents per 10 pound sack of potatoes) My estimate based on 1 pence (Brit. "d") coinage = ~ 2 (U.S.) cents. ((Regarding potatoes, the above seems to imply that Britain had some great source for food "calories" during WW2, i.e., potatoes; and one might wonder if Britain pressured Ireland to make that possible.))

…Rifle—(Browning?) Automatic rifle   ~$270 (like a very light machine gun)
…………"M1" (good "semi-automatic" rifle) ~~$60
…………(Mauser?) Carbine, light weight   ~$31 (like a cutoff, short-range rifle)
…………Machine gun   ~$2600 (per each one in a fighter plane)
…
…Rubber material--(I have no figures, but just mention that when Japan captured important rubber-supplying territories; the U.S. strained to have rubber plantations planted in South America, and to mix in as much "synthetic rubber" for the end product as feasible, without destroying quality. I guess rubber was recycled also, to the extent possible. Rubber became rationed; and shoes were too.) Before the war, a fine automobile 'Goodyear' tire cost ~$15/each retail; or for regular tires ~$10/each.

…Ship—merchant ship, see "Liberty ship", above.
…Ship—Battleship, 1940, prior to war~$77,000,000 (per the battleship N. Carolina)
……...---Battleship, ~1920 vintage   ~$26,000,000 (est. per Brit. Battleship Hood)
……...---Large Aircraft Carrier   ~~$45,000,000 (based on Lexington & Saratoga)
……...---Light, fast Aircraft Carrier ~~~$10,000,000 (based on old cruiser conversions)
……...---Heavy cruiser   ~~~$10,000,000 (very rough guess)
………---Light cruiser   ~$5,000,000 (based on Brit. Cruiser Arethusa)
………---(very small) Escort Carrier ~~~$5,000,000 (That is a rough guess for these cheap, slow, very small aircraft carriers, that carried only ~28 single-engine airplanes. Many were used to hunt enemy submarine, and they did that well. But these tiny aircraft carriers were packed with non-well shielded munitions, and they had wooden decks that were not long. They were not liked by most of their airplane pilots, but they still got their jobs done well. "Light" aircraft carriers were bigger than Escort carriers, and the "Light" carriers could carry ~~ 45 single-engine airplanes. Of course, if an Escort Carrier deck was just used to store airplanes to be unloaded by crane (i.e., without their having to be launched) then that "CVE" could deliver many more than 28 airplanes.

………---Submarine, fine, large type ~~$2,500,000 (guess based on WW1 subs and various interpolations. Note, Germany used some large subs, to refuel their smaller subs at 'secret' ocean locations, and for other uses.)
………---"large" destroyer ~$2,000,000 (very rough guess)
………---small destroyer or frigate ~$1,500,000 (very rough guess)
………---Submarine, efficient & small ~$1,500,000 (rough est. for Type VII U-boat)
………---small Sub-chaser or ice Cutter ~~$700,000 (very rough guess for a ~150 ft.-long, ocean-worthy, sub-chaser or small Coast Guard or Navy Ice Cutter.)

…Silver: (U.S. mine output had been high) $0.50/oz. (much silver from old days)

…Steel—hot rolled steel ~$40 per ton
…Steel—scrap steel ~$15 per ton

…Tank—light tank ~ $35,000
…Tank—medium weight tank ~$45,000

…Torpedo ~$11,000
…Note, the torpedo quality in the U.S. was very poor and unreliable for a long time even after Pearl Harbor was attacked. The reliability of Germany's torpedoes was poor at the beginning of WW2, but was corrected fairly soon. A torpedo is a very complicated underwater, fast propelled, 'rocket-shaped' explosive machine; usually intended to explode on collision. A WW2 torpedo might contain compressed air, which is also heated, and which drove an air-operated motor or turbine, for propulsion power. Or it might be propelled by an electric motor, supplied by the torpedo's internal batteries. A WW2 torpedo also had depth control, range & speed combination adjustment, gyro, etc., and sometimes a magnetic proximity explosion trigger that often didn't work correctly. It also contained many hundreds of pounds of explosives.

…Truck—1-1/2 ton (tough, modest size) ~~$1,300 (probably weighed ~6000 lbs.)
A "3/4 ton truck", of course means that in could carry a ~ 3/4 ton load, and such truck would actually weigh several tons, when empty.

…Voting (Poll-tax charge per year in Texas) $1.00 per year
(One dollar then bought as much gasoline as fifteen dollars does now; ~mid-2004)

…Wheat (what farmers got for a 1 pound yield) ~$0.017 per enough to make 1 pound of "wheat kernels".

…Note, the grocery store might sell bread for 6 cents per 1 pound loaf (likely 8 cents for ~20 ounce loaf), but the amount the farmer received was less than 2 cents on that 6 cents. ((The farmer was getting about 90 cents for a so-called "bushel" of wheat. A "bushel" was determined to be such harvested amount as would yield about 53 pounds of "wheat kernels", which I guess is the weight that results from of filling a "bushel" (defined as a ~1.25 cu. ft. volume) with those kernels.)) Just as an animal, before slaughtering, weighs much more than the "meat" to be derived from it—similarly, the actual weight of, say, an entire cornstalk, leaves, etc., is much more than the corn kernels derived from it. Incidentally, with regards to meats; the farmer got about half of the grocery store's final sticker price.

The cost tabulations (above) for submarine and battleships, (together with some historical Navy facts); can illustrate how one may use cost data to help draw certain conclusions: For example, it appears that Hitler's and Admiral Raeder's decision to built 3 large modern battleships instead of, say, 150 more modest-size U-boats, was relatively unwise. And that had Germany had the extra subs, instead; then Germany would have been able to hit the Allies with, perhaps, 8 times its initial submarine wallop; and much more harm would have likely been done. Britain's big Navy had more that enough battleships, etc., to neutralize Germany's 3 battleships, anyway. And it is not surprising that Admiral Doenitz, a former WW1 submariner, favored Germany's building more submarines, instead.

Somewhat similarly, the "*price-savings* attempt" of some early U.S. sub skippers to fire only two $11,000/each torpedoes at a ~$5,000,000 enemy ship, and thus to miss it or just damage it—seems unwise. Any submarine attack would also often result in enemy counter measures to locate and destroy our ~ $1,000,000 to $3,000,000 submarine and crew—thus making the submarine's weak and risky attack seem somewhat silly. Similarly, with the Navy Ordinance Department's hesitancy to test a half-dozen of its $11,000 torpedoes (by which they would have likely discovered that half did not work!). So by more extensive testing, then early corrections could have been made-- using parts costing only pennies. And we would not have had to wait until about halfway through the war to make those corrections. (Incidentally, my advice to all students and engineers is this: If possible, never *presume* that a slightly different part can substitute for another, without testing. There may be surprising, hard to predict, and 'unintended consequences'! (Similarly, in economics and politics.)

FLYING TIGERS: The name of an American volunteer group that was headed by General Claire Chennault; and which went to China ~1937 to help them combat industrial Japan's great air-power advantage. Since about 4 years went by before the U.S. and Japan were at war, President Roosevelt had to stretch alleged neutrality to its near breaking point to support that group. And even to form it, in ~ 1937. The group did not have enough pilots and good airplanes to do more than slow down the Japanese advance, somewhat.

One of the great things General Chennault did was to advise America about how our generally inferior "P40" fighters could defeat the generally superior Japanese "Zero" fighter. Basically, that was by never engaging the ultra-maneuverable Zero in a "turn-and-maneuver" style combat. But to use the P40's greater speed, especially when diving, and the P40's sturdiness, to make one firing pass at the Zero, and then dive swiftly away. And if another pass were desired; to get far away before turning around for another pass. Very *unfortunately*, Chennault's important tactical suggestions were merely filed away in Washington; and never shared with other U.S. and Allied flyers of "Merlin Mustangs" and Spitfires. Thus, later, when these generally superior Allied fighters first engaged the Zero; they tried to outmaneuver the Zero and failed. Many Allied airplanes were lost, because "Washington" did not spread Chennault's earlier tactical discoveries and deductions. So when some squadrons later "discovered" how to defeat the Zero, they were honored for a discovery that was originally Chennault's.

Optional: I have occasionally wondered if a large training program for Chinese pilots in the U.S., say between 1937-1940, should have been put into effect, thereby reducing the number of "U.S. volunteers" needed, or increasing their future effectiveness? ((Suppose that the U.S. production capacity had been more fully engaged sooner, and that we had just greatly stockpiled and supplied the nations that had already been invaded by Japan and Germany (i.e., before the U.S. entered the war).)) Then most of the Allies' burdens would have likely been appreciably reduced; including our burdens, after we entered the war.

HOLOCAUST: In the Nazi and Hitler Ideology, the overwhelmingly cause of Germany's and the World's problems was deemed to be the Jewish people, a very convenient scapegoat; and they were to be exterminated! Hitler and the Nazi tried to do that; and rather effectively succeeded, including in countries that they had conquered and occupied; and in which they had installed their puppet-like regime. And similarly, in countries that they had sufficiently intimidated. Jewish people were considered to be an evil race by Nazis. So they exterminated ~6,000,000 Jewish people; many in gas chambers with hydrogen cyanide, and many shot on the spot in occupied territories. And many died of starvation and disease while stored in camps awaiting execution. Also, many young workers were worked to death in forced labor camps, doing critically dangerous work—to be executed if and when their strength lessened from malnutrition, etc. In some ghettoes, such as the remains of the Warsaw ghetto; victims were killed during their significant, organized, armed rebellion; that they engaged in--rather than accept being shipped off to death camps or torturous forced labor camps. (Again, there is not enough space here to do the subject justice; but there are books and museums for further information.) Even those who succeeded in fleeing, or who survived until liberated, were often left penniless and with severely compromised and shortened lives.

Optional: It is interesting that the Nazi pre-holocaust business methods involved dividing their populous up into classes, the "lesser, sub-privileged Jewish people", and the Aryans--"special privileged". (For example, as occurred after "Crystal Night", with regard to already covered insurance.) That relates to one objection I have to something called "Corporate Greenmail paying", often occurring in the 1970s and 1980s. It, too, involves suddenly dividing common shareowners into privileged and sub-privileged, with regards to benefits per share.

LEND-LEASE: That was the U.S. program of lending (and ultimately giving) huge amounts of valuable supplies and military equipment to our Allies, who were sustaining huge casualties, to defeat the "Axis". Even before our "formal" lend-lease programs, FDR went out of his way to devise and carry out "schemes" to aid Britain in its war against the Axis. One example is the U.S. giving to Britain--50 old destroyers in exchange for some (crazy) 99-year leases—involving military bases in Iceland and some other places.

((Optional: In my opinion--it was absolutely ludicrous for Britain <u>not</u> to simply "give" us the bases, outright; instead of limited time "leases" (i.e., a "gift" of unlimited possible trouble). And it seems to me a wonder that FDR got it through Congress (or does it help, if such bills are ludicrous?). Or do history books describe that incorrectly? On other occasions (such as when FDR pushed the very <u>*non*</u>-neutral "neutrality" patrol and other extensions beyond certain limits)--I think FDR risked censor or impeachment. Some people may not fully appreciate that, when they over-stress the time "when Britain was *standing alone*", or criticize FDR for not doing more sooner.))

Under lend-lease, Great Britain got ~$31 billion; the USSR ~$11 billion; and China ~$1.5 billion. (France "got" $3 billion, but since she was "overrun" during most of the war, such descriptions sort of loose their meaning.) And many other countries got a little, relatively speaking. My figures are in old "1940s dollars"; and for what they could buy then—see my heading: "<u>**COST**</u>". One of the great things that Churchill and Britain did, <u>which was</u> <u>hopefully made easier by our Lend-Lease to Britain</u>, was to provide the USSR with some of Britain's latest "Hurricane" fighter planes. Those airplanes could help cope with the average German ME109; and the U.S. simply did <u>*not*</u> have such good fighter planes, at that time, <u>*at any price*</u>! Incidentally, due to U-boats and miscellaneous problems; only ~ 70% of the Lend-Lease which was sent--got to its final intended destination, according to what I have read.

((Optional: In my opinion, there has been a lot of <u>irrelevant</u> debate over whether our "Allies" ever paid us back, rather fully, for Lend-Lease. FDR and many Americans hoped that all our "Allies" would quickly give up their Colonial-like holding after WW2; that is, if the Allies even <u>re</u>-occupied them at all. Those "Allies" who did <u>not</u> promptly relinquish their "Colonies"; (and in some cases, only came to "liberate" them <u>*after* Japan had surrendered</u>)----showed great contempt for Lend-Lease, FDR, and the best American ideals. (And somewhat, in effect, used Lend-Lease <u>against</u> us!) A late, partial Lend-Lease repayment (or even, <u>eventually</u>, a full repayment) can <u>not</u> reverse the harm done by that disappointing <u>post</u> WW2 conduct. (That is my opinion; although admittedly, it is hardly the opinion of many U.S. leaders <u>after</u> FDR, who have shown great <u>dis</u>respect for the Dominican Republic, Panama, Grenada, Chile, and too many other small countries to list here! That is my opinion, regardless of whether those actions by those <u>post</u> WW2 U.S. leaders were "overtly" or "covertly carried out").))

<u>**LIBERTY SHIP**</u>**:** It became obvious, after WW2 began, that the Allies' mounting loss of ships, to enemy subs (U-boats) was a major obstacle to the Allied effort; and, in fact, England might starve. And Soviet Russia's manufacturing capacity and resources were also soon greatly reduced by initial German territorial gains. And the Soviets lost their labor force in areas occupied by Germany. So an astute U.S. Administration, with good

advisors and technical experts, drafted plans to manufacture great numbers of Merchant ships, using cheap, non-scarce materials, and high-efficiency technology. And the ships were to have great cargo capacity. Welding would replace rivets; large prefab sections would be utilized where possible. The ships' shape, propulsion, and general design were based on a cheap, old "tramp" ship that had been commercially successful.

I think it was fortunate, at least, that fuel oil was chosen, instead of coal to power Liberty ships, because that required much less crew, who might be killed or injured if the ship was torpedoed. And the U.S. Merchant Marine Service suffered a higher percent killed than any the large 'military' Branch of the Services; and did not need matters made still worse. (Of course, certain specialty services within each major Service, such as the U.S. Submariners, suffered even higher percentage killed.)

Oil fuel also increased the Liberty Ship's efficiency. In 1940, <u>about 40% of the world's ships still used coal</u>. Coal was much more commonly used in merchant ships, then; and was generally avoided for military ship propulsion. It was decided that Liberty ships would used cheap and relatively available engines, ((i.e., the triple expansion, reciprocating steam engines--even though their relatively low power output (totaling 2,500 HP) propelled the large ships slowly enough to be followed for a while, even by submerged U-boats.))

<u>Liberty Ship Technical Specifications</u>

…Speed**:** 10.5 knots (~12 mph), presumably even when fully loaded.

…Gross weight (i.e., weight of <u>empty ship</u>)**:** ……………………… ~7000 tons
…<u>Cargo</u> weight (applicable to ship's "full load displacement" rating)**:** <u>~7000 tons</u>
…"<u>Full load" Displacement</u> (Gross weight + full-load cargo weight)**:** ~14,000 tons

The so-called "Deadweight" (i.e., amount of *Cargo*, and the ship's own Fuel, etc., which the ship could carry on emergency missions if seas didn't become too rough, or in calm lakes, etc.)**:** …… <u>~10,500 tons</u>

Size**:** ~430 feet long; 57 feet beam (max width); 27 feet draft (depth into the water).
Power**:** total 2,500HP, from reciprocating steam engines.
Fuel**:** Oil

Crew**:** about 56 to 80; ((about 12 to 25 of those would likely be Navy personnel (guards) to man the ship's several defensive guns. The number of these guns per ship increased during the war)).

Notes: About 2,700 Liberty ships were made during the war, and about 200 were sunk. Where possible, bulky war machines, (like cargo ships that required much raw material)--were made in the U.S.; allowing England's labor force to concentrate more on labor intensive, smaller, technical machines (like their fine Spitfire fighter planes, and mine detecting and destruction equipment, and so on).

Optional: The value of the cargo carried by a Liberty ship often far exceeded the value of the Liberty ship, itself. If such ship could just make only one successful delivery to the Allies, it thus "paid for itself". Suppose, a Liberty ship carried 440 tanks weighing ~8000 tons total and worth ~$18,000,000. That value would obviously dwarf the ~$1,600,000 cost of the ship, itself. In fact, that is a strong argument for dispersing especially valuable cargo among various Liberty ships, so that an Ally receiving it does not find itself totally lacking in any one class of equipment, indispensable for carrying on the war. (Occasionally there were "too many of a particular type of 'eggs put in one basket', i.e., loaded on one Liberty ship".)

Incidentally, a ship's steam engine is designed to re-condense, recover, and recycle its de-energized warm steam, after each cycling sequence. And therefore, it need not make water stops or scoop up cool water for its engines; which railroad steam locomotives, unfortunately, have to do. (Large WW2 Warships, propelled by steam turbines, produced and utilized high steam pressures of ~575 psi., which seems much higher than steam locomotives of the period, i.e., ~250 psi.)

MACHINE GUN—see "**R**IFLES"

MONEY Conversions, shortly before WW2: ($ denotes U.S. "dollar)

……………………. $4.67 (U.S.) = ~~1.00 (British "*L*") Pound
…………………..or $1.00 (U.S.) = ~~0.21 (British "*L*") Pound
……………………..$1.00 (U.S.) = ~1.88 Netherlands Guilder
……………………..$1.00 (U.S.) = ~2.50 German Reichsmark (i.e., "RM")
……………………..$1.00 (U.S.) = ~~37.7 French franc?
……………………..$1.00 (U.S.) = ~5.31 (Polish) Zioty ("zi")
……………………..$1.00 (U.S.) = ~2.00 Japanese Yen (some est. ~3 or 4 Yen)
……………………..$1.00 (U.S.) = ~~4 to 8 Chinese Yuan? (a guess)
……………………..$1.00 (U.S.) = ~~5 to 28 Russian Rubles (a guess)
……………………..$1.00 (U.S.) = ~~2 Mexican Pesos or Philippine Pesos

NUMBER of People Commanded—see "**R**ANK"

POPULATIONS --of Allied and Axis Countries: (rough approximations before WW2)

…Australia, Canada, and New Zealand………………..~25.5 million (together)
…China……………………………………………..~500 million
(Note, that includes Chinese "Nationalist's regions" and "Communist's regions", even though fighting occasionally broke out between the two.)
…Great Britain…………………………………………~48 million
…United States……………………………………… ~125 million

…USSR……………………………………………… ~200 million
((Note, the USSR consisted of many diverse regions, like the Ukraine--in those days. That is--many of those regions are no longer a part of "modern Russia", today. (I.e., since the "break up" of the "USSR".) However, even in those old 'USSR' days; many people in various regions were <u>not</u> pleased with the Soviet "Union".))

…Belgium, Netherlands, Luxembourg…………………~17 million (together)
…France……………………………….……………..~43 million
(Incidentally, in terms of military deaths as a percent of their total population; France suffered a higher percent killed than Britain or the U.S.)

…Countries' total WW2 populations, continued……..
…Greece…………………………………………….....~7 million
…Norway……………………………………………..~3 million
…Poland……………………………………………..~36 million
…Yugoslavia……………………………...…………~15 million

…Germany…………………………….…………….…~72 million
…Italy………………………………………………..~45 million
…Japan………………………………………………~74 million

…Hungary………………………………….…..………~14 million
…Romania……………………………………….……..~14 million

A number of other countries were drawn militarily into WW2, in more complicated ways; and in most cases, with divided feelings; but below--some are listed, anyway:

…Albania ~1 million; Austria ~7 million ; Czechoslovakia ~37 million;
… Finland ~ 4million; India ~300 million?

<u>**P**RICES</u>—See <u>**C**OSTS</u>

<u>**RAILROADING**</u>: During WW2, over 90% of locomotives in the U.S. were coal-powered steam locomotives.

(Incidentally, in 1942 the Lionel Corporation suspended its manufacturing of its <u>Toy</u>-electric trains, and began manufacturing military products instead. Times were very frightening and difficult, indeed!)

After WW2, diesel locomotives began replacing steam locomotives because of the following reasons: Diesels did <u>not</u> have to stop to fill up with water every 150 miles or less; Diesels did away with the need for a locomotive "fireman" whom many considered more important than the locomotive engineer (and who also road with the engineer in the locomotive's "cab"); Diesels could be "fired up" to full power with the turn of a switch, without 2 hours of waiting for steam pressure to build up. If great power was needed, 2, 3, or 4 diesel locomotives could be coupled to one-another, and the total could still be operated by only *one* operator. And for smaller power needs, one Diesel unit could be used, with less surplus power standing by and being inefficiently vented, while waiting between jobs or for only switching a few cars.

Most steam locomotive *tenders* were designed to store enough coal to evaporate enough water so that only one "coal refill stop" was needed for each two "water refill stops". About 1 ton of coal is needed to evaporate and pressurize ~7 tons of water.

Optional: Let us imagine that a big railroad tender might have a 15-ton coal-storing compartment and a 50-ton water-storing compartment. Let us imagine that the tender is pulled by a locomotive that it serves, and along with many railcars. And that such tender could go 150 miles before absolutely needing its first water refill; i.e., another 50 tons of water. Then it still has about 7-1/2 tons of coal remaining from the original ~15 tons of coal. But at the end of the next 150 miles (finishing the 300-mile trip) the now empty tender needs a second 50-ton water refill and its first 15-ton coal refill. So a tender with a "coal to water" storage weight ratio of 1 to 3--at least saves some coal refill work, and with very little sacrificed. (That is a rather idealized example, but it might be applicable to an easy route with a very fine, strong steam locomotive. Such locomotive might burn 100 pounds of coal for each "1000-ton mile"; that is, we can calculate that such a 1000-ton freight train assemblage might make such 300-mile trip described above.)

Diesel engines were more efficient, requiring about 1/8 th as much energy (from oil) as the steam engines required (from coal) to do the same work. Although, by weight, oil may have been 4 times more expensive per energy provided; diesel powering was still, therefore, cheaper. And the locomotive's tender, when loaded with water and coal, was as heavy as one or two loaded freight cars, further hindering its economics. Finally, we must remember that there were many special major accessories needed to keep steam locomotives running, such a "water towers", and these required workers, maintenance, energy, and raw material. Coal storage and loading, similarly, was somewhat cumbersome. The tenders of some Eastern railroads were provided with "water scoops" to scoop up water, without stopping, from a long "canal" between the tracks. But that did not solve all problems; for example, these water ditches might "freeze up" in the winter, and they had other drawbacks.

A very large steam locomotive, made shortly before WW2, might weigh about 150 tons, and that probably does not include even an empty ~30 ton tender. Such locomotive might be about 4000 HP and provide a pulling force of up to 20 tons of traction, to pull railcars, before its wheels would slip on the rails. But steam locomotives could only deliver their great potential horsepower at reasonably high speeds; so less horsepower had to be tolerated at slow speeds. Large locomotives of the 1930s might "build up" and maintain a steam pressure of about 275 pounds per square inch during normal operations. One might ask, "how does a pair of locomotive wheels turn with the turning (curving) tracks (i.e., since a pair does <u>not</u> have the ‘universal joint’, that automobiles have)?” I was once told that the inside edges of the rails and contact surfaces of rail wheels—are not flat, nor entirely horizontal; and that a little sliding slack is also provided. And that that helps one wheel to ride a little higher than the other, while turning, which helps provide the solution. .

<u>**RANK** and Numbers of Troops Commanded</u>:

Like other terms and descriptions in this amateur’s *mini-encyclopedia*; what follows is just approximate; and what is below applies more to the Civil War than to WW2. (Generally, there were more troops in the large military units of WW2 than the similarly classed large units of the Civil War.)

A “<u>Platoon</u>” (i.e., infantry platoon) had <u>about 20 to 40 troops</u>; and was led typically by a <u>lieutenant</u>.

A “<u>Company</u>” might consist of, say, <u>100 to 120 troops</u>, or two or three Platoons; and would typically be led by a <u>Captain</u>. (Typically designated using letters, such as “Infantry Company A” or “B”, etc., or “Cavalry Company L” or “M”.)

A “<u>Regiment</u>” might consist of, say, <u>1000 to1200 troops</u>, or ten Companies; and be led typically by a <u>Colonel</u>. Lieutenant Colonels or Majors might assist the Colonel. (Regiments are designated by numbers. For example; during the Civil War, there was from Maine, the “20th Regiment” led by Colonel Chamberlain, or as is extremely customary--just termed the “20th Maine”. Such ‘truncated abbreviation’ in describing a ‘regiment’ is still common practice today.)

A “<u>Brigade</u>” might consist of, say, <u>2000 to 3000 troops</u>, or two or three Regiments; and be led typically by a Colonel or <u>Brigadier (one-star) General</u>. (They were typically designated by numbers, or sometimes by the charismatic commander leading it. Occasionally, even a Confederate Major General led a brigade, such as the “Stonewall Brigade” under General “Stonewall” Jackson.)

A “<u>Division</u>” might consist of, say, <u>6000 to 16,000 troops</u>, or three or more Brigades; and be led typically by a <u>Brigadier General</u>. (Divisions typically designated by numbers.)

A “<u>Corps</u>” might consists of, say, <u>18,000 to 60,000 troops</u>, or three or more Divisions; and be led typically by a <u>Major General</u>, or even a lieutenant general--if the number of troops was very great and the situation special. (During the Civil War “Battle of Gettysburg”; the Confederacy did not have a Corps commander quite as capable and experienced as General “Stonewall” Jackson, (killed some months before). But the Union <u>almost</u> lost the battle, anyway, due to Major General Sickles’ arbitrarily repositioning of his Corps, unwisely. Incidentally, it is somewhat vexing that the Confederate Generals understood which <u>Union</u> Generals performed superbly and poorly at Gettysburg--even though Lincoln and his top staff did <u>not</u> seem to. (An Army ‘*<u>Corps</u>*’ is pronounced like an Apple ‘*<u>Core</u>*’).))

An “<u>Army</u>” might consist of, say, <u>36,000 to 300,000 troops</u>, or two or more Corps; and be led typically by a <u>Major General</u>, or maybe a Lieutenant General who preferred to be nearer to his troops or if the situation was special. ((During the Civil War on the Eastern front, General Lee led his Confederate “Army of Virginia”; and General Meade led his “Army of the Potomac”, (i.e., the Potomac River region).))

An “<u>Army Group</u>” might consist of, say, <u>1,000,000 troops</u>, and consist of several armies. A <u>Lieutenant General</u> would typically lead it. (The term “Army Group” was not commonly used until WW 2. Example: During Hitler’s campaigns against Soviet Russia; Germany used an “Army Group South”, an “Army Group Center”, and an “Army Group North”. One of the Armies of “Army Group South” was General Paulus’s Sixth Army.)

…<u>Naval</u> <u>**R**</u>anks………

In the <u>U.S. Navy, a Lieutenant—Junior Grade</u> might command a small PT boat and its 11-17 crew. That is comparable to the <u>Army rank of Lieutenant</u>.

But a <u>full</u> <u>Naval “Lieutenant</u>” might command several PT boats, and is comparable in rank to an <u>Army “Captain</u>”. (Or even command a submarine, before subs got so big and important.)

In the U.S. Navy, a Lieutenant-Commander might command a Submarine with a crew of about sixty; or squadron of a several dozen airplanes. A Naval <u>Lieutenant-Commander</u> is comparable in rank to an <u>Army “Major</u>”.

In the U.S. Navy, a full Commander might command a “Destroyer” (a modest-sized, ocean-worthy fighting ship with a crew of about 140 to 210.) A Naval <u>Commander</u> is comparable in rank to an <u>Army Lieutenant-Colonel</u>.

In the U.S. <u>Navy</u>, a “<u>Captain</u>” might command a Battleship with a crew of about 1800; or an Aircraft Carrier with a crew about 1500 to 3000; or a Cruiser with a crew of about 650 to l200. A <u>Naval *Captain*</u> is comparable in rank to an <u>Army *Colonel*</u>.

(Note, the <u>*Naval* rank of “*Captain*</u>” is several ranks <u>above</u> the <u>*Army* rank of *Captain*</u>!!)

As mentioned in my previous article, the Naval ranks of ‘Rear Admiral—lower flag’, and ‘Rear Admiral—higher flag’, are considered of very high ranks, i.e., ‘<u>Flag</u> Officer Rank’; somewhat similar to important Army Generals, ‘Brigadier General--one-star’, and ‘Major General—two stars’, respectively. The naval word ‘Flag Officer’ arose from the tradition that the main ship directing the entire fleet of ships was known as the ‘Flagship’. It displayed a special flag that indicated that; and also carried the ‘Flag’ Officer in command of the entire fleet.

The U.S. Navy also has some ranks which use the term 'Officer', such as 'Petty Officer', but these correspond roughly to Army ranks which are below what the Army classifies as "Officers". And the Navy has a rank, 'Ensign', which may not sound like an Army second lieutenant of 'officer rank'; but it seems to be like such Army 'Officer rank', anyway.

All ranks, and the number of war machines and personnel commanded, evolved from the principle that certain sized units should <u>not</u> be too large to efficiently handle its particular task. Nor so small, as to lack the minimum (critical) mass to get its task done reliably--keeping in mind that there will likely be some casualties and other routine problems. And, of course, there is a "pyramid of command", because a few people can't be everywhere at once to give orders to all the soldiers who are encountering changing situations.

An airplane "<u>*Squadron*</u>" is about 14 to 37 airplanes. For example, it may be a Squadron of 'Torpedo Planes', or a Squadron of 'Dive-bombing Planes', or a Squadron of large, four-engine 'Heavy Bomber Airplanes', or a Squadron of protective light, agile 'Fighter Planes' or other specialized Squadron. Sometimes a few 'fighter airplanes' belonged to the same Squadron as many 'heavy bombers', to get the task done more safely, even though such Squadron was a sort of 'hybrid'. In the U.S. Navy (<u>not</u> the British Navy); an airplane '<u>*Group*</u>' might consist of <u>several Squadrons</u>, say, on a single aircraft carrier. And a '<u>Wing</u>' might consist of <u>several Groups</u>. (I.e., a fleet, with several aircraft carriers in it, might include enough airplanes to comprise a 'Wing'; that is, each of aircraft carriers in it might carry a Group of Squadrons.

In WW2, the "*Army* Air Force"; was <u>*not*</u> a separate branch of the Armed Forces; that is, it was <u>*not*</u> separate from the Army. (Of course the Navy and Marines each had their own supporting airplanes, somewhat like the Army had its own "Army Air Force".)

<u>Optional</u>; <u>Other Special Military Groups</u>, Sizes and Descriptions are as follows:

A regiment-sized military unit that specialized in artillery barrages was known, during the Civil War, as a "<u>Battery</u>". A single cannon might require ~ 6 people to position, aim, and operate it properly. Somewhat similarly, for still more specialized WW2 Anti-aircraft guns.

A military unit—comprising several Companies—might make up a "<u>Battalion</u>". Sometimes the Battalion had a very specialized role, such as a "Medical Battalion". It might be led by a Major or a Lieutenant-Colonel. Sometimes a Civil War "Battalion" was created from the residue of a Regiment that had been greatly reduced in troop strength, due to many casualties.

<u>RIFLES, CARBINES and MACHINE GUNS</u>: (See **<u>A</u>**rtillery for a Rifle's grooving.)

…"*Repeating Rifles*" were commonly in used somewhat after the American Civil War and before WW1. It required a separate manual action by the rifleman on a "bolt" (i.e., "bolt action") to extract and insert the next cartridge, that is, after the rifle trigger was pulled and released—before the next bullet could be fired. (Of course, the cartridge also contains the combined bullet and powder before firing, but the cartridge becomes an empty cartridge after the bullet is fired.) At least "Repeating Rifles" did away with the ~20 second minimum delay between each firing of a typical Civil War rifle; where gun powder, wad, and ball had to be jammed down the far-end barrel, (instead of breech loaded), and a cap insert in the near end—before each firing. (I believe "*Old Springfield*" rifles were of the "*Repeating*" type. And had a "cartridge clip" holding many cartridges, so that one need not have to grab another cartridge to stick in every time one was fired.)

…"*Semi-automatic rifles*" were commonly used during WW1 and WW2. A "clip (or magazine) containing many cartridges" could be inserted near the near end; and no "bolt" had to be fiddled with, by the rifleman, between shots. The rifleman merely had to pull and release the trigger each time he wanted to fire a bullet (i.e., one trigger action required for each bullet fired). The "M1" rifle was a famous "semi-automatic" rifle, and was very common in WW2 and the Korean War. It had good range with great accuracy, and it was reliable.

…"*Automatic rifles*" were commonly used in wars after the "Korean War", although some were used even as early as WW1. If one inserts a "clip of, say, 10 cartridges" and pulls the trigger; it fires quickly one bullet after another, until all 10 bullets or used up, or until one released the trigger, whichever ending event occurs first. But automatic rifles, like the M-16, can also be set to fire "semi-automatically", and thus can be used in the "automatic" mode or "semi-automatic" mode as the battle scene changes.

…A "*Machine Gun*" acts like an big, heavy, "automatic rifle"; but has a long feeding "belt" full of many cartridges, so it can fire large, powerful bullets very rapidly; one-after-another, for a long time, without "reloading". (A U.S. "machine gun" had been invented and developed shortly before the "Spanish-American" war, and was known as the "Gatling" Gun, after its particular inventor. During that war, it "saved the day" for Americans, in at least one very important battle, when it looked like many very skilled, well-positioned, Spanish riflemen could not otherwise be dislodged.)

…A "*Carbine*" was somewhat like a semi-automatic rifle, but with shorter barrel, lighter, and not as accurate. The carbines, during most of WW2, were "semi-automatic"; but later during that war, "automatic carbines" also came into significant use.

…*Rifle Ammunition:* Somewhat before WW1; it was decided that the "rules of war" would require a durable copper or other metal (that surrounds a bullet's lead interior) to be tough enough to maintain the bullet's integrity as it passes through its victim's body. That way, the bullet would not flatten out (like an objectionable "dum-dum" bullet) and gorge-out unnecessarily large amounts of tissue, as its passage was about completed. Although that refined (legal bullet) would cause injury, incapacitation, or even death; less long-term agony was likely to occur, in most cases. And the burden to an enemy of having their soldiers injured--is considered to be a greater drain on the enemy's resources and attention needs, than dead soldiers. So most WW2 bullets were of tough metal covered lead.

But there were also bullets made entirely of steel and hardened, to have significant armor-piercing capability. And there were "tracer" bullets, designed to provide a fiery, visible trail, to aid the rifleman, artillery man, or aviator, to see where his ballistics were really going. And there were developed carbine-shaped guns that threw out a long stream of flame, i.e., "flame throwers", to burnout hiding places and people in them.

Incidentally, with the development of "smokeless" gun powder, a rifleman's position became harder to detect. And some good rifles were often provided with an accessory to help hide the bright "flash", when the rifle was fired. A bayonet accessory was also often provided.

ROCKETS: There were large numbers of various types of small rockets in WW2; although not as famous as the very large, long range V2 Rocket of WW2. (A rocket's fuel contains its own "oxidizing" agent and does not depend on an atmospheric air supply to aid propulsion. That makes a rocket also suitable for "space" travel and ultra-high altitude "flights".) Some ways in which WW2 rockets were used, were as follows:
….To be launched from a "bazooka" (a ~ 5 foot long, tube-shaped, devise with open ends). That was used by a soldier who held it on his shoulder and aimed it at an enemy tank or bunker;
…or to be launched from airplanes to hit enemy bombers and ground targets (later in the war);
…or to be launched from a truck, with a rack mounting 8 to 60 firing tubes for such rockets. Presumably, there was very little "kick back" from these open tubes, unlike the recoil from a cannon or rifle.

Rocket launching ships ("LVMR"s) also launched huge numbers of such rockets against enemies on, or near, beaches prior to capturing beaches from the enemy. In at least one case; 250,000 explosive projectiles, of various types, were fired at beach targets by LVMRs, battleships, and other naval ships, before attempting a landing. In some cases, top enemy leaders wisely concluded that a landing on a beach, itself, was impractical to stop, when such strong Navies ruled the seas. And that more inland fortifications were easier to defend.

SHIPS and Boats: WW2 military "ships" might be as small as Patrol Torpedo boats, used near rivers and islands. Or they might be as large as very large Battleships and "fleet" Aircraft Carriers). ((Also, see separate heading: "**L**IBERTY Ship" and "**S**UBMARINE" and "**C**OST…" for lengthy description of various ships.))

The smaller naval ships had only light armor, if any; and had less powerful guns. But they generally had powerful torpedoes. The idea was to go in, get a good hit or two against an enemy, and then get out or hide. In the case of ships trying to hunt down and destroy enemy submarines; (such as a "Subchaser", "Destroyer", and sometimes "Escort Carrier"); the idea was also to find the enemy sub, using one's electric-electronic sensors, or one's airplanes, which also had hunting equipment. Submarine hunters could generally launch "depth charges" which descended down under water, and had a timed fuse to blow up; hopefully, near the sub. Or "hedge hog" explosives, somewhat like depth charges, but intended to blow up <u>on</u> <u>contact with a sub</u>. And after a few years of WW2, the U.S. even developed a "sound-sensitive" underwater torpedo to guide its own way to a noisy sub. (Sometimes a large Destroyer would be used to help protect an aircraft Carrier from enemy aircraft. Destroyers, some Cruisers, and Battleships carried many 'anti-aircraft guns' for that.)

The larger ships were intended to stay out of the firing range of the smaller enemy ships; and use their long-range guns to destroy the small ships and the enemy fleet. Generally, a large ship was suppose to have enough armor to give it rather adequate protection against any comparable ship's guns and against a smaller ship's guns; but not great protection against a bigger enemy ship having bigger guns. And no ships had great protection against torpedoes. The war paradigms were constantly changing; for example, for various reasons, some cruisers with extra anti-aircraft guns ended up protecting Aircraft Carriers as successfully as much slower battleships.

All the above glib paradigms, of course, were often successfully violated as the race for technical superiority progressed. Rather small Japanese Destroyers could, and did, launch long-range ("long-lance") torpedoes with the range and destroying power of a Battleship's big guns. And an enemy's airplanes (carrying bombs, torpedo, or even mines) could, and did, drop their explosives on our ships; even though they were launched from aircraft carriers 300 miles away. And, thus, fleets "fought" each other at distances too far for ships to fire at one another, or even "see" each others' directly. A very few types of medium-sized airplanes (like "Doolittle's B26 Bombers") could take off from aircraft carriers even without the carrier's "catapult" (assist). And a few other airplane types could land on very long carrier decks, even without a "hook and dampening wire brake" to quickly slow the plane down during its landing.

In order of "size"; …from the smallest to largest WW2 "ships"; we have: PT boats, subchasers, river gun boats, small Subs, Frigates, Destroyers, large Subs, large Destroyers, Light Cruisers, Escort (aircraft) Carriers, Heavy Cruisers, "Light" Carriers, medium-sized Carriers, Old battleships, Battle Cruisers, Fleet Aircraft Carriers, and the more modern Battleships. The above short list is only approximate; and not complete. For example; one specialized type of ship was developed, an "LST", (<u>L</u>anding <u>S</u>hips <u>T</u>anks). It was use for landing tanks and other vehicles on an enemy's beach, (without a dock). An LST was about the size of an average destroyer, but carried a heavier load. <u>Major military undertaking were often delayed because the specialized ships and contraptions which were needed had not yet been invented; or they had not yet been produced in sufficient quantity</u>.

SUBMARINE: These ships (i.e., historically termed submarine "boats", subs, or U-boats) could dive under water to hide, and launch very effective torpedoes at the enemy, while hidden below the surface. If a sub spotted an unarmed, small enemy ship; then the sub would likely rise to the surface and use its main gun to sink that enemy. (Such gun was provided on most subs, and could thereby save a ~$11,000 torpedo). Subs had a small diameter "periscope" tube, that submariners could raise from under the water; to stick up a little above the surface; and it was small enough to generally not be detected by the enemy surface ships. In fact, most submarines had such a low profile, even while surfaced, that they could spot their high profile enemy first, and then dive to get closer for their torpedo attack. Some subs could dive so fast that, even if they saw an airplane near the horizon, they could submerge before an airplane could get to them. Some subs had a second periscope for use even when the sub was on the surface, to see a little further over the horizon. Apparently, the U.S. developed a better-than-average computer for their submarines to use to quickly give the correct angles, etc., for the best chance of hitting enemy ships depending on relative speeds, distances, size of enemy ship, etc. Those knowledgeable about it were expected to try to protect its secrets with their lives.

Most subs could go almost twice as fast when surfaced as they could submerged. This was mainly because the submarine used its diesel engines to propel it, when on the surface; but had to rely on its battery power and its electric motors, when submerged. That battery power would not take the submerged submarine very far without running out of charge; and then the sub had to surface and run its diesel engines to recharge the batteries. Subs also had "creep" electric motors, to allow the submerged sub to move very slowly and very quietly. As WW2 progressed, some U-boats were finally produced that could go just as fast under water as on the surface; and a "snorkel" was provided (sticking above the surface) to allow the sub's diesels to recharge the sub's batteries without surfacing.

Most subs had "passive sonar" so that the submerged subs could hear an enemy ship's propeller sounds, and note the direction of that enemy. Then the sub could even launch their torpedoes based on "sound only", i.e., without raising its periscope. Some German "U-boats" were so small that they carried only two torpedoes; but their smallness made them hard to detect. These would sometimes just lay quietly, and launch their torpedoes "by sound". (Even though their prey had sonar and radar for locating the subs, such subs were still hard for their prey to detect.)

Toward the end of WW2, Germany developed a "snorkel" U-boat, which could recharge its batteries using diesel engines without the need to surface periodically to do that. Especially at night; sub-hunting airplanes would find it difficult to detect the small snorkel, either with the airplane's "Leigh-light" or its radar. So first, the Allies raced to develop anti U-boat equipment and to train personnel to destroy existing subs; and next raced to win the war before too many more of the advanced enemy subs could be designed, built, and their crews trained.

Fortunately, the Allies quickly developed secret, brilliant, "code-breaking" techniques, (project "ULTRA"). That helped the Allies learn about the enemy submarines' general locations, plans, and strategy. The Allies also improved their "passive radio detection" methods; so that when an enemy U-boat surfaced and sent radio communications to their cohorts; the U-boat's directional signal could be detected. And their locations determined. (The U.S. had its own big disappointments too; for example a large percentage of U.S. torpedoes had various defects. The problem continued for over a year. The torpedoes' paths and *non*-exploding collisions helped give away our submarines' locations; and that contributed to the loss of many U.S. submarines, and great damage to many others.)

Note, like other complicated subjects; my above discourse could have some errors or be rather incomplete, and I am no expert. But readers can further read books by true professionals, for expert information.

TUSKEGEE Airmen: The services were not racially integrated in WW2. There was a lot of long-standing prejudice, and Blacks were not generally regarded as fit for such prestigious roles as "fighter pilot". But they overcame double-difficult barriers and generally performed well, anyway--an example being the "Tuskegee Airmen". (Even though they realized that had they been captured by "the enemy"--they would have been generally treated with much greater respect than in many States where they had come from.)

VICTORY Ships: Beginning early 1944, the U.S. began producing "Victory" ships, where possible, in place of some "Liberty" ships. The "Victory" ships were faster, about 16 knots, and used more powerful and advance engines, (i.e., the steam turbines totaling ~ 7000 HP). Victory ships were slightly larger than "Liberties", and about 534 were built.

WAC, WASP, WAVE, see "WOMEN":

WOMEN's Corps and other miscellaneous groups:

In WW2, many women joined various groups; for example, the "WAC" (Women's auxiliary Army Corp). The idea was to assist in many "non-combative" roles in support of the Army. And that also freed much manpower for other military needs or helped support men in military tasks. The Navy's version of that was called the "WAVE". The Army Air Force's—was the "WASP". And there was a Marine and Coast Guard version, also.

One special group of "WASPs" consisted of many women who had taken private flying lessons and learned to fly, even before WW2. During WW2, some of these women flew airplanes, from their manufactured locations, to various U.S. border points for export. And flew far more hours per week and month than normal regulations would allow, and still flew reliably. For example, women flew many airplanes to Montana; and from there, Russian or American airmen flew them to Alaska. And from there, Russians flew them to Russia (as part of the Lend-Lease program). The WASPs flew many different types of aircraft, including some with various design weaknesses, which made the airplanes difficult to handle safely. But WASPs flew them dependably. And WASPs flew airplanes with trailing targets, for airmen-in-training to shoot at.

In fact, the "WASP" women must have done their jobs "too well"; because the "good-old-boys" and their ultra conservative Congressional friends, and likely some airmen who preferred not going overseas--finally succeeded in having Congress disband those WASPs around mid-1944. Unlike their WAC and Wave cohorts; the WASPs were never regarded, nor treated, as fully in the armed forces. ((Here again, there seems to have been some very powerful "reactionary", yet subtle, elements in U.S. society, (as usual), just "below the surface, steaming, and ready to explode". And Mrs. Roosevelt, FDR, and General Marshall had to struggle to keep the lid on, lest it boil-over further and even more seriously hurt the Allied cause)).

Many women also served in factories; for example, 30% of the Liberty Ships' production forces were women; and over 50% in ammunition factories. And women served in many other constructive organizations which aided the war effort and military personnel. And in other difficult roles. (As with some other topics, there is not enough space to cover the subject well, here.)

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Return to**:** **Part III-A** (beginning WW2 discourse)