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Modern Warfare

"Can we say that in today's [wars] man is pitting his strength, skill, courage, or endurance against man? Certainly not! War has become a contest between machines, industrial enterprise, and financial organizations." Bronislaw Malinowski, Address, Harvard, September 1936.

Humans have always waged war. Alexander the Great used war to carve out an empire extending from Greece to India during the 3rd Century BC. Charlemagne reunited Europe in 800 AD, and was crowned Holy Roman Emperor. Genghis Khan's conquests created an empire in Asia during the 12th Century AD. During such conquests; strength, skill, courage, and endurance could still win the day. However, humans have also always been inventive, and through the centuries technology has played an ever-increasing role in warfare.

This is because; technology makes people better at performing actions they are already inclined towards. Give a gun to someone on the street, and they will not become a murderer. Give a gun to a murderer and they can become an "efficient" mass murderer. A similar coupling of military technology and national tendencies has also occurred. If your country started out peaceful, technology offered you a better defense. If your country had colonies, technology offered a new and improved imperialism. If your country was warlike, technology increased your capability to wage war. In short, technologies were (and are) researched, designed, and implemented to help fulfill a specific goal. During World War II; Bombers bypassed entrenched troops hitting targets in the rear, radar spotted enemy planes as they approached, and the atomic bomb brought a decisive end to the war.

However, the world is not as simple as Occam, or his razor, would suggest. Technology often works more like a shovel than a tweezers. Sure you can use it to pick out a diamond in the rough, but you will get a lot of dirt, and if your lucky some other gems, in the process. Today airlines carry passengers—not bombs—across foreign borders, radar helps detect approaching

thunderstorms, and medical doctors use radioactive isotopes to monitor body functions—quickly identifying clogged arteries and veins.

This paper attempts to examine some of the military and social impacts that have accompanied the research and development of military technology over the last hundred years. To do this we will look at not only the individual military technologies, but also the industrial establishments that enabled, or grew out of, the advances. These industries include: chemical explosives, synthetic fuels, aeronautics, nuclear power, space, and electronics (to name a few).

Chemical Explosives

In the 13th Century A.D. Roger Bacon wrote down a prescription for making gunpowder; seven parts saltpeter (potassium nitrate), five parts coal, and five parts sulfur. (R1, p.221) Whereas the Chinese had used this recipe for celebrations and religious festivals, the Europeans used it to literally knock down the aristocracy.

In 1867 Alfred Nobel, a Swedish chemist, made another advance in explosives. His invention was Dynamite. Nobel thought his new explosive was so powerful that it would bring peace through deterrence. This idea was certainly MAD (Mutually Assured Destruction), and would be picked up a Century later after mankind had invented the atomic bomb. In any case, Nobel helped establish a power chemical explosives industry, and contributed his vast fortune to fund the Nobel Peace Prize.

Across the Atlantic, in the United States, a fledgling company named I.E. Du Pont De Nemours & Company began producing dynamite for both military and civilian purposes. It provided the majority of gunpowder and explosives during every American conflict from 1800 to the present. On the civilian side, dynamite was used in mining minerals and digging railroad tunnels. It was not until the invention of dynamite that enough earth could be dislodged to construct the concrete world we are now accustomed to.

However, the company's main profits came from military sales. As such, the massive use of machine guns and artillery during World War I made the company a fortune. However, it also made the company some enemies. After the war an overzealous U.S. congressman dubbed the Du Pont family "Merchants of Death." The media ate up the story, as did American society.

How had so many brave boys been slain in the Great War? The "evil" chemical industry provided a reasonable scapegoat.

Yet, the answer was more complicated than this. During World War I a revolution in military technology had occurred. Machine guns and artillery, used in conjunction with barbed wire and chemical weapons (not made by Du Pont), had forever altered the nature of warfare. As usual, the poor bloody infantry paid the price for a combination of new technology and old tactics.

Machine Guns & The Lesson of WWI

"Guns are neat little things, aren't they? They can kill extraordinary people with very little effort." John W. Hinkley, Jr. Time, May 17, 1982.

Richard Gatling (1818-1903) developed his rapid-fire weapon in 1862. It consisted of five, or so, rotating barrels which used gravity to feed and eject shells. The rotating action cooled the barrels and allowed firing rates of up to 700 rounds per minute. (R1, p. 221) However, Gatling's gun found only limited use during the Civil War (1861-65). In the latter half of this Century, a faster and more powerful version returned as the Vulcan machine gun that is typically mounted on fighters or armored personnel carriers (although Jessy 'The Body' Ventura likes to carry one all by himself).

Hiram Maxim (1848-1916), another American, made an even greater contribution to machine gun technology. He began life working on electric lights, but after loosing an important patent to Thomas Edison he moved to England and established the Maxim Gun Company. His brother, Hudson, was also militarily inclined and developed a powerful explosive (Maximite), a type of smokeless powder, and a torpedo. Hudson's explosive company was later bought out by Du Pont. Lastly, Hiram's son, Richard, invented a gun silencer. It was later used to silence the engines on jet aircraft. But, Hiram's "Maxim Machine Gun" was the family's greatest contribution to military technology.

Maxim's gun used the recoil force generated by the round as it was fired to eject the spent shell and load the next one. The weapon had only one barrel but was water-cooled allowing prolonged use. All the industrialized nations of the world relied upon Maxim's basic design.

For his contributions to the empire, Hiram Maxim was made a British citizen and Knighted in 1901. England used his gun to slay countless Sudanese when they attacked near Khartoum. However, this and other victories were attributed to European racial superiority, not just Maxim's weapon. It surprised the generals of World War I when they discovered it could kill English, French, Germans, and Americans with the same brutal efficiency as the Sudanese.

Machine gun nests allowed a single infantryman (or group of two) to devastate dozens of men as they advanced across the open fields of World War I. Artillery also prevented rapid advances by forcing enemy troops into trenches and making intervening terrain almost impassable. Massed troops advancing shoulder to shoulder, no matter how well trained or disciplined, were simply no match for a machine gun nest with artillery support. By the end of the war it was obvious that this type of traditional, honorary, warfare was over.

Instead troops were trained to operate in small teams, using infiltration tactics, and able to take the initiative. The only notable exception to this was the Russians, who would continue to make all tactical decisions from the top down. Stalin deserves a great deal of blame for the Soviet's failing in this regard. In 1935 he purged (killed) all Bolsheviks who might threaten his power. This included the cream of leadership in the Soviet Army, erasing any memory of the lessons that had been painfully learned during the First World War. The loyal, but inexperienced replacements, exercising no individual initiative, and used mass formations caused the Russians to suffer tremendous casualties during World War II (7,500,000 Russian soldiers died as opposed to 2,900,000 Germans and "only" 400,000 American troops, W1).

To train troops to function in a multidisciplinary team oriented group capable of using their own initiative the U.S. military used its tried and tested behavioral modification technique known as "boot camp". During World War II about 6 million U.S. combat troops were trained with the new philosophy; as opposed to the rigid, repetitive, disciplined, unquestioning soldier mentality that had come before the machine gun. What effect these young men had on the U.S. economy upon returning home, or the possibility of teaching this philosophy to future generations, has not been studied to my knowledge. However, it is interesting to note that these are the types of skills one would think necessary in a society to make the transition from a "Machine Age", of repetitive mass production, to an "Information Age", of free thinking

innovative entrepreneurs. In any case, it is obvious that the machine gun forever altered military tactics, and may have altered the very fabric of society.

Synthetic Fuels

"Napoleon's dictum should be revised to fit the modern army. It moves not on its stomach but on gasoline." General Omar Bradley.

"The Kingdom of Heaven runs on righteousness, but the Kingdom of Earth runs on OIL!" Ernest Bevin in the British Parliament concerning the Middle East.

It was said that the Allies floated to victory in World War I on a sea of oil. This was a point not missed by Germany, who was not blessed with crude oil, and instead was forced to rely upon her coal reserves. For another country this lack of natural resources might have limited its war making capacity. However, Germany possessed the worlds greatest chemical industry; a cartel called I.G. Farben. Using high-pressure hydrogenation techniques, originally developed for the Haber-Bosch process to make synthetic ammonia, I.G. Farben was able to convert their coal into gasoline. A second technique, called the Fischer-Tropsch process, was able to make a diesel fuel.

With these two techniques, and petroleum from stockpiled imports and annexed Austria, Germany was able to enter World War II with its tanks, mechanized infantry, and air force operating at full capacity. This mobile firepower would not get bogged down, as had been the case in World War I, but instead would strike across Europe with lightning speed. Wherever they advanced, this military machine would "liberate" gasoline stockpiles. This fueled future conquests, and produced a new type of mechanized warfare, the *Blitzkrieg*.

Tanks & Mechanized Infantry

"I managed to get astride one of the German trenches…and opened fire with Hotchkiss machine-guns. There were some Germans in the dug-outs and I shall never forget the look on their faces when they emerged…" Captain H. W. Mortimore, September 15, 1916, commander of the first tank.

"Employment of tanks in mass is our greatest enemy." General Erich Ludendorff.

Blitzkrieg tactics used mechanized troops and tanks, in conjunction with air power, to rapidly strike across enemy territory. Field commanders had to act with individual initiative, surrounding and bypassing areas of resistance to assure the invasion proceeded forward unabated. *Schwerpunct* was another German military doctrine that preached leading strong points of forces towards the most important objective, ignoring the rest. These two philosophies made World War II unlike any war that had come before.

It is often, incorrectly, assumed that Germany's great success in World War II lay in superior tank designs. In fact, the German Panzer IIIG and IVD were no match for the French Char B1 or the Russian T-34. Germany saw early success because of an integrated system of tanks, infantry, air power, and artillery; not any lone technological superiority. It was this same integrated system that was used so effectively by the Americans during Dessert Storm in 1991. Modern warfare requires both military hardware and shrewd leadership to be successful.

After the war the U.S. still recognized the importance of mechanized warfare. Any foreign attack could only be stopped by bringing tanks and mechanized infantry rapidly to the battlefield. Out of these concerns the interstate highway system was funded by the government. The civilian population also greatly benefited from the highway system. Travel across the country was suddenly easy and fast. Winding single lane roads, like Route 66, were replaced by lane after lane of freshly paved asphalt running straight away as far as the eye could see. It is difficult to imagine the country without interstate highways, yet they owe their existence to military expenditures after World War II.

Aeronautics

"It is probable that future war will be conducted by a special class, the air force, as it was by the armored Knights of the Middle Ages." Brigadier General William 'Billy' Mitchell, 1924.

On December 17, 1903, Orville and Wilbur Wright made the first successful heavier-than-air powered flight. The longest flight of the day was a 852 feet jaunt by Wilbur which lasted 59 seconds. On May 20, 1927 Charles Lindbergh landed in Le Bourget Field near Paris after successfully crossing the Atlantic. Mankind had at last fulfilled a long desire to soar like

eagles. Yet, the aeronautics industry would not hit its stride until World War II, when the pressures of war brought rapid development.

Fighters & Tactical Bombers

"Anyone who has to fight, even with the most modern weapons, against an enemy in complete command of the air, fights like a savage against modern European troops, under the same handicaps and with the same chances of success." Field Marshal Erwin Rommel, *Rommel Papers*, 1953.

While fighters saw some action during World War I, this was only a glimpse of things to come. During World War II fighters and tactical bombers were an integral part of the armed forces. The Germans used them to first clear the sky of enemy planes, and then terrorize troops on the ground. Enemy columns could not effectively advance and counterattack when harassed from the skys. Dive-bombing Stukas also more than made up for the poorly designed German tanks. Superior French and Russian tanks littered the battlefield courtesy of the Luftwaffe. While fighters and tactical bombers were an essential part of German's blitzkrieg, they were also reshaping the war at sea.

On December 7th, 1941 the Japanese demonstrated what a swarm of carrier-based fighters and tactical bombers could do to an enemy navy. Three hundred sixty Japanese planes destroyed One hundred seventy U.S. planes and eighteen naval vessels. Yet, the U.S. was fortunate to have its two local carriers, the Enterprise and Lexington, out at sea.

The war in the Pacific became a war between aircraft carriers, not between battleships. Midway was the most decisive naval battle of the war. During it, the Enterprise, Hornet, and Yorktown squared up against the Japanese fleet. When the battle was over, the Japanese had lost four carriers while the Americans only lost the Yorktown. After Midway, the Japanese navy was outmatched, although the war would go on for several years.

Strategic Bombers

"I have seen the science I worshipped, and the aircraft I loved, destroying the civilization I expected them to serve." Charles A. Lindbergh, Time, May 26, 1967.

Strategic bombers were not the decisive military weapons that fighters and tactical bombers turned out to be. Instead they were designed to cripple a nations ability to make war and spread terror among the populace, at least that was the idea. Heavy bombers were more of a psychological weapon, than a military one. Yet, the first U.S. raid of the war, headed by Doolittle on Tokyo was largely a success. His sixteen B-25 twin-engine bombers left the Hornet on April 18, 1942, attacked Tokyo, and crash landed in China were most of the pilots were recovered. While the actual military damage to Japan was slight, it showed that the U.S. could attack their mainland, and worried the populous. In response the Japanese commander responsible for Tokyo's air defense killed himself, and Japanese fighters were transferred to defend the mainland. It also caused the Japanese to hasten their plans for Midway, the "decisive battle".

However, later bomber attacks would not seem so heroic or justified. Nighttime fire bombings of Tokyo killed more people than the atomic blast at Hiroshima. Yet, it was not clear what was gained by such an attack. Over in Germany the situation was basically the same. Strategic bombers, while they killed many civilians, did not cripple Germany's war making capacity until the very end of the war when victory was already at hand. Germany fell into a similar trap by foolishly bombing London. This only increased the British resolve.

At the end of the war the Germans developed the jet engine. While it was too little too late as far as World War II was concerned, this invention would revolutionize aviation. B52's could threaten Moscow with nuclear weapons. The Soviets had a similar bomber fleet, and both sides used MAD (Mutual Assured Destruction) during the cold war. The jet engine proved to be as efficient at carrying civilian passengers as nuclear warheads. Today's airline industry is based around the jet engine, and provides incredible mobility to the population. Jet lag seems to be another phenomenon that one can trace back to World War II.

Nuclear Power

"One has to look out for engineers-they begin with sewing machines and end up with the atomic bomb." Marcel Pagnol, Critiqu des critiques, 1949.

In 1938 Germany invaded Poland and World War II began in Europe. In 1939 Germany stopped all sales of uranium ore from mines in conquered Czechoslovakia confirming fears that they were considering developing an atomic bomb. Albert Einstein then wrote a letter to President Franklin D. Roosevelt explaining the situation. After some initial success, and America's entry into the war with the Japanese attack on Pearl Harbor, the Manhattan Engineer District of the Corps of Engineers was established. America's effort to develop the atomic bomb was fueled purely by military intentions and was dubbed the Manhattan Project.

The Manhattan Project, Hiroshima

"A tremendous flash of light cut across the sky. Mr. Tanimoto has a distinct recollection that it traveled from east to west, from the city toward the hills. It seemed a sheet of sun. Both he and Mr. Matsuo reacted with terror." John Hersey, Hiroshima, 1946.

The world's first man-made nuclear reactor was activated on December 2nd, 1942 in the squash courts under the football stadium at Chicago University. Chicago Pile No. 1 contained 40 tons of uranium, and was controlled with cadmium rods. The group of scientists, lead by Enricho Fermi, conducted the test with only theoretical physics to guide them. As the cadmium control rods were removed, theory predicted that neutrons released from the fission of uranium atoms would start a controlled nuclear chain reaction and give off energy in the process.

The safety measures, should anything have gone wrong, consisted of a cadmium rod hanging from a rope with a scientist standing at ready welding an ax. Should the reaction have gotten out of control he was to cut the rope, dropping the control rod into the pile. Ever since then the emergency shut down procedure at a nuclear plant has been called a SCRAM (for Safety Control Rod Ax Man). In any case, the experiment was a success and the atomic bomb moved into rapid development.

General Leslie Groves, of the Army Corps of Engineers, assigned Dr. Robert Oppenheimer to head the Los Alamos research center in New Mexico. This was where the design for the atomic bomb was carried out. Two other important facilities included the uranium production plant in Oak Ridge, Tennessee, and the plutonium production plant at Hanford, Washington. Both were of vital importance to the project, producing ultra-high-purity fissionable material.

At the start of the Manhattan Project, the government had asked the Du Pont Company to build the Hanford plant. Still smarting from being labeled "Merchants of Death" by the government after World War I, Du Pont was reluctant to start producing atomic bombs! However, its sense of duty won out and the company agreed to build the plant. However, Du Pont charged only one dollar over cost and relinquished all patent rights to the government. Du Pont wanted nothing to do with nuclear weapons.

On July 16, 1945 the fruits of this labor were detonated on a 100-foot tall tower in the New Mexico desert. The new President, Henry Truman, who had seceded the deceased President Roosevelt, was informed of the success of the "Trinity" bomb test. The decision was then made to end the war as decisively as possible, avoiding a possible invasion of Japan, and sending the Soviets a strong message of American resolve. On August 6th, 1945 an atomic bomb containing uranium, named "Little Boy", was dropped on Hiroshima, Japan. The blast leveled the city and killed 92,000 on impact. Three days later a plutonium bomb, named "Fat Man", was dropped on Nagasaki with similar effects. The war was over, and mankind had entered the atomic age.

Nuclear Power & MAD

"The bomb that fell on Hiroshima fell on America too. It fell on no city, no munition plants, no docks. It erased no church, vaporized no public buildings, reduced no man to his atomic elements. But it fell, it fell." Hermann Hagedorn, "The Bomb That Fell on America," 1960.

"Right now we have a theory of mutually assured destruction that supposedly provides for peace and stability, and it's worked. But that doesn't mean that we can't build upon a concept of MAD where both sides are vulnerable to another attack. Why wouldn't an enhanced deterrent, a more stable peace, a better prospect to denying the ones who enter conflict in the first place to have a reduction of offensive systems and an introduction to defensive capability. I believe that is the route this country will
eventually go." Senator Dan Quayle discussing nuclear weapons at a speech in Chicago. (reported in the NY Times 9/9/88)

With the war over, it seemed that nuclear energy might be converted to more civilian needs. Some envisioned nuclear power producing energy that was "too cheap to meter!" After the war the Atomic Energy Commission (AEC) was established. In 1957, the first full scale nuclear power plant opened in Shippingport, PA. However, as more was learned about the

effects of radiation and the hazards of the fission waste materials, public sentiment began to oppose nuclear power.

In 1979, no one was injured, but many were terrified, by a nuclear reactor incident at Three Mile Island, Pennsylvania. In 1986, Chernobyl Nuclear Reactor #4 exploded, releasing large amounts of radioactivity into the atmosphere. The disaster revealed the dangers of a poorly designed reactor. There are currently 55 nuclear plants in the U.S., but no new plants have been built since 1974. With the rapid depletion of the nations oil reserves (gone by 2010 or so), and the failure to perfect cleaner nuclear fusion, the country will have to decide between coal powered plants or nuclear energy.

Yet, after the war the military was not through with nuclear weapons. In 1949, the Soviet Union detonated its first nuclear device. In 1952 the U.S. responded by detonating the hydrogen bomb. Other nations soon joined the nuclear club, conducting their own tests. All of this saber rattling created fear among the general public. School children were taught to "duck and cover" in case of a nuclear attack. Yet, with weapons a thousand times more destructive than "Fat Man" and "Little Boy", this would have done little good in an actual exchange. The only way to survive a nuclear attack was not to be involved in one to begin with. Such deterrence was obtained through MAD (mutually assured destruction). Stockpiling massive numbers of bombs seemed the way to prevent someone from using their own.

As more and more countries joined the nuclear club, a new fear took shape. What if a terrorist organization got their hands on some fissionable material? Hopefully, they would not be able to create a bomb! In 1979 an undergraduate physics student, John Phillips, at Princeton University designed an atomic bomb for his senior thesis. His sources were all unclassified, and the final device would have weighed only 125 pounds and cost $2,000 (excluding fissionable material). While he never made the device, he showed that any reasonably intelligent and motivated individual could build such a weapon. No longer did strength exist in numbers, instead power lay with whoever had the technological know-how.

Energy and weapons were not the only developments of the atomic age. The navy, under Hyman G. Rickover, used nuclear power for propulsion. This gave the fleet greater range, less dependence upon petroleum, and allowed submarines to stay submerged indefinitely. Submarines, called boomers, carried nuclear warheads and were a significant part of MAD.

Other, less militaristic uses of nuclear physics include; Sterilization of medical products, identification of clogged arteries and veins, power plants in space probes (Voyager 1 & 2), radioactive tagging to study complex biochemistry, and radioactive dating of archeological finds (carbon 13) or the age of the earth (potassium-argon). The atomic bomb has greatly affected military tactics, civilian markets, and society's habits.

Space

"So there he is at last. Man on the moon. The poor magnificent bungler! He can't even get to the office without undergoing the agonies of the damned, but give him a little metal, a few chemicals, some wire and twenty or thirty billion dollars and vroom! There he is, up on a rock a quarter of a million miles up in the sky." Russell Baker, New York Times, July 21, 1969.

"What is it that makes a man willing to sit on top of an enormous Roman candle, such as a Redstone, Atlas, Titan or Saturn rocket, and wait for someone to light the fuse?" Tom Wolfe, The Right Stuff, 1979.

During World War II German V-2 rockets attacked London, dropping their warhead indiscriminately. After the war, the German rocket designer Wernher von Braun came to the U.S. to continue his work. However, it was the Russians who took the early lead by launching Sputnik in 1957, and Yuri Gagarin in 1961. The Americans appeared behind the Soviets. The military, seeing space as a new battlefield, felt we had lost the highest of high ground. Delivering nuclear warheads with rockets seemed a very promising technology, and would later be achieved with ICBMs (Inter-Continental Ballistic Missiles). To alleviate such fears, and show the U.S. was committed to space, President Kennedy challenged the Soviets to race to the moon, and suddenly a new organization, NASA (National Aeronautics and Space Administration) found itself with a research project to rival the Manhattan Project. The space race was on.

Space Race

"For NASA, space is still a high priority." Vice President Dan Quayle, talking to NASA employees, 9/5/90 (reported in Esquire, 8/92)

"Welcome to President Bush, Mrs. Bush, and my fellow astronauts." Vice President Dan Quayle addressing the 20th anniversary celebration of the moon landing, 7/20/89 (reported in Esquire, 8/92)

From the start, the Americans and Soviets took different routes into space. The Soviets relied upon relatively low-tech solutions to difficult problems. For example: Yuri Gagarian's capsule was simply weighed down on one side so that it would reenter the atmosphere with the proper orientation. Alan Shepard's capsule relied upon a complicated series of gas jets to perform the same task. Simple, straightforward designs gave the Soviets a large early lead, and they may have beaten the U.S. to the moon using such a philosophy.

However, Nikita Khruschev, the Soviet Premier, took control away from "The Great Designer", Sergi Korolev, to claim glory for the communist party. Khruschev insisted upon using the enormously powerful and complicated Proton rocket. Constrained with timelines dictated from the top, and therefor having to ignore reasonable quality control measures, the Proton rockets were plagued with failure after failure. Just months before Apollo 11, a Proton rocket exploded on the launch pad killing the cream of the soviet scientists. The disaster meant the Soviets had lost the space race.

Satellites & Probes

"We should develop anti-satellite weapons because we could not have prevailed without them in 'Red Storm Rising'." Senator Dan Quayle, 9/6/88 (reported in Esquire, 8/92)

"Mars is essentially in the same orbit... somewhat the same distance from the Sun, which is very important. We have seen pictures where there are canals, we believe, and water. If there is water, that means there is oxygen. If oxygen, that means we can breathe." Former Vice President (and space program coordinator) Dan Quayle

The real success of the space program lay not in the political victory of reaching the moon first, nor in the "spin off" technologies such as Tang and Teflon, but instead with the satellites and probes that have been deployed. Spy satellites give our military detailed knowledge of happenings in other countries. It would be virtually impossible today to launch a major surprise attack against the U.S. (although the Iraqi's were able to do so to Kuwait). Knowledge of enemy movements means security.

Weather and communications satellites also improve life for the common citizen. Knowing about an approaching storm, such as Hurricane Andrew, can save many lives. Communications satellites, used in conjunction with electronic equipment, allow instantaneous communications from the remotest parts of the planet. Probes to other planets reveal details

about the solar system, and even unexpected knowledge about earth. It was a study of Mars that first revealed the possibility of an ozone hole on our own planet, and Venus is an ominous reminded of where a run-away greenhouse effect can take us. Another beneficial system is GPS (Global Positioning Satellite), which guides travelers and helps the military deploy and control troops.

Electronics

"After the year 2015, there will be no airplane crashes. There will be no takeoffs either, because electronics will occupy 100 percent of every airplane's weight." Norman R. Augustine, President and CEO, Martin Marietta

Each year, electronics play a larger and larger role in our lives. We spend more of our time with the TV, radio, telephone, and computer. As communications improve, travel seems almost unnecessary. Why go to work when you can do your job from home? Why go to the store when you can shop from your couch? For the military also, electronics have revolutionized the way they do business. Command, Control, and Communications (C3) are infinitely easier when you have instantaneous access to the location and status of all your troops and all those of the enemy! The electronic battlefield separates the technological haves from the have-nots. As shown in Desert Storm, the have-nots cannot compete with electronic assisted C3.

Radar & Sonar

"A destroyer was patrolling a strait, and picked up a large, unidentified radar target. The destroyer challenged the unknown on the radio: 'Vessel off my starboard bow, radar indicates you are on collision course with me. Please identify yourself and alter course.' The response came back: 'Collision course confirmed. Suggest you alter your course. This is a lighthouse.' " Anonymous.

The Battle of Britain was won because of radar, not superior aircraft or pilots. Despite relatively inferior electronic equipment, the British were able to establish an integrated radar system. It allowed them to detect the heading and range of approaching German aircraft. British fighters could than be deployed to intercept. This type of C3 capability had never before been utilized with an air force. It allowed the British planes to fight off a numerically superior enemy

by being in the right place at the right time. Today AWACS planes, which are essentially flying radar platforms, give such C3 capabilities to our air force no matter what theater it is operating in.

Sonar (both active and passive) was another technology that grew out of World War II. Leonardo Da Vinci had once observed that if one places a cup in the water and listens, one can hear an approaching ship at great distances. During World War II just such an approach was necessary to detect enemy submarines that were strangling off shipping lanes. Once again an electronic technology greatly enhanced C3 capabilities, but this time for the navy.

After the war both sonar and radar found more civilian uses. Radar is used to guide aircraft, avoiding midair collisions, and can detect approaching storms. Microwave ovens and radio astronomy are both related to radar technology. Sonar is used to map the floor of the ocean and watch the progress of unborn babies.

Computers & The Internet

"Man is still the most extraordinary computer of all." John F. Kennedy, speech, May 21, 1963.

"[The] Internet is so big, so powerful and pointless that for some people it is a complete substitute for life." Andrew Brown

During World War II the government became interested in using computers to generate ballistics tables. The ENIAC was created from such funding, and its inventors went on to build the first mass produced computer, the UNIVAC I. Later, integrated circuits, known as computers on a chip, would find their way in to all manner of military weaponry. Guidance technology has been revolutionized by the computer. Today a lone F117A, using laser targeting and computer guidance, can destroy targets that would have required swarms of B17's.

Yet, it is Command, Control, and Communications that have reaped the greatest benefits from computer technology. With the use of networks, and eventually the Internet, computers were not just for number crunching anymore. The Internet was originally funded almost exclusively by the military. Its lack of any central control was designed to prevent total system failure during a nuclear attack. Yet, it is this same lack of central control that is now making it almost impossible for the government to restrict the types of information transmitted. Relays view censorship as the equivalent of a nuclear attack and simply route around it.

With advances like the Internet, the line between communications and computers blurred. Information transmission is suddenly both instantaneous and "shiftable", meaning it can be obtained at the users convenience. The enormous popularity of the Internet suggests that this new way of communicating may change the fabric of society. However, it is still difficult to separate hype from historical events. In any case, electronics as a whole have certainly changed the American lifestyle.

Summary & Conclusions

"Before we give you billions more, we want to know what you've done with the trillion you've got." Les Aspin, Armed Services Committee, to Defense Secretary Weinberger, New York Times, October 4, 1985.

World War I & II were total wars that pitted entire nations, not just armed forces, against one another. The outcome of these wars was determined not just by the soldiery, but by the military technologies employed. Machine guns, tanks, aircraft, atomic weapons, computers, even the origins of the space program were developed during the great wars. These advances in turn altered not only military practice, but society itself. Interstate highways, airlines, and the Internet can be traced back to military expenditures. Surly warfare has enriched our quality of life through technological advances…

Yet, there is a problem with this logic. It assumes that none of these advances would have occurred without warfare and the associated military expenditures. Many of the advances, like radar and the computer were already being development before the war. Military finances simply speeded their completion. It seems unlikely that airplanes would still be blind during flight or engineers would still be using slide rules had it not been for World War II. We must guard against glorifying warfare for accomplishments it does not deserve. For, in modern total war the military is mobilized, industry is galvanized, and science and technology are hypocrisized.

Works Cited

(B1) Bronowski, J. *The Ascent of Man*. Little, Brown, and Company: Boston, Massachusetts, 1973.

(B2) Bunch, Bryan & Hellemans, Alexander. *The Timetables of Technology: A Chronology of the Most Important People and Events in the History of Technology*. Simon & Schuster: New York, 1993.

(B3) Burke, James. *Connections*. Little, Brown, and Company: Boston, Massachusetts, 1978.

(B4) Burke, James. *The Day the Universe Changed*. Little, Brown, and Company: Boston Massachusetts, 1985.

(C1) Copp, Newton & Zanella, Andrew. *Discovery, Innovation, and Risk: Case Studies in Science and Technology*. MIT Press: Cambridge, Massachusetts, 1994.

(C2) Cross, Gary & Szostak, Rick. *Technology and American Society: A History*. Prentice Hall: Englewood Cliffs, NJ, 1995.

(K1) Krammer, Arnold. Operation PLUTO: A Wartime Partnership for Petroleum. *Technology and Culture*, July 92, 33, 3.

(L1) Layton, Edwin T. *Technology & Western Civilization: 19th & 20th Centuries*. Beckwith Copy Center: University of Minnesota, 1996.

(L2) Layton, Edwin T. *Technology & Western Civilization: Renaissance to Industrial Revolution*. Beckwith Copy Center: University of Minnesota, 1994.

(R1) *Reader's Digest Book of Facts*. The Reader's Digest Association: Pleasantville, NY, 1985.

(W1) *World Book Encyclopedia*. World Book-Childcraft International Inc.: Chicago, 1984.