Science, Technology

And The Civil War

How They Changed Each Other And

Influenced The World To Come

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A conflict unlike any other before or since

The war that tore us apart, claiming my great-great grandfather and more than 360,000 others, made numerous and surprising changes to America's realities, expectations, and its course toward the future. In the very moment the North achieved hard-fought victory over the South, an assassin's bullet left us with a Southern President. Old assumptions of the antebellum period were cast aside both by the press of time and force of arms. Virtually every established order was upset not just by the war itself but also by the difficult reconstruction years that followed. Everything, it seemed was turned upside down.

This is the first war made real to subsequent generations through the power of photography. And echoes of so many prematurely silenced voices can still be heard on debates about Confederate flags, slavery reparations discussions, the natural divide between North and South and even in vernacular expressions such as "sideburns." But what did the war contribute to science? Fact is, little discussion is given to science and its progress during the American Civil War. Some view the conflict mostly an interruption to scientific progress.

However others might draw the conclusion that the war was in fact a springboard for progress in areas that would be significant in many aspects of life over the coming years.

Midway through the 1800s, the United States was in the midst of a scientific boom (Bruce, 1987) that would have an impact through even the 20th Century. The Civil War, coming when it did, clearly reflected a number of the discoveries and inventions brought forth through the pursuit of scientific and technological advancement. With unparalleled domestic destruction and a long, difficult aftermath it is natural to look for areas of good. Which begs the question: Did the Civil War help to advance the cause of science or was it an interruption to an increasingly fertile scientific period? Did the understandings of the late 19th Century and 20th Century Americans have of their world become richer because of exigencies of war?

To those questions there is no resounding “yes” but many answers of varying degrees of exactitude. Most point to progress, which could only come about through that essential combination of necessity and technological potential. The Civil War was important in spawning or introducing repeating firearms, aerial surveillance, the use of rapid transport methods over rail and various other innovations that changed the way battling armies faced each other. Inventors made numerous appeals to the War Department and even Lincoln himself in an effort to cash in on the war or make sincere contributions to the effort.

While some say that the Civil War interrupted an otherwise fertile scientific period (Bruce, 1987) others call it the first modern war, even the first *scientific* war (Reingold, 1976; Bruce, 1987; Arnold and Wiener, 2001). It was, at the very least, the ultimate proving ground for so many new technologies from the first rapid troop transport by train (Confederate forces to First Manassas) to the strategic and tactical use of the telegraph (Arnold and Wiener, 2001). So, although the impact of the Civil War did not produce tectonic shifts in the understanding, practice or teaching of science, its very nature forced new ways of thinking. In the end, it had a significant impact not only on munitions and military science, but also on commercial endeavor, medicine and many other fields that apply science.

Mid-Century America and its increasingly scientific perspective

Faith in Science was pervasive in nearly all aspects of mid-19th Century life. People recognized the possibilities for solving long-vexing problems relating to medicine, transportation, agriculture and more. People of that period shared the view that science and scientific enterprise could significantly improve their lives (Goldstein 1994; Rosenberg 1976). What's more, they saw a natural link between technological progress and morality, believing that if the Burmese, for example, could not produce a steam engine it must be because they lacked evangelical Christianity (Rosenberg, 1976).

Science was playing a part in the debates over the most incendiary issue of the time as well. It used methods like measuring cranial capacity of five races; statistics citing declining fertility of mulattos, and other ethnological "studies" designed to bolster pro-slavery arguments (Will, 1998). Antebellum America's growing inclination toward statistics, quantification and numeration pervaded everything from commerce and social programs to penal reform and temperance to humanitarian pursuits (Cassedy, 1992).

Science had an important role in the nation's expansion, too. Along with widespread exploration of the country's topography there were consistent and ongoing efforts to uncover more and more about what comprised our natural world. Botany studies, fossil explorations and other examinations of the natural sciences were conducted throughout the expanding country (Bruce, 1987).

Of course, science and the military had many natural linkages. While the army's efforts sought new ways to exploit the country's natural endowments for strategic purposes the navy launched numerous expeditions between 1847 and 1860 with at least some stated scientific purpose touching every continent. Ranging from species gathering to cosmological and topographical work, the Navy's efforts were prodigious compared to the Army's work during this time. Not only did this bolster America's scientific reputation, it played a role in helping to assure peacetime appropriations for the Navy. In addition, it had a natural role in helping to expand and simplify maritime trade and commerce (Bruce, 1987). New ways of shrinking distance had become commonplace. Along with travel innovations such as steamships and rail transit, the telegraph was invented by Samuel Morse, assisted by the innovations of others including Joseph Henry.

As perhaps the preeminent American scientist of the era, Henry had a hand in a number of key innovations including both electric magnets and the electric motor (Sherman, 1999). Later, he would be involved in the war effort as a key advisor in scientific matters to the War Department, Navy and the President himself. It is difficult to speak about American science during this period or of Joseph Henry without mentioning a centerpiece of America's emerging scientific "self" without mentioning the Smithsonian Institution.

Born of the largess of an Englishman who never visited U.S. shores (but was later entombed here), the Smithsonian began in 1846. While the Smithsonian may have been originally envisioned as an American version of Britain's Royal Society, its many creators intended it to serve alternatively as a museum, university and observatory. Initially the Smithsonian was dubbed an "institution" responsible for the vague directive to "increase and distribute knowledge" (Smithsonian, 2004).

Early years saw the Smithsonian attempt to extend itself well beyond Washington through a nationwide network of correspondents (Goldstein, 1994). Throughout the 1850s, the number of correspondents grew nationwide based on the desire of founders to extend Smithsonian's work in earth and life science. Correspondents were used to increase and to distribute that knowledge more widely. The people participating in the program were typically those who pursued science though their work in medicine, dentistry, pharmacy, but also as clergymen and as hobbyists. Though few in number, some correspondents such as Rochester, New York's Henry A. Ward even operated businesses devoted to scientific activity (Goldstein, 1994).

The Smithsonian also found itself used for purposes apart from the advancement of science. For example, it would become the focal point of abolitionists early in the war during another collision between science and the issue of slavery. One famous example has Joseph Henry closing the institution's large lecture hall to the famous and wildly popular Washington Lecture Series because it had become a forum for radical abolitionists pushing Lincoln to make the war about abolition, first and foremost (Conlin, 2000).

Lincoln: The scientific President

> "He would stop and stand in the street and analyze a machine or other thing—mechanical or other power as exhibited in a wagon—a threshing machine—or a lightning flash…Clocks & words—omnibuses and language—paddle wheels and idioms never escaped his observation"—William Herndon, Lincoln's Law Partner (Havlik, 1977, p. 3)

When Abraham Lincoln was shutting down his law practice in 1860 his final case prior to making the trip to Washington was a patent matter. Lincoln, by the account above and many others, was a man fascinated by science and its practical applications. Indeed, he remains the only president to actually hold a patent— No. 6,469 for a device to lift boats over shoals (Havlik 1977; Dobyns 1994). Though his efforts as an inventor were frustrated (his device never was manufactured), Lincoln continually demonstrated a passion for innovation and achievement.

He was fascinated by military technology, personally tested guns and kept his hands in virtually everything relating to advancing the Union cause through science and technology. During his time in office, Lincoln was continually besieged by inventors of all kinds, from all parts of the country as well as around the world. Inventions and ideas were directed to him, presumably because the bulk of writers had no idea who else to approach. The White House received numerous letters as well as personal visits, the latter approach being far more effective at getting the President's attention. Among reasons given for Lincoln's patient indulgence toward many of the creative petitioners was that he genuinely appreciated the necessity to encourage development and use of better tools of war. Another view was held by presidential assistant John Hay, who believed simply that Lincoln enjoyed the company of "men of some originality of character, not infrequently carried to eccentricity" (Bruce, 1956, p. 81).

Lincoln was no stranger to Joseph Henry and the Smithsonian, either. An amusing story tells of continuing tests of calcium lights set up to flash Morse code. After viewing several nights of demonstrations, Lincoln was interrupted in conversation with Henry and others by an irate citizen who had been made aware of Henry's "seccesh" leanings. His tattling on the treasonous signals he spied from the Smithsonian elicited this response from the President who said solemnly, "This is Professor Henry; perhaps he will be able to answer for himself' Then he burst out laughing" (Bruce, 1956, p. 85).

The fact that science and technology were spurred to new heights or at the very least in new directions is undeniable, given the numerous changes that took place in munitions, tools and healing. The degree to which an interested, engaged president accelerated these efforts is unclear. We do know that Lincoln was the key behind approving, encouraging or acquiescing in several major developments that would (Bruce, 1956; Reid, 1997) place new firearms and other technologies into service. These at least make it clear that he did seek out practical value in the invention of the time. It was practicality he may have hoped would save his country.

Firsts in firepower and ground conflict

As the Civil War began, the tools that men of the Union and Confederacy used did not differ significantly in effectiveness from those used nearly 100 years earlier. Percussion cap ignition proved a more reliable method of igniting the powder charge, but in large measure, the Americans who faced each other did so initially with smoothbore muskets. These weapons were best used at close range and even then not with a high degree of accuracy.

But the real problem for a soldier was not the limited range or limited accuracy of these weapons, but the highly tedious and ultimately dangerous process of loading them. The soldier would have to first use his teeth to tear open a paper cartridge containing both the powder and ball. Then he would have to pour the powder down the barrel (Bruce, 1956). Next he would start the ball down the barrel with his thumb before drawing his ramrod out in a two-movement process necessitated by the length of the barrel and ramrod. After pushing the ball down the barrel in another two-movement process he would withdraw the ramrod and reinsert it in its place beneath the barrel. He would then cock the gun, remove the old percussion cap and put on a new cap. Finally, he was ready to fire.

To a modern observer the process might seem incredibly time consuming. And the fact that some soldiers were capable of repeating these procedures up to three times a minute is nothing short of remarkable, given the distractions of black powder smoke and anguished cries of stricken comrades and foes. What makes this inefficiency even more hellish is that it was in all likelihood unnecessary.

Breechloading weaponry along with the idea of repeating arms is one idea whose time had clearly come, despite the fact that the technology—though available—saw limited use. Lincoln himself was involved in testing numerous weapons and (Bruce, 1956) including the Marsh and Sharps breechloaders and the Spencer repeating rifle. Many of these tests took place at Treasury Park, not far from the Whitehouse. Lincoln was well aware of both the tediousness of the muzzleloader and the potential offered by breechloading, especially the repeaters. So, he personally saw to it that bureaucracies were removed for the likes of Spencer and others wishing to secure government contracts. Nonetheless, the standard muzzleloaders continued as the primary infantry weapon throughout the war. One thing hindering progress was the desire of Chief of Ordnance, James Ripley, for consistency of caliber and other uniformity. Some even believed that the more efficient arms would lead to a wasting of ammunition.

What might be the most significant advancement of the war was not in a gun, but in the area of ammunition, specifically the increased use of the conical-shaped “minie ball” introduced by the Frenchman, Claude Minié years earlier. The minie ball and rifle musket gained increasing use as the war wore on, resulting in encounters that typically were a bit more tactical in nature. Greater accuracy meant fewer close encounters. The close-up slaughter of buck and ball battles of the early war was reduced somewhat as the rifle-musket and mine ball became more dominant.

Both Confederate and Federal troops dealt with other issues that tested scientists of the day. Most notable was concerns for nitre supplies (a necessary ingredient in gunpowder). The South felt its supplies threatened by the destruction brought on by Yankee forces (Donnelly, 1956) and employed scientists from both civilian and military ranks to the search for nitre or a replacement. The North on the other hand was relying on nitre from India and felt its supply threatened by the possibility of hostilities from England.

By the end of the war, repeating rifles, breechloading long guns and cannons were beginning to make their presence felt. The Union Army ordered more than 9,000 breechloading rifles and more than 80,000 breechloading carbines, some of which were employed by Hiram Berdan's "Sharpshooters" (Reid, 1997) (though the name is said to relate to the accuracy of the marksmen not the firearms). Along with these, the repeating Spencer rifle, capable of firing seven rim-fire cartridges, was ordered in fairly significant number by the end of the war—more than 77,000 carbines and 12,000 rifles (Bruce, 1956). In addition, the advantage of repeating fire extended to revolvers of which more than 160,000 were sold.

But if repetition represented efficiency it also increased raw killing power. Perhaps the most deadly was the forerunner to the machine gun. In 1866, the U.S. army ordered 100 50-round Gatling Guns—too late for impact in the Civil

War. These, the product of inventor Dr. Richard J. Gatling, were like most arms inventions, products that combine earlier principles and technologies (Reid, 1997). First tested in 1862, the gun combined the hand-cranked idea of the "coffee mill" gun with other recent developments including copper rim-fire cartridges. The first large scale orders coming just after the war gained worldwide attention no doubt because as the Montreal Gazette observed in 1867, "This terrible weapon…can be discharged at the rate of 200 shots per minute" (Reid, 1997, p. 221). The Gatling Gun, with its deadly efficiency would win converts among many armies and set the stage for automatic weaponry such as machine guns

> "Because the unit of scientific achievement is the solved problem and because the group knows well which problems have already been solved, few scientists will easily be persuaded to adopt a viewpoint that again opens to question many problems that had previously been solved. Nature itself must first undermine professional security by making prior achievements seem problematic." (Kuhn, 1996, p. 162)

The challenges to which the Union and Confederacy were subjected resulted in an upending of established warfare principles. No longer were the tactics of smoothbore muzzleloaders with large balls and several smaller shot—known as "buck and ball" enough once enemy forces had to confront the accuracy of the minie ball or the efficiency of repeating and breechloading weapons.

Throwing larger and larger numbers of men against greater and greater destructive power seemed to assure that this conflict may forever remain our most deadly national conflict. And from the time Fort Sumter fell, it was clear that classically designed forts would never hold up under modern bombardment.

Thus was born the idea of earthwork fortifications, which would become the norm for the next century's warfare late in the war.

U.S. Grant described another type of earthworks encountered by his troops in the summer of 1864:

> "The enemy's line consisted of redans occupying commanding positions, with rifle-pits connecting them. To the east side of Petersburg, from the Appomattox back, there were thirteen of these redans extending a distance of several miles, probably three. If they had been properly manned they could have held out against any force that could have attacked them, at least until reinforcements could have got up from the north of Richmond. Smith assaulted with the colored troops, and with success" (Grant, 1886, p. 295).

Desperate Southern troops devised another low-tech but enduring innovation in kneeling trenches and field fortifications (Arnold and Wiener, 2001). Without question, the professional security of those behind Civil War fighting tools and methods was undermined—continually. The science of war simply had to change.

Why science gained ground in the Navy

That U.S. and Confederate Soldiers continued to fight each other with smoothbores and rifle muskets despite the fact that products such as the Spencer and Henry repeater would have greatly simplified their work on the field. In other areas however, the warring armies deployed new technologies in an attempt to outflank each other strategically. One area where this occurred is in the area in naval operations.

Early in the war, the Federal Navy was besieged by inventors motivated by a unique combination of patriotic fervor and greed. To help match the needs of the navy with the enthusiasm of potential suppliers, Navy Secretary Gideon Welles established a naval permanent commission to advise the Navy (which counted Joseph Henry among its members). Welles' instructions stressed that recommendations should "state the advantages and the economy that will result from its use and the total expenditure that it will occasion" (Reingold, 1976, p. 163). Perhaps the most urgent matter faced was occasioned by one of the most famous patents in the tiny Confederate Patent Office—Patent 100 for the CSS Virginia, better known as the Monitor (Dobyns, 1994).

This invention was particularly threatening to the Union because of the location of the project at the far mouth of the Chesapeake Bay. Such a looming threat meant the Northern forces would need to counter with its own ironclads. So in August of 1861, Congress authorized $1.5 million to begin its ironclad project.

The innovation of iron cladding and the proximity of the Confederacy's project upended security in a way that forced the Union to a more scientific perspective in preparing for naval defense. It is said that the Navy was more innovative than the Army during the Civil War because this is the only area in which the Confederacy threatened the Union with novel devices such as the Merrimac/Virginia (Reingold, 1976).

This aspect of the conflict that made the war "scientific" made it essential that the best scientific minds work to improve existing or devise new weapons, equipment and processes. As with standard understandings of scientific wars new or drastically improved weapons then appear in battle with significant enough presence to alter the tactics and strategy of the armed forces (Reingold, 1976).

The design for a Union ironclad that ultimately won approval was that of John Ericsson—a low freeboard vessel with the world's first steam powered revolving turret (Arnold and Wiener, 2001). This smaller, more nimble ironclad came just in time, too. The Virginia had just destroyed the wooden frigates Congress and Cumberland, which had been blockading Hampton Roads, Virginia on March 8, 1862. The initial Monitor steamed hurriedly down from New York and fought the Virginia to a draw on March 9, greatly relieving a nation that was becoming uneasy over the South's short-lived naval superiority (Reingold, 1976).

The awarding of a contract to Ericsson's syndicate spawned numerous plans and proposals for copying or improving the basic Monitor design (Roberts 1999). There was immediate request from the navy for numerous additional Monitor class ships, based on the Ericsson design (Roberts, 1999). Of course, the full embrace of ironclads brought its own problems, which required further scientific attention, one example being the employment of scientists to work on ways to prevent corrosion and other problems unique to Ironclads (Reingold, 1976).

Innovation on the Southern side went well beyond the C.S.S. Virginia. Before it sunk, the short-lived submarine Hunley was responsible for a naval first with the torpedo sinking of a Union sloop. And thanks to another bit of Confederate cleverness, the Union ironclad Cairo was the first victim of an underwater mine—five gallons of black powder encased in glass and activated by a friction primer, all hidden beneath the water's surface (Arnold and Wiener, 2001). From the Hunley to the numerous ironclads and small artillery boats, naval activities served to advance the art of seagoing warfare—both on inland waters and in the Gulf of Mexico and Atlantic. The technology of metal armor on ships may have given the Confederate Navy a brief advantage, but the resources the Union was able to bring to bear won out. So the outcome it seemed was following patterns similar to the land conflict. Southern pluck and daring were defeated by larger, more resource rich northern forces (Arnold and Wiener, 2001).

The Union "Air Force": New heights in reconnaissance

The world was introduced to the possibility of independent flight via balloons in the late 1700s. And like so many other examples of commercial or scientific progress, flight eventually found its way into warfare. And while most assume that World War I saw the first use of military flight, balloons were actually deployed by the French in the Battle of Fleures in 1794. In the U.S., the notion of using balloons for reconnaissance, was conceived and recommended by TSG Lowe (Bruce, 1956).

Lowe who had caught the interest and attention of Joseph Henry had both the ballooning methods and personality gifts to gain the attention of the War Department who instructed him to proceed with a balloon containing 20,000 cubic feet of gas (Squires, 1937). In the first summer of the war, Lincoln and Henry saw the first successful military air force in American history. Over the next few years Lowe presided over a corps of balloons that was used effectively throughout Virginia and the Carolinas (Bruce, 1956). Championed by then commanding General George McClellan and others, his program had wide early support. In addition to scouting and espionage, Lowe pioneered the idea of aerial photography, including magnifying the images through various combinations of lenses and glasses (Squires, 1937). He also made the first aerial telegraphy just over Washington in 1861 one week after selling Lincoln on the concepts of both airborne reconnaissance and air-ground communication, reading in part:

> “The city with its girdle of encampments presents a superb scene—I have pleasure in sending you this first dispatch ever telegraphed from an aerial station in acknowledging indebtedness to your encouragement for the opportunity of demonstrating the availability of the science of aeronautics in the military service (Bruce, 1956, p. 86).”

Military use of balloons soared during McClellan’s leadership but declined after his command ended. Though perhaps a victim of changing political fortunes, Lowe’s program had proven the benefit not only aeronautics as a method for reconnaissance as well as the merits of aerial photography and sky-to-ground communication. These would become essential tools in later wars, lending significant credibility to the notion that Civil War was both the first scientific and first modern war.

Medicine. New tools for the healing arts.

Total U.S. dead: 360,222.
- Battle: 110,070.
- Disease (etc.): 250,152.

Total C.S. dead: 258,000

Battle: 94,000.
Disease (etc.): 164,000.

(civilwarhome.org, 2004)

It seemed that throughout the Civil War, death was truly the only certainty. In the Wilderness Campaign near the close of the war, Union forces alone suffered 17,666 casualties. With battle deaths and disease rampant, the need for medical attention was pervasive. Not only did the war lead to a swelling in the ranks of medical personnel from little more than 100 at the start of the war to thousands by war's end, it created hundreds of semi-permanent and ad hoc hospitals (civilwarhome.org, 2004). So, the operation of medical societies, medical education, peacetime statistical operations and other humanitarian activities was greatly diminished due to the press of war.

Washington became an encampment of hospitals, numbering up to 50 by many accounts (Cassedy, 1992). Part of the U.S. patent office was among facilities given over to the treatment of wounded and ill. In Richmond, Chimborazo Hospital with over 200 buildings became the largest military hospital in history, capable of treating 10,000 at a time (Arnold and Wiener, 2001). In addition, hospitals sprung up in numerous other cities close to the various theaters of operations.

Along with ad hoc facilities on or near the various, and constantly moving battlefields, these facilities processed hundreds of men suffering from diseases such as dysentery, which killed more than 35,000. The Civil War changed medicine in other areas, too, spawning the field of neurology and introducing widespread use of anesthesia. Necessity begot other inventions, as the North introduced the first ambulance trains to quickly transport large numbers of wounded away from battle areas (Arnold and Wiener, 2001).

Another noteworthy efficiency brought to medicine was the support generated though the non-governmental United States Sanitary commission. Organized throughout the North, the commission supported hospitals and other medical needs throughout the country with bandages and numerous medical necessities. The commission was supported through huge fairs designed to appeal to both a desire for entertainment and wish to aid the cause. By some accounts, the fairs funded the commission with the then staggering sum of $4 million (Thompson, 1958).

A more scientific orientation toward medicine was also driven by the application of statistics to the field. The first battle of Bull Run was the focus of an early statistical investigation into the sanitary and medical inadequacies hindering the Union cause. Undertaken by a Boston statistician who just happened to be in the Washington area during the time of the battle, a survey of 75 questions and items of information produced information compelling enough to convince authorities of the value of statistical expertise in scientific work. Camp and hospital medical information was channeled to a new statistical bureau for tabulation and analysis (Cassedy, 1992).

Medicine also became an area where women could play an essential role. They provided the labor, energy and much of the funding for the Sanitary Commission as well as “ladies aid societies” in the south (Arnold and Wiener, 2001). Along with increasing use as nurses (and doctors in limited cases), women became leading advocates for certain health reforms. One of the country's first female physicians, Elizabeth Blackwell was one of several key proponents of an effort to upgrade the quality, safety and effectiveness of hospitals. Based on principles advocated by the well-known Crimean War nurse, Florence Nightingale, hospitals were to be built according to several key criteria. These included introduction of female nurses, construction and management according to sanitary principles plus the continuing use of numeration and statistical analysis (Cassedy, 1992). Criteria such as these not only underscore the stark reality of death, disease and the perils of unsanitary conditions, they clearly contributed groundwork for overall improvement in our understanding of ways to cure the wounded and diseased. While not remarkable as scientific achievements, these moves undeniably led to improvement in the human condition in years to come.

Advancing in separate columns

The science of 150 years ago was an endeavor that appears far more egalitarian and down-to-earth when contrasted with 21st century notions of the field. Scientists of the day were likely to be little more than enthusiastic gardeners, seed growers, hobbyists, and geologists. The field, however, was united through a number of different organizations, including the Smithsonian and the American Association for the Advancement of Science (AAAS). The years prior to the war saw significant growth in AAAS membership.

Once the war began, it immediately consumed not only material resources and manpower, but the mental energy of scientists as well. Southern scientist Joseph LeConte lamented that “The absorption of the mind in the war and its possible results made abstract thinking and writing seem an absurdity if not a crime” (Bruce, 1987, p. 282). The field had similar impacts in the North. Henry observed that all thought seemed to be absorbed by the war effort (Bruce, 1987, p. 282). The consequences of war affected science in a less direct but no less significant way, too. Depression raged through the North and South early in the war forcing reduced revenue and closing numerous businesses.

The AAAS went dormant. Conferences and meetings of numerous societies and organizations were cancelled. War’s economic effects damaged or destroyed local scientific groups like the Cleveland Academy of Natural Sciences and Indiana Association for the Advancement of Science and took many members from others like the Boston Society for Natural History. Those colleges that found their enrollment seriously eroded were probably fortunate considering that some scientific facilities at Virginia Military Institute or the College At Charleston met with outright destruction (Bruce, 1987).

Interestingly the Civil War may have been such a preoccupation that scientists said very little about one of the most pressing topics in the field—Darwinism. Well known Louis Agassiz spoke up against the concepts presented by Darwin while Asa Gray was known for his defense (Ruse 1999). Gray, through his book reviews, kept the topic of Darwinism and evolution alive in the American Journal of Science. Part of Gray’s argument centered on its compatibility with religion and its growing acceptance by European Scientists (Bruce, 1987).

Advancing science commercially and educationally

In the North, the year 1862 produced a flurry of activist legislation. Included in this war-inspired fit of change was an act establishing land grant colleges, setting the stage for many large, modern day state universities. The agricultural colleges have played an important role in the twentieth-century growth of American agricultural productivity, with its economic, social, and demographic impact. Equally important, many of the precedents for government designed and supported research—and the ramifications of this dependence for the scientific community—were forged most prominently in the agricultural colleges and experiment stations. Though perhaps not spurred by war, the Congress was certainly not hindered by possible objections from the south when it enacted legislation establishing the agricultural department and the national academy of sciences (Bruce, 1987).

If the Civil War indeed stifled the regular activities of the scientific community of the mid 1800s, that is certainly not clear from looking at the increase in patent recordings. During 1865 (a partial war year, no doubt reflecting inventiveness of the several prior years) the U.S. Patent Office saw a 40% increase in overall patents compared to any prior year. In all the patent office granted 16,051 patents during between 1861-1865. By contrast, the short-lived Confederate Patent Office granted only 266—more than half of which were devoted to war-related items. Two years after the war's end, as progress accelerated, the U.S. Patent Office granted 13,015 patents a new record and far outstripping the 10,000 issued in the office's first 46 years of operation (1790-1836) (Dobyns, 1994). Thus, in the aftermath of war, it was clear that the U.S. economy was benefiting from a new kind of technological energy. One small example is Glidden and Sholes invention of the typewriter, mass produced by war contractor and arms maker E. Remington & Sons (Rehr, 2004), just one of many manufacturers adapting itself to peacetime production.

Conclusion: Advancing Life And Its Destruction

Historian Robert V. Bruce presents the Civil War as an interruption to scientific progress of the middle 1800s. And evidence shows that the war did have direct, detrimental effects on many of the scientific pursuits taking place at the time (Bruce, 1987). But viewed from a wider perspective that comes with the passing of many decades, it is obvious that the war was also productive for the field of science—not so much because it advanced scientific pursuits but also because its destruction knocked away old assumptions and barriers to progress. With the war came new perspectives on areas such as medicine, military technology, naval design, industrial production and other areas of discovery and progress. The unprecedented acceleration in patent filings between the beginning years of the war and 1867 tells of a nation energized to achieve scientifically and technologically.

While the pioneering efforts of people like balloonist TSG Lowe ultimately faded away, they also produced progress and imitative in unintended ways. His observational and reconnaissance efforts surely planted seeds for the future as his efforts are known to have caught the attention of German inventor and businessman Ferdinand Zeppelin who first discovered flight as a young military observer for the Union army. The famous Graf Zeppelin—although significantly different in principle than airplanes—was viewed as a likely vehicle for long distance air travel.

Tests of the various repeating rifles ultimately won converts throughout the military. Both the Spencer and the Henry rifles (the latter designed by B. Tyler Henry) found themselves the properties of Winchester Arms (Bruce 1956; Reid 1997), known for the lever action guns that "won the west." Indeed, by the time of the Spanish-American War just over 30 years later, the standard Military Issue Firearm was the Krag—a repeater. Just as the Civil War marked the end of reliance on muzzle loaders and black powder in warfare, its introduction of Gatling Guns would see the devices in use worldwide within 20 years and spawn development of even more efficient killing machines.

This was unlike any conflict fought before or since—combining battle styles of past eras with increasingly deadly tools and methods. The catastrophic results were accompanied by widespread changes in how people viewed warfare and the way that combatants sought to improve their odds. It is at this point in history where technology and science began to play the key role that has only accelerated to modern times. The Civil War was fundamental to our understanding of human warfare and pivotal to the way science and technology "learned" how to change to help us cope with it.

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