

MARKETING THE BREECH-LOADER:

Weapons Manufacturers and Vested Social Interest
in Civil War Era America

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Introduction

In 1776, a British Regular Army Captain named Patrick Ferguson set out to solve certain problems associated with muzzle-loading firearms. One of the main issues with muzzle-loading firearms was their relative inability to create a snug fit of the musket ball in the barrel of the weapon. Without a snug fit, the weapon was susceptible to severe windage, where a portion of the blast escapes around the musket ball resulting in a loss of force of the charge. One solution, employed by the Americans, who were decidedly advanced on this front, involved wrapping a piece of greased cloth or light leather around the ball would create a sabot-like effect, fitting the bullet to the barrel without distorting bullet's shape.¹ This tactic certainly reduced windage, but Captain Ferguson had other ideas. His contribution to the field of weaponry was an alternate form of the long barreled rifle. This version loaded from the breech and not the muzzle. Breech-loading means that the ball loads from the rear of the barrel near the trigger mechanism instead of the end of the barrel at the muzzle. Ferguson's rifle fired between four and five shots per minute. In addition in a field test, after completely soaking through the weapon with water, the

¹ W. Y. Carman, A History of Firearms; From Earliest Times to 1914 (London: Routledg & Kegan Paul Ltd 1995), 107.

rifle was able to resume firing in less than thirty seconds.² This weapon was issued to Ferguson's regimen, roughly one hundred men, who implemented it in their campaign during the American Revolutionary War. This weapon was exceedingly effective in combat and the regimen enjoyed exceptional success in their campaign. In fact, several American war commentators wrote that "had Great Britain manufactured more of the Ferguson rifles, perhaps she would have gained even further victories."³ Ferguson's rifle enjoyed continued success throughout the course of the Revolutionary War. Despite its many achievements in battle, and its harsh reputation with the enemy, the British government ultimately elected to discontinue the Ferguson rifle in favor of the traditional musket. After its discontinuation, the breech-loading rifle remained out of mind, a forgotten technology for roughly sixty years, until it came back to prominence in the years leading up to the American Civil War.

The example of the Ferguson rifle illustrates that what is considered technologically advantageous is ultimately socially constructed. Societal factors are important catalysts for change pertaining to all forms of technology. The Ferguson rifle, one of the first breech-loading rifles ever utilized, did not immediately become the predominant rifle, which reveals that there is a social root for all apparently technical categories of importance. Humans justify creating technology in light of problems or issues they find pressing at the time. Despite apparent success in battle,

² Carman, *A History of Firearms*, 108.

³ *Ibid*, 109.

the rifle did not stay in production. Therefore we have to assume that the Ferguson Rifle was not superior because it was not seen to solve a problem. Although the rifle may appear to succeed according to the current criteria for success in weaponry, we must recover the historical categories by which success was measured to understand why the Ferguson rifle was not produced. The Ferguson Rifle is not an example of a superior weapon abandoned for an inferior one. This example shows that we do not understand the categories that were used at the time to establish superior and inferior. This thesis will trace the concrete mechanisms by which the breech-loading rifle came to be judged as superior, namely, the construction of categories of comparison, and the identification of what it means to succeed in those categories.

There is no better analysis of military technology than the breech-loading rifle. In the case of the breech-loading rifle, I will argue that social factors formulate a specific problem in the field of military technology. By building the breech-loading rifle, weapons manufacturers create the very issue for which their product is the solution. These companies fabricate specific categories that appear unassailably technical—interchangeable parts, increased rate of fire, reduction of windage, and increased durability, among others.⁴ However, because these technical categories are the construct of a motivated weapons company, they are inherently social. We

⁴ For a more full list of categories, see *Report of a board of officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States musket and rifle, and their relative qualities and efficiency, and the cost of manufacturing each arm*. Communicated to the Senate, September 19, 1837.

can truly understand technological modifications by understanding that the technical categories of comparison are in fact the result of very real social debates and discussions. In addition, is it important to question how social factors determine the specific categories of technical comparison. Through the case of the breech-loading rifle, I will show that technological development is ultimately social in nature. I will also show that notions of better or worse and superior and inferior are extremely important. We must seek to understand the categories of comparison that were used to assess what constitutes better and worse. What is important are the social dynamics that create problems for which the breech-loading rifle is offered as the solution. I will show that the fabrication of specific categories, while at first glance unassailably technical—interchangeable parts, increased celerity of fire, reduction of windage, reduced recoil, &c.—are the constructed categories of motivated weapons manufacturers seeking government patronage, and are thus inherently social. Furthermore, I will illustrate that success within these categories is also a product of social decisions.

In order to accomplish this, this thesis draws from a bank of primary source documents. The majority of my primary sources deal in some way or another with the logistical aspects of obtaining military ordinance. These include government contracts for certain weapons, such as the Beale and Hall rifles, and the state papers

associated with the decision making process.⁵ I have also included general documents concerning the market for new weaponry, advertisements of specific rifle manufacture companies, and published government pamphlets on the state of the military force in the United States.⁶ I also have a series of secondary sources that detail the history of the breech-loading rifle, and provide firsthand accounts from soldiers both using and fighting against the breech-loading rifle. Other secondary sources, such as Stebbins' *One hundred years' progress of the United States*, are general histories of the United States, with sections about weaponry and the breech-loading rifle.

With the exception of a select few, secondary sources discussing the breech-loading rifle are mainly informational, and deal only with the basic history of the weapon. These works, such as Carman's *A History of Firearms from Earliest Times to 1914* and Hess' *The Rifle Musket in Civil War Combat; Reality and Myth*, provide the chronological progressions of different weapons, or deal with the general history of

⁵ See *Application of Beale's Rifle Company for a grant of land on account of extraordinary service in defence of New Orleans. Communicated to the Senate, December 31, 1835; On a proposition to purchase the patent right of John H. Hall for making rifles, and for his employment to superintend the manufacture of the same, Communicated to the House of Representatives, February 24, 1836; Report of a board of officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States musket and rifle, and their relative qualities and efficiency, and the cost of manufacturing each arm, Communicated to the Senate, September 19, 1837.*

⁶ *Letter from the secretary of war, accompanying sundry statements & reports, relative to, I. The present military force of the United States. II. Measures which have been pursued to obtain proper sites for arsenals. III. Measures which have been taken to replenish the magazines with military stores. IV. Measures which have been taken for opening a trade with the Indians. V. Progress made in providing materials for the frigates, and in building them. Published by order of the House of Representatives. Philadelphia, Printed by Francis Childs?, 1795, United States, Congress (4th, 1st session 1795-1796), House.*

firearms in the military⁷ These works go into great detail about the weapons themselves, describing the components of the machines, how they were used, their effectiveness in combat, chronological progressions of breech-loading weaponry, and even in some cases the specific technological modifications that brought a particular technology into being. However, these texts involve little to no analysis of any kind. Aside from presenting chronological information, they do not address the social catalysts of technological modification, or the specific case of the breech-loading rifle.

The majority of scholarship that does focus on societal and technological interaction does so on a much larger scale. Although these works might have a small section on military technology or the breech-loading rifle, they deal mainly with the interactions between society and technology across a range of technological fields. One example of scholarship dealing with social and technological interaction is *The Social History of American Technology*, by Ruth Schwartz Cowan. In this book, Cowan takes a comprehensive look at the relationship between society and technology and argues that, as a society shifts towards industrialization, people become more dependent on both technology and each other.⁸ Cowan's book is important to the field of technological development, but she focuses on technology in broader terms,

⁷ For more works on chronological histories of both the military and specific technologies, see Michael Brzoska, and Frederick S. Pearson, *Arms and Warfare; Escalation, De-escalation, and Negotiation*, (Columbia: University of South Carolina Press, 1994).; Peter Maslowski and Allan R. Millet, *For the Common Defense; A Military History of the United States of America*, (New York: The Free Press, 1984).; Charles B Norton, *American Inventions and improvements in Breech-Loading Small Arms, Heavy Ordnance, Machine Guns, Magazine Arms, Fixed Ammunition, Pistols, Projectiles, Explosives, and Other Munitions of War, Including a Chapter on Sporting Arms*, (Springfield, MA: Chaplin & Gould, 1880).

⁸ See Ruth Schwartz Cowan's *The Social History of American Technology* introduction.

where military technology is only a small part of the whole. Cowan's work has helped solidify a core theme of this thesis, that "technology is shaped by the context in which it is developed, applied, and diffused."⁹

In addition to the works on the breech-loading rifle itself, there is also an overlying theoretical framework pertaining to military technology. This literature is dominated by historiographies that do not deal with the way in which specific technologies come into being and come to dominate a given market. These works of scholarship are content to take a teleological approach, assuming that a specific technology succeeds simply because it is better, and rarely if ever probe past their teleological safe zone. This theme exists across the spectrum of examples of military technology, especially nuclear submarines, and the atomic bomb.

The terms advancement, innovation, and success must be problematized. The teleological discourse on technology holds these words as self-evident. By assuming the breech-loading rifle as a solution to a problem, by maintaining that a pre-existing problem or issue sparked the technological innovation of the breech-loading rifle, the common teleological discourse completely overlooks the true catalysts for technological change. My work will challenge these assertions, and alter how we see the adoption of the breech-loading rifle. I will argue that the important questions are not technical categories of reload speed or interchangeability of parts, but the social debates that made these particular

⁹ *Ibid*, 90.

categories meaningful. Helping shape my work has been Collins and Pinch's *The Golem at Large: what you should know about technology*, specifically the section dealing with the patriot missile.¹⁰ In this chapter, Collins and Pinch discuss the notion of success. *The Golem at Large* has helped shape this thesis because it has problematized the idea of success for inherently technological categories. Collins and Pinch show that what is important varies between individuals due to their personal vested interests, and they demonstrate that what constitutes success in technology is ultimately social. In addition to the social nature of success, my thesis attempts to illustrate that the categories of comparison in which success is measured are also socially constructed. In this work I challenge the work of previous scholarship that utilizes innovation and advancement as the deciding explanation for technical modification.

The first section deals with the categories of comparison themselves—windage, recoil, interchangeable parts, simplicity of design, durability, safety, and rapidity and celerity of fire. My work will uncover the social impetus of the categories, showing that social actors with vested interests construct the categories for comparison of breech-loading rifles, thus making those technical categories inherently social. My second section will examine what constitutes success within these categories of comparison. Here I will show in order to understand success within the criteria, we must understand the historical actors, their vested interests,

¹⁰ H. M. Collins and T. J. Pinch, *The Golem at Large : what you should know about technology*, (New York: Cambridge university Press, 1998).

and the relative importance they place on each category. In doing this I will show that technological success is not a reflection of technology per se, but of societal preference, and what society views as meaningful.

Section I: Construction of Categories

Is there perhaps any Senator on this floor who can show me an arm as good as the Springfield breech-loader of 1866? Go around and look at them, and you will find that almost all of them have the old muzzle-loader, and some of them perhaps even the old smooth-bore musket.¹¹

There was no argument in response to this statement made on the Senate floor in 1872, by a senator from Missouri. Although the focus of this specific statement was a single rifle, the Springfield model 1866, confidence in breech-loading weaponry carried over many to other manufacturers—Hall, Colt, Sharpe, Spencer, etc. By the late 1800s the government was all but convinced that breech-loading technology was the better and brighter future of firearms for the United States military. However, in the early 1800s, this sentiment within the government was not always the case. In fact, at the advent of the breech-loading rifle, the majority of military leaders were vehemently against the breech-loading rifle in favor of the old standard musket, often referred to as the Brown Bess. One officer, when asked to commentate on the state of weaponry in the military, said “many old

¹¹ *Sale of Arms to French Agents, Speeches of Hon. Carl Schurz, of Missouri, in the Senate of the United States, February 15 and 20, 1872*, in [Pamphlets. American history]. [n. p., 1825-1901], 17-18, Making of American Books online database, accessed January 18, 2012.

wiseheads still seem to prefer the smooth-bore musket—Brown Bess, as it is called—and consider it more destructive than any.”¹² The first working breech-loading rifle was utilized in the Revolutionary war *circa* 1777, and the first breech-loading arms presented to the United States government in the early 1830s. This 1864 quotation, voicing doubt as to the superiority of breech-loading arms, illustrates how difficult it was to convince key military figures that the breech-loading rifle was not only better than the existing technology, but also better than any other forms of new military technology.¹³ Even around one hundred years after the first breech-loading rifle, breech-loading technology was not at the forefront of military technology. The shift to breech-loading technology was certainly not an immediate switch away from the muzzle-loading musket. It took many years to convince the old wiseheads, and the government, to switch to the breech-loading rifle. In fact, the shift was an arduous process, with proponents and detractors battling continuously for decades.

In order to make their breech-loading technology succeed, weapons manufacturers constructed specific technological categories of comparison that were meaningful to key interest groups such as the U.S. Government, for which their technology was the superior. Weapons manufacturer Samuel Colt stated in a letter to the United States government that his greatest goal in weapons manufacture is

¹² *Battle-fields of the South, : from Bull Run to Fredericksburgh; with sketches of Confederate commanders, and gossip of the camps*, (New York: J. Bradburn), 1864, p. 312-313. Making of American Books online database.

¹³ Carman, *A History of Firearms*, 108.

the "pride of making improvements worthy of Government patronage."¹⁴ Although these claims of pride may be rhetorical tools to garner favor, they show that either having the government purchase their patent in a lucrative deal or having the government sign a contract for weapons manufacture was an extremely desirable result.

Although the muzzle-loading musket was official weapon of the U.S. military into the mid 1800s, it was not without its flaws.¹⁵ Repeated loading of a muzzle-loading arm would lead to clogging and choking of the barrel from the poured gunpowder, which made the weapon increasingly difficult to load.¹⁶ In addition to the clogging issue, there was also a problem with the actual ramming of the projectiles down the length of the barrel. There were many high-ranking military officials who detested the use of the ramrod as a muzzle-loading tool. One officer voiced this opinion stating, "It requires no great amount of scientific knowledge to see that the rammer and ramrod are totally behind the age, and should be discouraged and disused."¹⁷ Not only was the ramrod a clumsy piece of equipment that could easily bend and thus be rendered useless, but it was also next to impossible to load a musket with a ramrod from a concealed position, which leads

¹⁴ *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt. May 18, 1840. Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503.*

¹⁵ For discussion on military issues with the muzzle-loading musket see: Frederick Wilkinson, *Arms and Armour* (London: The Hamlyn Publishing Group Limited, 1978).; W. Y Carman, *A History of Firearms; From Earliest Times to 1914* (London: Routledg & Kegan Paul Ltd, 1955).

¹⁶ Carman, *A History of Firearms*, 115.

¹⁷ J Bradburn, *Battle-fields of the South, : from Bull Run to Fredericksburgh; with sketches of Confederate commanders, and gossip of the camps* (New York. Making of American Books Online Collection, 1864), 311.

to countless unnecessary injuries on the battlefield. As another military commentator explains

[The ramrod] should be abolished. Half the men you see walking about town with arms in slings have been hit while loading, for the enemy fire high, and had we breech-loading muskets in our battles, few would have been struck at all...If you lose your ramrod in the confusion or excitement, how much is your weapon worth?¹⁸

Although there might have been many different ways to solve each of these issues, one method to account for both was to find a way to load a projectile into a firearm from the base of the barrel, or the breech. The issues with muzzle-loading technology prompted people to look for new weapons, but did not limit the ways in which those problems could be solved. Breech-loading technology is one way to go about addressing the issues of the muzzle-loading weaponry, and to this method there were certainly a multitude of breech-loading designs. They usually break down into two classes. The first class is a single shot weapon that loads from the breech, such as the arms of Hall, Hackett, Sharpe, and Spencer. The second class is “many chambered” or “repeating guns” of Colt and Cochran.¹⁹ By founding their weapons on a specific set of mechanisms or principles, such as these two different designs, weapons manufacturers illustrate a conscious decision to give emphasis to certain technological categories over others. The manufacturers’ choice of

¹⁸ Bradburn, *Battle-fields of the South*, 312.

¹⁹ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm*, Communicated to the Senate, September 19, 1837, 25th Congress, 1st Session, Ex. Doc. No. 740, p. 470.

mechanism influences the relative importance they place on the categories of comparison, which becomes an important factor when it comes to arguments for superiority.

Windage

Windage was a major issue with muzzle-loaders. Windage is basically the force of a charge lost because of the inability to fit the rifle ball perfectly within the barrel.²⁰ The breech-loading weapons manufacturers saw the elimination of windage as a way to distance their arms from muzzle-loading weaponry. First breech-loading manufacturers sought to eliminate loss of charge escaping around the ball, the main problem with muzzle-loaders. In 1837, a government sponsored committee assigned with the testing of several types breech-loading rifles stated

*The advantages of [the breech loading rifle] are, of course, common to all, viz: that the ball used may be of a diameter so great as to destroy all windage, and this cause a greater range, more exactness of fire, and, in consequence of less power being required by the absence of windage, diminished recoil.*²¹

The committee was tasked with the evaluation of six different breech-loading arms and the comparison of those arms to the United States musket. Through this extensive testing, the committee found that the breech-loading weapons eliminate this first source of windage in shoulder arms—force of the charge lost around the

²⁰ Report of a board of officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States musket and rifle, and their relative qualities and efficiency, and the cost of manufacturing each arm, Communicated to the Senate, September 19, 1837, 467.

²¹ Ibid, 470.

musket ball due to an improper fit in the barrel.²² Loading from the breech enables a much larger ball to be used because a rifleman does not have to force the ball down the barrel. Instead, the ball can be of a diameter that will fit perfectly into the chamber at the breech, thus creating a seal and reducing or eliminating windage around the bullet. The publication of this document was extremely beneficial for breech-loading technology. The breech-loading manufacturers emphasized the importance of windage in weaponry in order to show through government testing that their breech-loading weaponry has solved the important windage problem found in muzzle-loading rifles.

However, in their attempt to eliminate windage, breech-loading manufacturers also presented themselves with a great obstacle. Especially in its early stages, breech technology was often faulty, and was thus an extremely dangerous safety hazard. Breech mechanisms were either simply not strong enough to withstand the primary powder charge, or they were not completely sealed, resulting in some of the charge exploding out from the breech itself. For muzzle-loaders, windage was an inconvenience, an unfortunate loss of charge. Although some of the force of the charge would escape around the ball and out the barrel, muzzle-loading windage presented little danger to a soldier. With the breech-loading technology, the charge could not escape around the ball. Therefore, the full force of the charge would now have to be contained by the breech mechanism. The 1811 model of John Hall's breech-loading rifle, when tested, demonstrated a

²² Carman, *A History of Firearms*, 107.

tendency for gas and flame to leak from the breech.²³ This not only decreased the overall velocity of the bullet, but endangering the soldier as well. If the breech failed, the explosion could seriously wound a soldier. Hall, along with all other weapons manufacturers took the issue of windage seriously.

Recoil

In order to address these newly created windage problems, weapons manufacturers sought to alter the breech mechanism of their weapons. As breech mechanisms improved to the point where windage was all but eliminated, weapons manufacturers discovered and exploited a new technological category of comparison. One of the unforeseen effects of reduction of windage was the reduction of recoil. In order to compensate for windage in muskets, a greater main charge was necessary. Due to this extra charge, the recoil of the weapon was much greater. Eliminating windage ensured that full force of the main charge will expel the bullet out of the barrel. Therefore, a weapon absent windage requires a diminished charge of powder to produce results equal to those acquired with greater charges in the weapon prone to windage. A larger charge creates a greater explosion in the weapon, which makes the recoil of the weapon quite severe. Even though all the force is contained, the recoil from the smaller charge is less than that of a muzzle-loading weapon of the same caliber.²⁴ Manufacturers portrayed the

²³ Allen R. Millett and Peter Maslowski, *For the Common Defense: a Military History of the United States of America* (New York: The Free Press, 1984), 124.

²⁴ *Report of a board of officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt*, 468.

reduction of recoil as an important and positive category. The weapons manufacturers built up reduction of recoil as category by emphasizing the importance of reduced recoil to the soldier in battle. Less recoil means less wear on the soldier fighting over an extended period of time.

In addition, the breech-loading manufacturers also sought to illustrate that the smaller charge of powder necessary in the breech-loading rifles also enables soldiers to fire more shots with the same amount of powder. Being able to fire a greater number of shots with the same amount of powder would conserve powder, which could forestall tactical withdrawals due to a lack of powder or other resources. Often in military engagements, larger battles and smaller skirmishes are drawn out affairs with neither side giving much ground, with a steady rate of fire from both sides. Being able to keep fighting and outlast the enemy supply of powder was crucial in wartime.

The government had a vested interest in conserving resources for the obvious reason of saving money. As breech-loading rifles began to proliferate, the government began a series of inventories. These inventories sought to formulate a comprehensive list of the government military arsenal—including all manner of weaponry, attachments, supplies, and parts—at each arsenal, fort, and military base in the United States.²⁵ As these surveys continued, the Government also began

²⁵ Two examples of these inventories are: *Quantity and condition of the ordnance and ordnance stores and arms belonging to the United States at the armories, arsenals, depots, and forts; and expenditures at the several armories and arsenals, and for the manufacture of Hall's rifles, from 1816 to 1834*, Communicated to the House of Representatives, January 5, 1836.; and *Report of the Secretary of War, being part of the message and documents communicated to the two Houses of Congress at the beginning*

research into the cost effectiveness of the many new technologies that flooded the weapons market. The government commissioned one report specifically to detail the cost of the weapons themselves, but also the ability of breech-loading rifles to conserve ammunition and supplies. The report shows that not only do breech-loading arms require less powder to produce the same results as muzzle-loading rifles, but also that breech-loading rifles will save between fifty to eighty grains of powder per shot fired.²⁶ In these actions we see that cost effectiveness was extremely important to the Government, making the reduction of windage and recoil very significant categories.

Interchangeable Parts

In 1798, American inventor Eli Whitney came to the Government with a plan to create a mechanized system that would assume the manufacturing jobs originally done by skilled laborers. As Whitney explained to Oliver Wolcott, Secretary of the Treasury

One of my primary objects is to form the tools so the tools themselves shall fashion the work and give to every part its just proportion—which when once accomplished, will give expedition, uniformity, and exactness to the whole...In short, the tools which I contemplate are similar to an engraving on a copper plate from which may be taken a great number of impressions, perceptibly alike.²⁷

of the first session of the Forty-third Congress, Serial Set Vo. No. 1599, Session Vol. No. 2, 43rd Congress, 1st session, H.Exec.Doc. 1 pt. 2, v3.

²⁶ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm*, Communicated to the Senate September 19, 1837, 25th Congress, 1st Session, Ex. Doc. No. 740, 469, 472-475.

²⁷ Constance M. Green, *Eli Whitney and the Birth of American Technology* (New York, 1956), 102.

Whitney's vision called for a process that would create a breech-loading rifle with interchangeable parts. This principle holds that the machinery used in fabrication is so precise that each piece that will comprise a whole rifle is identical to all others manufactured. A primary concern for the War Department of the United States was obtaining equipment and arms that could be easily repaired instead of having to be replaced or thrown away.²⁸ One letter to the House of Representatives from the Committee of Military affairs, voiced the opinion that a "the ability to reconstruct good and complete arms from the uninjured parts of damaged ones of the same kind, whenever they get injured in service, and to do it without much loss of time or the intervention of workshops" was a vital advantage in battle.²⁹ In response, weapons manufacturers endeavored to situate the system of interchangeable parts as the solution to the issue of field repairs.

In Whitney's quote, we see his aspirations for his new approach to weapons manufacture. First, Whitney claimed that the machines would greatly increase the rate of production. Reducing or eliminating human involvement in favor of machinery, and thus eliminating human error, would also make the manufacture process drastically more efficient. In addition, Whitney emphasizes the meticulousness and consistency of his machines, stating that the parts they produce will be so precise that they will be completely interchangeable with like parts.

²⁸ Cowan, *A Social History of American Technology*, 80.

²⁹ *On a Proposition to Purchase the Patent Right of John H. Hall for Making Rifles, And For His Employment to Superintend the Manufacture of the Same*, Serial Set Vol. No. 649, 24th Congress, 1st Session, Communicated to the House of Representatives, 1836, 105.

Whitney presents one of the best examples of a weapons manufacturer with the vested interest that the category of interchangeable parts is the most important. He placed his reputation as a manufacturer, and a considerable portion of his own wealth, on the belief that interchangeable system would attract government support. The government was so taken with the idea of interchangeable parts, and the money they might save with this system, that they offered Whitney a contract for arms in advance, even before Whitney had proved that his system would work.³⁰ The Government had just allotted \$800,000 for the purchase of weaponry. The order placed by the government attests to this fact, as Whitney was commissioned to manufacture 10,000 muskets in only two years, at the time a seemingly impossible feat.³¹ Whitney's machines never achieved the results he was commissioned for, and he continually asked the United States Government for both more time and more money to perfect his system of manufacture. The Government continually funded Whitney until he finally produced the weapons in 1809.³² The continued government funding clearly illustrates that the category of interchangeable parts remained a key issue for the Government and the War Department.

After Whitney, another weapons manufacturer, John H. Hall, used the same platform of interchangeable parts as the principle category for his breech-loading arms. Unlike Whitney, Hall was able to prove that his manufacturing systems did indeed create weapons with interchangeable parts. Hall used the category of

³⁰ Wiklinson, *Arms and Armour*, 101.

³¹ Green, *Eli Whitney*, 110.

³² Cowan, *A Social History of American Technology*, 79.; Millett and Maslowski, *For the Common Defense*, 124.

interchangeable parts as a main selling point in an attempt to increase the popularity of and support for his rifle.³³ In fact, three key government documents highlight the use of interchangeable parts as a main component of the Hall rifle. One of these, sent from the Committee on Military Affairs, implores the House to “adopt [Hall’s manufacturing techniques] generally, and apply [those techniques] to *all* the different kinds of our small fire-arms.”³⁴ In an attempt to spread the positive attitude towards interchangeable part systems through the House and Senate, Hall allowed his weapons to be put through a series of tests to prove the value of interchangeable parts. In order to truly prove that his rifles have interchangeable parts, Hall sent the Committee on Military Affairs one hundred completed rifles in boxes. He then had the rifles disassembled, the rifle stocks taken off and put away, and the parts mixed up.

³³ *On the Importance and superiority of Halls rifle for the public service, and the propriety of making compensation to the inventor for its use*, Serial Set Vol. No. 747, 25th Congress, 2nd Session, Communicated to the Senate, December 21, 1837, 1.

³⁴ *On a proposition to purchase the patent right of John H. Hall*, 104.

One hundred stocks were then brought from Hall's armor, which had been just finished, and on which no work or mounting had ever been put. The workmen then commenced putting the work taken from off the stocks brought from the United States arsenal on to the one hundred new stocks, the work having been repeatedly mixed and changed by us and the workmen also; all this was done in our presence, and the arms as fast as they were put together were handed to us and minutely examined. We were unable to discover any inaccuracy in any of their parts fitting each other, and we are filly persuaded that the parts fitted, after all the changes they must have undergone by the workmen, as well as those made designedly by us in the course of two or three days, which as much accuracy and correctness as they did when on the stocks to which they originally belonged.³⁵

Until this point, the system of interchangeable parts had never been successfully proven to the government. This test, carried out under a committee of "practical armorers and intelligent gentlemen, appointed by the United States ordnance department," is particularly innovative because of it involves active participation in the demonstration.³⁶ This test is so important because, with it, Hall turns the category of interchangeable parts from merely an idea or claim, into something very real and tangible. The document makes it clear that Hall's changes in the area of manufacture are groundbreaking. From this point on, having interchangeable parts was a necessity for all new rifles. However, after the repeated backing of projects like Whitney's that do not meet expectations, the government turned to extensive testing in order to prove a weapon or manufacturing system's capabilities. Although testing did occur prior to this point, after the Hall rifle testing, the government formed an increasing number of committees to analyze and test military weaponry.

³⁵ Ibid, 106.

³⁶ Ibid, 109.

These tests—physical demonstrations and expert examinations by high ranking military officials, weapons manufacturers and common soldiers, all with extensive experience in weaponry and ordnance—become a new form of marketing for weapons manufacturers to further their weapons through testing of criteria of success. In addition to an increase in testing, some weapons manufacturers turn to expert testimony to defend their technology. Colt uses expert testimonies in his many letters to the Secretary of War and the Secretary of the Navy as key defenses for the superiority of his weaponry.³⁷ By doing this, Colt is able to, at least superficially, distance himself from his weaponry. Colt is the manufacturer, and as such, he has a great personal interest in the success of his product. Expert testimonies remove Colt's bias from the equation and present a seemingly objective opinion of Colt's rifles.

Simplicity of Design

Another category that goes hand in hand with interchangeable parts is simplicity of design. In the above example, Hall's weapons are lauded for the ease in which they may be assembled or taken apart. The document does not explicitly state it, but it is apparent that simplicity of design is directly related to the reparability of the weapon, and both are important characteristics for any weapon. As government testing became the standard for weapons analysis, methods developed to test the

³⁷ See, *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt. May 18, 1840. Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503.*

simplicity of design. The most effective and empirical method for measuring simplicity was by simply counting the number of pieces that make up the complete rifle. It is important to understand that simplicity is separate from the category of interchangeable parts. Having interchangeable parts is important because of the ability to replace individual parts instead of replacing the entire weapon. Simplicity of design is important because it enabled for soldiers to make repairs in the field of battle. Even if a system of interchangeable parts was in place, if the weapon itself was overly complicated, an ordinary soldier might not be able to repair his weapon. Simplicity of construction would become a crucial component of any arm in use by the military because of the U.S. Government's great concern with a soldier's ability to make field repairs to his weapon.³⁸ Being able to make quick repairs to a broken weapon and continue fighting was very important.

In fact, by 1840, a lack of simplicity was viewed as a great negative when evaluating a breech-loading weapon. When Samuel Colt attempted to convince the U.S. Navy to adopt his rifles, some high-ranking naval officials claimed that the mechanisms of Colt's multi-chambered weapons were overly complicated and that the overall arm was comprised of too many parts. This would make the rifle impractical and difficult to repair. We see the emphasis placed on this category by how intensely Colt defends these accusations. In multiple documents and personal letters to the Secretary of the Navy, Colt seeks to quell the negative association between his rifles and overly complex construction. He does this by comparing his

³⁸ Cowan, *A Social History*, 80.

rifles to both Hall's rifle and the current musket in use by the military. He explains that if you count all the pieces of his lock mechanism, and do the same to the current musket and to Hall's rifle, that the number of pieces is "no more than in the simplest of common construction, and the entire number of pieces composing one of [Colt's] repeating-guns is considerably less than composing either of the arms now used in government service."³⁹ This example shows the importance of a simple design as a category of comparison. By 1875, simplicity of design was one of the main categories of comparison used by government committees tasked with evaluating breech-loading arms.⁴⁰

Durability

As interchangeable parts and simplicity of design become important categories of comparison, so too does the durability of military technologies. As with the category of interchangeable parts, cost plays an important role in the category of durability. As the number of breech-loading rifles in use increased, the government began taking stock of all weaponry issued to the military. The finding was that the large amount of the weaponry was in a state of rust and neglect. The government

³⁹ For this and additional letters to the Secretary of the Navy, see *Report of The Secretary of the Navy, in compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt*, May 18, 1840, Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503, 1-2.; and *Report from the secretary of the navy, in compliance with a resolution of the Senate, in relation to the adoption to the improved boarding pistols and rifles invented by Samuel Colt*, May 18, 1840, Read, and referred to the Committee on Naval Affairs, May 25, 1840, ordered to be printed, 26th Congress, 1st session, Ex. Doc. No. 503.

⁴⁰ *Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War, relative to the manufacture at the Springfield Armory of the Roberts breech-loading musket ad carbine*, February 3, 1875,-Referred to the Committee on Military Affairs and ordered to be printed, 43rd Congress (house of reps), 2nd session, Ex. Doc. No. 152, 4.

found that the annual loss of weaponry due to wear was thirteen percent for infantry rifles, and sixteen percent for the rifle attachments.⁴¹ From this, the government calculated that the average life of an infantry rifle was five years. An increase in the durability of the infantry breech-loading rifle means that the government would not have to replace the arms as often, allowing the government to save money. With money saving in mind, the government began to increase the amount of durability testing on new breech-loading weaponry. By the mid 1830s, the Government established temporary committees, made up of a board of officers, assigned the job of testing and examination of military technologies. One of the first of these committees, formed in 1837, was assigned the job of testing several breech-loading small arms, and giving their opinion as to any improvements that might be made. Within this document, there are several specific categories for which each rifle is to be measured. Item number seven on that list is durability. For the issue of durability, the board of officers concluded that

The means of testing durability of the several descriptions of arms is not within the control of the board. It can only be determined by requiring the inventors to undertake a fatiguing course of firings, greater than some could endure, or by placing the arms in the hands of troops and having them exposed to all the incidents and trials of active service.⁴²

From this treatment we see that durability is an important issue with military technology, as it is among the list of categories to be tested. As the government

⁴¹ Henry Latham, *Black and white. A journal of a three months' tour in the United States*, (Philadelphia: MacMillan and co., J. B. Lippincott and co., 1867), 77-78.

⁴² *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt*, 469.

creates several additional testing committees in subsequent years the importance of weapons durability becomes increasingly apparent. One committee, formed by the United States Navy in 1840, includes the testing category "To prove [the weapon's] capability to stand exposure to salt water."⁴³ However, the increase in importance of durability does not become truly apparent until the writings of a later committee, dubbed the St. Louis Board. Ordnance Memoranda, No. 11., the official findings of the St. Louis Board, documents the most extensive battery of durability tests of any previous committee. In fact, the government creates The St. Louis Board almost exclusively for the testing of durability. Whereas the 1837 committee felt that active combat was the only real way to test durability, the St. Louis board formulated a plethora of tests with measurable results, to cover a wide range of battlefield scenarios. The St. Louis board created tests for effects of exposure to weather and firing, effects of sand, dirt, and dust on the breech mechanism, effects of both saltwater and fresh water, effects of defective ammunition on the rifle, the strength of the breech mechanism, and the overall endurance of the weapon.⁴⁴ The increase in testing shows that the government places increasing importance on the category

⁴³ *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt. May 18, 1840. Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress 1st Session, Ex. Doc. No. 503, 2-3.*

⁴⁴ *Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War, relative to the manufacture at the Springfield Armory of the Roberts breech-loading musket and carbine, February 3, 1875,-Referred to the Committee on Military Affairs and ordered to be printed, 43rd Congress (house of reps), 2nd session, Ex. Doc. No. 152, 7-8. A detailed description of the results of these tests and the measure of success will follow in the second section.*

of durability. Durability becomes a key category of comparison because the government views it as a way further its own interests by saving money.

Safety

Coupled with the importance of durability is the seemingly obvious category of safety. In government testing, durability and safety could both be measured in the same test. If a breech failed during a test of its durability, then the weapon was neither durable nor safe for a soldier. For a weapon to be considered safe, it needed to fire repeatedly for extended periods of time, and present no danger to the soldier that used it. The importance of safety is evident in the claims of weapons manufacturers. Due to the fact that some breech-loading rifles were not safe—Hall's 1811 rifle would often leak flame out of the breech on the detonation of the primary charge—other weapons manufactures saw safety as a way to set their rifles apart. The issue of safety becomes a vital category, not necessarily because of concern for the soldiers, although that may have been a factor, but because of the desire of motivated weapons manufacturers to demonstrate that their weapons were superior to the weapons of their competitors. Perhaps the most vocal on the issue of safety was Colt, whose testing for safety was the most extensive of any weapons manufacturer of the time. Colt claimed that his weapons were “perfectly safe in the hands of the most careless.”⁴⁵

⁴⁵ *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, 7.*

We also find that the government was concerned about the category of safety. One government document, discussing the many merits of one particular breech-loading rifle, stated "if there be anything gained by the peculiarities over the common musket and Hall's guns in point of celerity of discharging, such advantage has been acquired at too great a sacrifice of important and indispensable principles; that in the desire to reach perfection in the construction of the arms, the convenience, physical power, and safety of those who are to use them, have been wholly overlooked."⁴⁶ Although the particular breech-loading rifle discussed in this quote may have made advances in categories such as ease of firing, the government finds that this has been accomplished at the expense of safety. Here the government situates safety as a vitally important category of comparison.

Rapidity/Celerity of Firing

Perhaps the most contested category of comparison is the issue with the rate of fire. Its very nature as hotly debated shows its importance as a category of comparison. Early on in the life of breech-loading technology, celerity of fire was an important topic of discussion. The mechanic principles of the breech-loading rifle at their base level brought about faster reload times than the muzzle-loading arms in use. Throughout the history of government testing of rifled arms, breech-loaders universally recorded faster reload times than their muzzle-loading counterparts. In one extensive experiment, forty-one rifles from fourteen different manufacturers

⁴⁶ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt*, 471.

were tested for rapidity of fire. The test itself entailed the discharge of twenty-five shots at a target from a distance of one-hundred yards. In this test, the breech-loading arms held the fastest times.⁴⁷ In comparison to the muskets, breech-loading arms have greatly superior reload times. However, being faster to reload does not necessarily mean the weapon was better. A discussion of the debate over rapidity of fire is a discussion of what constitutes success within the categories, which will come in the second section. This first section discusses the social basis for the construction of categories of comparison. Having thus established the categories and their social foundations, we must now move to the notion of success.

⁴⁷ *Roberts Breech-Loading Musket and Carbine*, 7-14.

Section II: Establishing Success

We must now move to the way in which these categories are measured. The second half of the argument against teleological assertions deals with the concept of success. The question of success is, in actuality, two vital questions. The first is what exactly counts as success within the many categories of comparison? In *The Golem at Large*, Collins and Pinch break down criteria into direct and indirect categories. In the case of the breech-loading rifle, the direct criteria of success will include all of the categories discussed in the first section—windage, recoil, interchangeable parts, simplicity of design, durability, safety, and rapidity and celerity of fire. From here we can move on to what Collins and Pinch call the “less proximate areas.”⁴⁸ These categories, which shall be called indirect criteria of success, are not directly linked to the technological aspects of the breech-loading rifle. The three indirect categories covered in this section are the confidence of soldiers, increase in breech-loading rifle sales, and the cost of the breech-loading weaponry. It is also important to understand that some of the categories, such as the category of interchangeable parts, have both direct and indirect qualities. Each of the criteria of success has its own metrics and manner of evaluation.

⁴⁸ H. M. Collins and T. J. Pinch, *The Golem at Large : what you should know about technology*, (New York: Cambridge university Press, 1998).

The second question is whether or not a particular breech-loading rifle succeeds with respect to the specific metrics of analysis for a given criterion of success. To answer this question we must analyze the important actors involved in each category of success. These historical actors have a vested interest in both the categories they decide are important, and in the metrics they choose for success in those categories. By understanding who places importance on which criteria, we can determine the definition of success for any category. This section will first deal with the indirect measurements of success before moving on to the more direct technological gauges of success

Confidence of Soldiers

The first of the indirect criteria of success is the effect of the breech-loading rifle on the soldier's confidence in battle. By turning away from the direct technological criteria for success, we first come to the group that relies most heavily on the new technology, the soldiers. The confidence of soldiers becomes a criterion of success due in part to one weapons manufacturer in particular, Samuel Colt. Colt uses the personal testimonies of soldiers to illustrate success in this category. He argues that soldiers who used breech-loading arms, his in particular, felt more confident in battle, while the soldiers who fought against the breech-loading rifle were often demoralized and had low morale. We find in the personal correspondence of soldiers and officers to the government that this was often the case. In a letter to Colt, one such officer, P. W. Henry stated that

In passing through Indian country, I always felt myself safer with one of your rifles in my hands, than if I was attended by a body of ten or fifteen men armed with the common muskets or carbine. In fine, sir, I do not hesitate to say that a regiment of light infantry armed thus, would, on all occasions, act with great efficiency, and, undoubtedly, achieve the best results.⁴⁹

As reports like this one come in, in favor of breech-loading arms, weapons manufacturers realized the benefit of a favorable testimony from soldiers. Colt promptly sent this letter to the government as evidence in favor of his weaponry. These personal testimonies from soldiers using the breech-loading rifle illustrate the increase in the overall confidence of soldiers using breech-loading arms.

Conversely, there are also many accounts supporting the breech-loading rifle's negative effect on enemy morale. "An account of the campaigns of Lieutenant General N. B. Forrest" contains a narrative of Confederate troops attempting to take a Union occupied town. The confederate troops entered the town "with spirit" and "began to fire, with their long rifles, as they came within one hundred yards of the enemy; but the short breech-loading firearms of federals gave the latter one *more* advantage...and the Confederates, the most of whom young men in their first action, were staggered."⁵⁰ Yet another account details troops armed with the Colt repeating rifle, fighting against a band of Native Americans. The document explains "the

⁴⁹ *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt. May 18, 1840. Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503, 12.*

⁵⁰ General Thomas Jordan and J. P. Pryor, *The campaigns of Lieut.-Gen. N. B. Forrest, and of Forrest's Cavalry*, (New York: Blelock & co., 1868), 385, 393.

Indians were acquainted with a 'one-fire' piece, but when they saw troopers fire six times without loading, they thought it time to give in."⁵¹ Again we see Colt using these testimonies to lend support to his rifles. By using these testimonies Colt places importance on the category of soldier confidence. Colt uses these accounts to laud his breech-loading rifle for inspiring confidence in soldiers carrying the arm, and causing fear and apprehension in those soldiers forced to go against it. This clearly shows that, according to Colt, his rifle is a success within this criterion of success.

Breech-Loading Rifle Sales

Moving away from the men actually fighting the battle and focusing on the weapons manufacturers, we come to another measure of success: the increase of breech-loading weapons sales. Weapons manufacturers viewed government patronage, namely a government contract for weaponry, as an end goal, and obtaining patronage would naturally result in an increase in sales. The United States government, after proving the worth of John Hall's breech-loading rifle, awarded Hall ten thousand dollars to pay off debts accrued while developing his weaponry. In addition, the government bought Hall's patent and employed him at the national armory at Harper's Ferry to continue oversight of the manufacture of his weapons. At this post Hall received sixty dollars per month and a one dollar for each rifle manufactured. With this contract, Hall's productivity increased exponentially to four

⁵¹ L. Stebbins, *One hundred years' progress of the United States ... With an appendix entitled Marvels that our grandchildren will see; or, One hundred years' progress in the future ... By eminent literary men. Embellished with two hundred and eighty engravings*, (Hartford, CT:, 1870), 331.

thousand rifles per year.⁵² The mere purchase of Hall's rifles is enough to constitute success for this criterion. However, success in this category is not limited to one rifle. Within this category, each rifle is judged independently on the basis of its sales and Hall's case constitutes only one example. There were in fact many breech-loading rifles—the Colt, the Burnside, the Sharps, the Springfield, the Spencer—that can claim an increase in success in this category.⁵³

In the case of Eli Whitney, we see similar success. Whitney was financially crippled after his attempts to popularize the cotton gin. When creating a new enterprise, Whitney understood that he would need an eventual buyer who could also afford the starting costs before actual production. Whitney began work in weaponry because of the extensive financial backing possible through the United States Government.⁵⁴ As an inventor with extensive debts turning a profit was very important. Whitney promised the government a rifle with a system of interchangeable parts. For this he was awarded a government contract and tasked with the manufacture of ten thousand guns.⁵⁵ Although Whitney did ultimately fail this assignment, this is not to say that Whitney intended to do so. As an inventor, adding his name to an invention was placing his reputation on the line. But because Whitney was paid in advance for his arms, it did not matter that he went over his

⁵² *On a Proposition to Purchase the Patent Right of John H. Hall for Making Rifles, And For His Employment to Superintend the Manufacture of the Same.* Serial Set Vol. No. 649, 24th Congress, 1st Session, Communicated to the House of Representatives, 1836, 104-105, 109.

⁵³ Norton, Charles, B. *American Inventions and Improvements in Breech-loading Small Arms, Heavy Ordnance, Machine Guns, Magazine Arms, Fixed Ammunition, Pistols, Projectiles, Explosives, and other Munitions of War, including a chapter on sporting Arms.* (Springfield, MA: Chapin & Gould, 1880).

⁵⁴ Cowen, *A Social History*, 78.

⁵⁵ Wiklinson, *Arms and Armour*, 101.

deadline, or that he could not meet the full ten thousand breech-loading weapons requested. Obtaining a contract, despite poor technological results, was a success.

Cost of Weaponry

Another measure of success deals with the costs of weaponry. The government began appropriating money for the purchase of weaponry in the late 1700s.⁵⁶ With this finite amount of money, the government needed to be fiscally responsible, and the cost effectiveness of weaponry was very important. By 1836, the government was keeping tremendously detailed ordinance reports cataloguing the condition of arms stores, and yearly military expenditures. One comprehensive ordinance report details the "average cost of each kind of ordnance and small arms, and the accoutrements in each year, from 1798 to 1835." From this document, we find that muskets were in fact cheaper every year than both the breech-loading rifles and carbines. The price of the government musket remains steady at seventeen dollars, whereas the cost of Hall's breech-loading rifle is seventeen dollars and fifty cents. By the late 1820s the cost of the muzzle-loader drops to fourteen dollars and fifty cents, while the breech-loaders listed remain the same.⁵⁷ From these figures, we see that the category of cost was not always something that fell in the breech-loading rifle's favor. In fact, cost was often a criterion of success to be overcome.

⁵⁶ Cowen, *A Social History*, 79.

⁵⁷ *Quantity and Condition of the Ordnance and Ordnance Stores and Arms belonging to the United States at the Armories, Arsenal, Depots, and Forts; and Expenditures at the Several Armories and Arsenal, and for the Manufacture of Hall's Rifles, from 1816 to 1834*, Communicated to the House of Representatives January 5, 1836.

In order to meet the demands of the government, some weapons manufacturers began to highlight the cost effectiveness of their rifles. However, many of these cost effective rifles were of extremely poor quality. In order to find the best rifle contract, the government enacted an old law that required weapons manufacturers to submit a bid for the price of their rifles.⁵⁸ The after extensive testing to eliminate faulty rifles, the award was given to the lowest bidder. Within this criterion of success, it is evident that the breech-loading rifle does not necessarily succeed. As breech-loading rifles become more prevalent, however, we see a shift in the government's stance on cost effectiveness.

Interchangeable Parts

However, the rifle price listings are for complete weapons only. One way in which some breech-loading rifles exacted a measure of success in the cost category was through the system of interchangeable parts. A weapon with a system of interchangeable parts could no longer be judged solely by the price of the whole weapon, or by the original manufacture cost. The machinery used to fabricate the rifle formed all the parts separately to be put together after the fact. With each piece created individually, it became important to problematize the simple cost of a weapon. Now, the cost of a weapon needed to be broken down into its component parts. The first attempt at this began in 1837, when a board of officers tasked weapons manufacturer John H. Hall, one of the most successful implementers of the

⁵⁸ Weigley, *History of the United States Army*, 219.

interchangeable part system, to detail the cost of component parts for the main breech-loading rifles of the day. In his report, Hall lists the pieces of each rifle and their corresponding prices.⁵⁹ In this task, we see the government realizing the potential cost effectiveness of the interchangeable part system. If a piece of the rifle breaks, instead of the rifle being completely worthless, the government need only commission a replacement part for the single broken piece. If some mechanism of the breech becomes faulty, instead of spending seventeen dollars for a new Hall rifle, the government could spend a mere four cents for new breech plate screws, or sixty-three cents for a guard plate.⁶⁰ In this manner, weapons with an interchangeable parts system can be said to succeed under both criteria of cost effectiveness and interchangeable parts.

The direct side of the category of interchangeable parts is much more straightforward. Success in this category comes from testing and practice. The first and simplest question is also the most obvious. Is the weapon actually comprised completely of interchangeable parts? For this category, John Hall believed that a successful interchangeable parts system entailed that one completed rifle would have parts identical to all other rifles of the same model. Hall's rifles can be counted as a success because they have been proven through extensive testing to meet the metrics of success set by Hall. Hall's test for interchangeability is also the most

⁵⁹ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm*, Communicated to the Senate September 19, 1837, 25th Congress, 1st Session, Ex. Doc. No. 740, 475-482.

⁶⁰ *Ibid*, 478.

extreme. To test his claim, he had workers disassemble one-hundred of his rifles, mix the parts up on the table, and then reassemble the one-hundred rifles in no particular order. For this test, there was no way to cheat. Carried out in front of a committee of military officers and weapons experts, this test was definitive proof of the veracity of Halls claim. As we have seen, claiming interchangeable parts and actually having them are two starkly different things. Eli Whitney may have used the platform of interchangeable parts as a main staple in the argument for his weaponry, which bolstered the importance of the category. He may have had a measurement of success almost identical to Hall—having identical parts for all rifles of the same model. Yet Whitney's weapons do not succeed within this category for the simple fact that his products did not have interchangeable parts according to his own measurement of success.

Windage and Recoil

The next direct criteria of success are windage and recoil. The government measured the reduction of windage by the difference in force produced by a given weapon. One experiment tested the penetration power of breech-loading weapons. After firing both the breech-loading weapons and the government muskets at a plank of wood, it was determined that the breech-loading arm penetrated an entire inch further into the wood than the government rifle.⁶¹ The findings of this test

⁶¹ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm, Communicated to the Senate September 19, 1837, 25th Congress, 1st Session, Ex. Doc. No. 740, 468.*

concluded that the arms loading from the breech would send a ball with much greater force than those loading from the muzzle. Having thus out-performed the muzzle-loader, breech-loading weapons manufacturers sought to set their weapons apart from the other breech-loading weapons constructed by their competitors. In another windage test, Colt uses the same amount of powder in his weapons as used in the standard Government arms and Hall's rifle, and then fires the weapons from identical distances into a material with even resistance such as cartridge paper. The results of this test showed that the breech-loading arms produced a greater force than the musket, and that Colt's rifle produced a greater force than Hall's. Colt attributed the success of his rifle to the elimination of windage by his breech-loading mechanism.⁶² Colt then calls attention to the differing breech designs of his weapons and Hall's. In doing this, Colt connects the superior performance of his rifle to his breech design. Colt states that, because his rifle performed better than Hall's rifle and the government musket, the design and principles of his rifle must be better as well. After observing these tests, the board ruled that

One hundred or more of these rifles, as they now are, might be placed in the hands of soldiers now to be found in the second regiment of dragoons...And it is firmly the opinion of the board that, when this firearm is once introduced, and its superiorities over every other became known, it will be universally used.⁶³

⁶² *Report of The Secretary of the Navy*, 3.

⁶³ *Ibid*, 10.

This and other similar boards laud the positive effects of the reduction or the elimination windage, and a call for active military use is surely a sign of success in this category.

Much like the category of interchangeable parts, windage and recoil also become integral aspects of the indirect category of cost effectiveness. The reduction of windage means that the main charge of powder can be smaller. This has the double effect of reducing recoil, and saving money. Less powder per shot means more shots with the same amount of powder. This was important to the government because it meant that they would save money on powder, and because it allowed soldiers in battle to carry more charges, thus increasing their long-term effectiveness in battle.⁶⁴

Durability

The most extensive measure of success comes with the category of durability. The testing for durability needed to account for the many different situations climates, and regions that the rifle might be used. Therefore, within the overarching term of durability, there are several smaller more specific determinants for success. Durability as a whole is an extremely important category for the government, and their testing of new weaponry illustrates that point. Each individual test constitutes its own definition of success. The first of these tests is the effect of exposure to

⁶⁴ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm, Communicated to the Senate September 19, 1837, 25th Congress, 1st Session, Ex. Doc. No. 740, 470.*

weather and the elements. In 1875, a government testing committee tested this by firing the arm repeatedly, and then leaving the arm outside to be exposed to the effects of the sun and rain. They repeated this cycle for three days.⁶⁵ This test was meant to simulate a rifle in the hands of a soldier on the front lines. Although the decision to test for three days was probably arbitrary, the rest of the test is quite calculated. The repeated firing will simulate a battle, and leaving the rifle exposed to the elements will simulate a rifle kept by a soldier as he slept outside. For success in this definition of durability, the rifle would have to continue to perform for the three-day span without breaking down, or becoming muddled by the weather or the repeated firing.

Another test of durability involves the effects of salt water on the weapon. This test was used extensively for naval firearms, but it was used for the army as well. In one particular instance, Colt attempts to sell his weapons to the United States Navy. He does this by putting on a series of demonstrations. To test the effects of salt water, he loads his rifles, along with all the various weapons currently in use by the government, and places them underwater for a length of time. The guns on ships would often be pre-loaded in case of emergency, and this test seeks to simulate those loaded rifles, which would be exposed to the sea for extended periods as they awaited use. The test finds that after exposure to salt water, the government weapons will be useless until the weapons dry or until they are extensively cleaned. In contrast, Colt's weapons will "shoot as well after being

⁶⁵ *Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War, 7.*

underwater for hours as before they were put there at all."⁶⁶ Yet another test for durability deals with the effect of dirt, sand and dust on the weapon.⁶⁷ As with the exposure test, this test simulates the grit that can compromise a soldier's rifle after extended use in foul conditions. There are several different variations of this test, but most of them involve firing the weapon, then pouring sand over the breech mechanism and firing the weapon again to test for negative effects or irregularities. As before, success means no negative effects of sand or dirt for the weapon.

Safety

Some tests for the safety of the weapon also fall under durability. The main tests for the safety of the rifleman deal with the structural integrity of the breech. The first of these tests is the firing of the weapon with a double and then a triple charge of powder.⁶⁸ This extra charge will put a much greater strain on the breech system. If the breech remains intact with a greater charge, then the rifle should be able to withstand repeated firings at the normal charge of powder. Government-formed committees often tested safety in controlled settings. However, there were some individuals—weapons manufacturers, older military officers—who felt that the only true way to test the a weapon for safety was to use it in actual combat, and

⁶⁶ *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt*, May 18, 1840, Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503, 2.

⁶⁷ *Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War, relative to the manufacture at the Springfield Armory of the Roberts breech-loading musket and carbine*, February 3, 1875.-Referred to the Committee on Military Affairs and ordered to be printed, 43rd Congress (house of reps), 2nd session, Ex. Doc. No. 152, 7.

⁶⁸ *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt*, 2-3.

to have the soldiers take responsibility for the weapon in day to day life.⁶⁹ Some officers offered to test new rifles. For one test, involving three different rifles, the government manufactured one thousand of each rifle, and gave them to separate regiments for field-testing.⁷⁰ By doing this, the rifle would experience for real what the government testing could only simulate.

Simplicity of Design

The next direct category of success is simplicity of design. This category breaks down several ways. The first test for simplicity of design was to count the total number of parts that comprised a given rifle. From the late 1830s to well into the 1880s, we find government documents testing the simplicity of breech-loading rifle design. Although some of these tests involve each arm to be disassembled and examined, all tests for simplicity involve obtaining a precise count of the number of pieces that make up the weapon.⁷¹ The government viewed weapons that had fewer parts viewed fewer parts as superior because of an importance placed on field repairs. One committee's report to the Secretary of the Navy, discussing the simplicity of several breech-loading arms, explains "The guns of Hall, and apparently

⁶⁹ For examples of rifles issued to active troops for testing see: *Report of The Secretary of War, In answer to A Resolution of the Senate calling for information in relation to Sharpe's rifle carbine*, March 9, 1859.- Ordered to lie on the table, Motion to print referred to the Committee on Printing, Report in favor of printing submitted, considered, and agreed to, 35th Congress, Special Session, Ex Doc. No. 2.

⁷⁰ *Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War, relative to the manufacture at the Springfield Armory of the Roberts breech-loading musket and carbine*, February 3, 1875.-Referred to the Committee on Military Affairs and ordered to be printed, 43rd Congress (house of reps), 2nd session, Ex. Doc. No. 152, 2.

⁷¹ *Ibid*, 1-2. See also "*Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt*" and "*Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War.*"

of Hackett, presenting in their construction this desired simplicity, are more easily managed, present less accountability to the soldier, and are less liable to get out of order, and when they are so are more easily repaired."⁷² From this document we see the government's desire for weapons simple enough for field repairs. Due to the fact the government placed such a high value on simplicity, some weapons manufacturers went to great lengths to prove the simplicity of their rifles. In multiple letters to the Secretary of the Navy, Colt argues strongly against the notion that his weapons are overly complicated. He implores the naval committee to count the pieces in his rifle and compare them to the government musket and Hall's rifle.

This examination will show that the number of pieces in the locks of my repeating-guns is no more than in the simplest of common construction, and the entire number of pieces composing one of my repeating-guns is considerably less than composing either of the arms now used in Government service.⁷³

A rifle cannot be successful within this criterion of success if it is believed to be overly complex or have too many parts. Colt's avid defense of the claims against his rifle illustrates the importance of the category of simplicity, and reiterates that the measure of success in the category is a minimum number of pieces.

⁷² Report of a board of officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States musket and rifle, and their relative qualities and efficiency, and the cost of manufacturing each arm, Communicated to the Senate, September 19, 1837, 467.

⁷³ Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt, May 18, 1840, Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503, 1-2.

Rapidity of Fire

The final direct category of success is celerity or rapidity of fire. As discussed in the first section, the success in this category was hotly contested. The celerity of fire issue falls into an intense debate between those for the increased rate of fire, and those vehemently against it. Generals were wary of the increased rate of fire brought about by breech-loading technology, because they felt troops would use far too much ammunition.⁷⁴ This would cause a difficult problem if extended battles were to take place far from secure supply lines. In addition, the aversion to increased celerity of fire was written explicitly in military journals on tactics and strategy. The "treatise on the tactical use of the three arms: infantry, artillery, and cavalry," published in 1865, questioned whether breech-loading weaponry would become preferable to muzzle-loading arms. The treatise cites the breech-loading weapons propensity to exhaust ammunition at a much quicker rate. This, in turn, would lead to a cessation of fire and an eventual withdrawal from the field of battle until a new supply of ammunition might arrive. The treatise also makes it clear that it often takes a great deal of time for new supplies to arrive. In addition, the way that the supply lines of the time operated, essential supplies, such as rations and clothing, came in the first supply train, while ammunition was usually carried in the second.⁷⁵ For those individuals who saw increased celerity of fire as a negative, the breech-loading rifle was a failure.

⁷⁴Russell F. Weigley, *History of the United States Army*, (New York: The Macmillan Company), 1967, 238.

⁷⁵ Francis J. Lippitt, *A treatise on the tactical use of the three arms: infantry, artillery, and cavalry*, (New York: D. Van Nostrand), 1865, 56.

The "treatise on the tactical use of each arm" shows the negatives of increased rate of fire, but it also discusses the positives. One of the main arguments for the increased rate of fire was the infantry's ability to repulse mounted units. The "treatise" explains that the breech-loading rifle, and the increased rapidity of fire that comes with it, would be ideal for infantry who are charged by cavalry.⁷⁶ This argument is echoed in several other government documents. In one government report, detailing certain improvements that can be made to certain breech-loading firearms, each arm was tested for its advantages when used against a charge of cavalry.

In sustaining an attack from cavalry, arms have an advantage in proportion to their capacity of keeping up a continuous fire, preserving at the same time their position of defence with the bayonet; the muskets of Hall and Hackett possess this advantage in an eminent degree, being, even during the process of loading, in readiness for personal defence.⁷⁷

For those who held the breech-loading rifle's use against cavalry in high regard, we can take an increase in celerity of fire as a success. Although we see that certain military officials were opposed to the breech-loading technology because of the increased rate of fire, it is apparent that the government is rather positive on the issue of increased rate of fire. A letter to the Secretary of the Navy, from a board of officers, discussing celerity of fire seeks to "show the advantages to be derived from

⁷⁶ Ibid, 56.

⁷⁷ Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm, Communicated to the Senate September 19, 1837, 25th Congress, 1st Session, Ex. Doc. No. 740, 470.

the use of a repeating gun."⁷⁸ The language of this document is very revealing. The document does not seek to simply display the results, but to illustrate the advantages of the weaponry. The teleological argument, which has the benefit of hindsight—seeing the path weapons modifications have taken—uses the increased rate of fire as one of the main reasons for the breech-loading rifle's success. Although, at the time, some individuals within the government may have deemed the breech-loading rifle successful within this criterion, this view was not universal.

⁷⁸ *Report of The Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt, May 18, 1840, Read, and referred to the Committee on Naval Affairs, May 25, 1840, Ordered to be printed, 26th Congress, 1st Session, Ex. Doc. No. 503, 3.*

Conclusion

By the middle of 1866, the United States government was calling upon inventors to come up with a plan for the mass conversion of all muzzle-loading arms to breech-loaders. The response to this task was overwhelming. Of the multitude of different alteration plans, the government selected five that appeared to be the most promising. For each of these five, the government converted fifty muskets to breech-loading rifles according to the principles of each plan. These newly converted breech-loaders were then issued to five separate regiments of U.S. soldiers for testing. After two years of this field-testing, it was determined that the Allin method was the most favorable.⁷⁹ After this result was announced, the Secretary of War directed that "immediate measures be taken for the conversion of twenty-five thousand Springfield muskets into breech-loaders" according to the Allin method. By 1867, the United States had ceased production of muskets and focused entirely on the conversion of muskets to breech-loading rifles.⁸⁰ Over the following years, an ever-increasing number of muskets were converted into breech-loaders and the

⁷⁹ J. B. Ely's Heirs. *Letter from The Secretary of War Relative to The claims against the government on account of the alleged use of certain patented devices in the mechanism of the Springfield breech-loading rifle-muskets*, January 9, 1873,-- Referred to the Committee on Military Affairs and ordered to be printed, 1-2.

⁸⁰ Latham, *Black and white*, 75.

muzzle-loading rifles began to disappear from the hands of American troops, while the breech-loading rifle became the predominant firearm of the U.S. military. In this testing we see an aggressive shift away from muzzle-loading to breech-loading technology.

In this thesis I have argued against teleological assertions concerning technological modifications. These assumptions claim that technological advancement is merely a response to a societal problem. However, this thesis has shown the opposite is true by demonstrating that notions of technological advancement and progression fail to take into account the exterior social implications of technology. In the case of the breech-loading rifle, the technology did not succeed simply because it was better, as the teleological argument suggests. In fact, the breech-loading rifle's shift to prominence was a long process that took over one hundred years. For those loyal to the "Brown Bess," acceptance of the breech-loading technology was no easy feat. Yet the actions of certain historical agents with a vested interest in the success of the breech-loading technology, such as Hall and Colt, brought about technological change. The breech-loading weapons manufacturers not only establish the categories of windage, recoil, interchangeable parts, simplicity of design, durability, safety, and rapidity and celerity of fire as meaningful, but they also construct the metrics of success within the categories. If the category of comparison was important to the government, the weapons manufacturers strove to meet the demands and ensure that their technology was superior within each category. The American breech-loading weapons

manufacturers of the nineteenth century succeeded where British Army Captain Patrick Ferguson could not. These weapons manufacturers crafted the technical categories of comparison through which their rifles would be judged, and masterfully established methods of measurement within these categories that enabled their technology to not only succeed, but to become the dominant military technology.

Bibliography

Primary Sources

Kettell, Thomas Prentice. *History of the great rebellion,; from its commencement to its close, giving an account of its origin, the secession of the southern states, and the formation of the Confederate government, the concentration of the military and financial resources of the federal government ... together with sketches of the lives of all the eminent statesmen and military and naval commanders, with a full and complete index. From official sources.* Hartford, CT: L. Stebbins; F.A Howe, 1866.

Latham, Henry. *Black and white. A journal of a three months' tour in the United States.* Philadelphia: MacMillan and co.; J. P. Lippincott & co., 1867.

Battle-fields of the South, : from Bull Run to Fredericksburgh; with sketches of Confederate commanders, and gossip of the camps. New York: J. Bradburn, 1864.

Lippitt, Francis J. *A treatise on the tactical use of the three arms: infantry, artillery, and cavalry.* New York: D. Van Nostrand, 1865.

McCabe, James Dabney. *Life and campaigns of General Robert E. Lee. By James D. McCabe, jr. With steel plate and maps.* Philadelphia, PA: National Publishing Company, 1870.

Norton, Charles, B. *American Inventions and Improvements in Breech-loading Small Arms, Heavy Ordnance, Machine Guns, Magazine Arms, Fixed Ammunition, Pistols, Projectiles, Explosives, and other Munitions of War, including a chapter on sporting Arms.* Springfield, MA: Chapin & Gould, 1880.

"Sale of Arms to French Agents, Speeches of Hon. Carl Schurz, of Missouri, in the Senate of the United States" In *Pamphlets. American History.* N.P: 1825-1901 from Making of American Books Online Database.

Stebbins, L. *One hundred years' progress of the United States ... With an appendix entitled Marvels that our grandchildren will see; or, One hundred years' progress in the future ... By eminent literary men. Embellished with two hundred and eighty engravings.* Hartford, CT: L. Stebbins, 1870.

Thomas, Jordan. *The campaigns of Lieut.-Gen. N. B. Forrest, and of Forrest's Cavalry ... by General Thomas Jordan and J. P. Pryor.* New York: Blellock & co., 1868.

United States. Navy Department. *Ordnance instructions for the United States Navy*. Washington: Government print. Off., 1866.

U.S. Congress. House. *Letter from the Secretary of War Transmitting a report showing the causes which have delayed an answer to the resolution of the House of Representatives of the 11th of February, 1839, respecting the prices at which muskets, rifles, and pistols, might be procured at private armories, &c., &c.* May 21, 1840.

U.S. Congress. House. *On a Proposition to Purchase the Patent Right of John H. Hall for Making Rifles, And For His Employment to Superintend the Manufacture of the Same*. 24th Congress, 1st Session, 1836, Serial Set Vol. No. 649.

U.S. Congress. House. *Quantity and Condition of the Ordnance and Ordnance Stores and Arms belonging to the United States at the Armories, Arsenals, Depots, and Forts; and Expenditures at the Several Armories and Arsenals, and for the Manufacture of Hall's Rifles, from 1816 to 1834*. Communicated to the House of Representatives January 5, 1836.

U.S. Congress. House. *Roberts Breech-Loading Musket and Carbine. Letter from the Secretary of War, relative to the manufacture at the Springfield Armory of the Roberts breech-loading musket ad carbine*. 43rd Congress, 2nd session, 1875, Ex. Doc. No. 152.

U.S. Congress. *Report of a Board of Officers on improvements in fire-arms by Hall, Colt, Cochran, Hackett, Fisher, and Leavitt, as compared with the United States Musket and Rifle, and their relative qualities and efficiency, and the cost of Manufacturing each arm*. 25th Congress, 1st Session, 1837, Ex. Doc. No. 740.

U.S. Congress. *Report of the Secretary of the Navy, In compliance With the Resolution of the Senate, in relation to the adoption of the improved boarding-pistols and rifles invented by Samuel Colt*. 26th Congress, 1st Session, 1840, Ex. Doc. No. 503.

U.S. Congress. *Report from the Secretary of the Navy, in compliance with a resolution of the Senate, in relation to the adoption to the improved boarding pistols and rifles invented by Samuel Colt*. 26th Congress, 1st Session, 1840, Ex. Doc. No. 503.

U.S. Congress. *Report of The Secretary of War, In answer to A Resolution of the Senate calling for information in relation to Sharpe's rifle carbine.* 35th Congress, Special Session, 1859, Ex Doc. No. 2.

U.S. Senate Committee on Military Affairs. *J. B. Ely's Heirs. Letter from The Secretary of War Relative to The claims against the government on account of the alleged use of certain patented devices in the mechanism of the Springfield breech-loading rifle-muskets.* 42nd Congress, 3rd session, 1873, Ex. Doc. No. 72.

U.S. Congress. Senate. *On the Purchase of the Patent Right of John H. Hall to his Rifle, and on Making Provision for his Employment for Making the Same.* 24th Congress, 2nd Session, 1837, Serial Set Vol. No. 712.

U.S. Congress. Senate. *On the Importance and superiority of Halls rifle for the public service, and the propriety of making compensation to the inventor for its use,* 25th Congress, 2nd Session, 1837, Serial Set Vol. No. 747.

Secondary Sources

Carman, W. Y. *A History of Firearms; From Earliest Times to 1914.* London: Routledge & Kegan Paul Ltd, 1955.

Collins, Harry and Pinch, Trevor. *The Golem at Large : what you should know about technology.* New York: Cambridge University Press, 1998.

Cowen, Ruth Schwartz. *A Social History of American Technology.* New York: Oxford University Press, 19

Green, Constance M. *Eli Whitney and the Birth of American Technology.* New York, 1956.

Macksey, Kenneth. *Technology in War: The Impact of Science on Weapon Development and Modern Battle.* New York: Prentice Hall Press, 1986.

McWhiney, Grady and Jamieson, Perry D., *Attack and Die : Civil War Military Tactics and the Southern Heritage.* University, Alabama: The University of Alabama Press, 1982.

Millett Allen R., and Maslowski, Peter. *For the Common Defense: a Military History of the United States of America.* New York: The Free Press, 1984.

Weigley, Russell F. *History of the United States Army*. New York: The Macmillan Company, 1967.

Wilkinson, Frederick. *Arms and Armour*. London: The Hamlyn Publishing Group Limited, 1978.