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The Steam Engine and How it Revolutionized Modern Power
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Historical Paper

The steam engine revolutionized the way we view energy today and sparked the industrial revolution; an event that changed the world forever. The steam engine drove the world into the modern age as we know it and was arguably the most revolutionary idea of its day. Before steam power, artisans used every bit of their own energy to handcraft items necessary to their lives. As Andrew Ure, a scientific philosopher, once said, "The grand object therefore of the modern manufacturer is, through the union of capital and science, to reduce the task of his work-people" (Revolution, Liberalism and Nationalism). This was revolutionary. For the first time in history, immense amounts of work did not have to be done by human or animal labor. Upon the development of the steam engine, energy was completely changed, causing a reaction almost ending the way humans have powered things since the dawn of our beginnings.

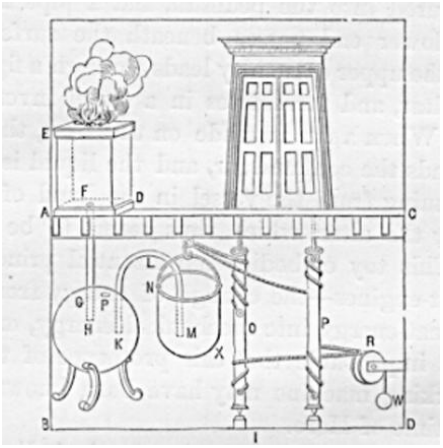
Before the power of steam, people relied on animals and their own muscles for power to construct buildings and grind grain (Kras 6). Animals, such as oxen and donkeys, were used to help build structures and lay roads. Later, people used running water to turn waterwheels for crushing stone, grinding grain and pumping water up from wells (Kras 7). Wind power was also harnessed before steam power. Windmills were used to grind grain. Some windmills had large scoops that lifted water out of marshlands so people could farm. These waterwheels and windmills were revolutionary for the time, because an energy source was almost constantly working. Unfortunately, waterwheels and windmills were not always effective, as the wind did not always blow, and water could dry up or freeze (Kras 8).

Previous to steam engines, people had to pump huge amounts of water from mines. Men had to drain the water by hand when they dug farther down. Sometimes more water seeped in which could take months to drain (Kras 8). Travel by land was also a problem before steam power, as roads were mere dirt tracks which turned muddy when it rained (Kras 9). Stagecoaches

were pulled by horses, but were ineffective as they had a lethargic speed of about eight miles per hour. Stagecoaches could only carry 25 pounds of luggage and, unlike locomotives, horses had to be refreshed and fed often. Other forms of transportation included covered wagons, handcarts, horses, or by foot. Before threshing machines powered by steam, grinding wheat and other agricultural tasks were done mainly by hand or with the help of oxen or horses (Kras 10).

Before the advent of steamboats, ships were powered by wind, men rowing oars, or the current of the water (Kras 11). These methods were not very reliable, as the wind would not always blow, men would tire of rowing, and going against a current was practically impossible without the two other power sources being available (Kras 12). Long before the steam engine and even other machines that helped manufacture textiles, people made fabric by hand. This took large amounts of time and not everybody had this skill (Kras 13). Prior to textile mills, most fabric was made at home. Like early fabric making, shipbuilding and furniture-making was done by hand (Kras 15).

The history of steam power began long before it was even thought about as an energy source. The earliest form of steam power came around the year 100 C.E., when Hero of Alexandria, a Greek inventor in Egypt, created a device powered by steam (Collier 12). This idea was so revolutionary, Greek citizens thought the steam power was the work of the gods. After Hero's ideas, there was a long period of time with no documented uses of steam power until the 1600s. A good portion of these later innovators were Italian or English. In the 1600s, Edward Somerset (DeFord 6), Giambattista Della Porta (Collier 12), Salomon de Caus (Collier 15), Giovanni Branca (Kras 11), and Samuel



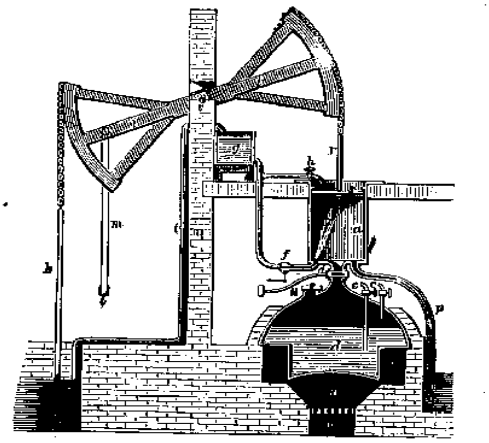
Hero of Alexandria's apparatus
(A History of the Growth of the Steam Engine Thurston)

Morland (Collier 15) built and tested many steam powered apparatuses which inspired later engineers to attempt power from steam. Principles like Morland's and earlier steam powered device inventors were different from Newcomen's and Watt's whose used an atmospheric steam engine, which applied the principles of atmospheric pressure (Collier 15). Most of these ideas had a large reaction on the world of science at the time, and soon more engineers wanted to get in on the action.

In the late 1700s and 1800s, people focused on improving the steam engine from its crude form. Between 1779 and 1787, James Picard and others developed innovations to steam engines like a crank, a flywheel, and other apparatuses that were almost as important as the earlier ideas of the 1600s innovators (Collier 102). In 1802, Richard Trevithick created a threshing machine powered directly by steam, unlike other steam engines of the time (Collier 103). Later, in 1804, Oliver Evans, an American, patented his Columbian steam engine which was smaller, cheaper to build, and easier to run and take care of than the British engines, proving it wasn't only the British who were experiencing a steam revolution (DeFord 28). These small improvements and ideas soon lead to the refined steam engine.

Although these inventors were important, they did not make as many contributions to steam technology as Thomas Savery, and Thomas Newcomen. In 1698, Thomas Savery patented the first crude steam engine based on the Frenchman Denis Papin's pressure cooker of 1629 and turned a good idea into a revolutionary new way to view energy sources (Steam Engine History). Soon after in 1702, Thomas Savery set up the world's first steam-pump manufacturing shop in London, ready to sell his machines to mines (DeFord 11). Unfortunately, his first engine was not very efficient. Boiler explosions and meltdowns were common. Even Savery knew this, as he said in a book he wrote for miners ". . . and, therefore, present you with a draught of my

machine, and lay before you the uses of it, and leave it to your consideration whether it be worth your while to make use of it or no." (Savery). Enter Thomas Newcomen, the inventor who made some of the greatest improvements to the steam engine, but is rarely recognized. Thomas Newcomen was an English blacksmith who lived from 1663-1729, and is arguably considered the inventor of the atmospheric steam engine - an improvement over Thomas Savery's design (Steam Engine History). Savery's problems with boiler explosions and meltdowns were solved by Thomas Newcomen. Newcomen engines were extremely inefficient though, because the steam cylinder had to constantly be cooled and heated, wasting a large amount of energy (Steam Engine History). Although inefficient, these engines were the best at the time, and were soon widely used all around Britain.



Newcomen's atmospheric steam engine (A History of the Growth of the Steam Engine Thurston)

Savery and Newcomen designed atmospheric steam engines, which used atmospheric pressure to help with the steam cycle. This revolutionary type of steam engine was the first to be put into widespread use. It was vital to create a vacuum for this type of steam engine. Some of the first vacuum experiments took place in the 1600s, around the same time as some of the first steam power experiments. In 1654, Otto von Guericke developed an air pump to create vacuums. Concurrently, a man named Evangelista Torricelli did important work on vacuums (Collier 15-17). With the assistance of Robert Hooke, in 1658, Robert Boyle designed an important type of air pump in which he created his vacuum (Hills 13). Circa 1690, a Frenchman named Denis

Papin in London created a vacuum using steam, an incredible breakthrough for atmospheric steam technology. (Collier 18). These contributors influenced further steam engine engineers.

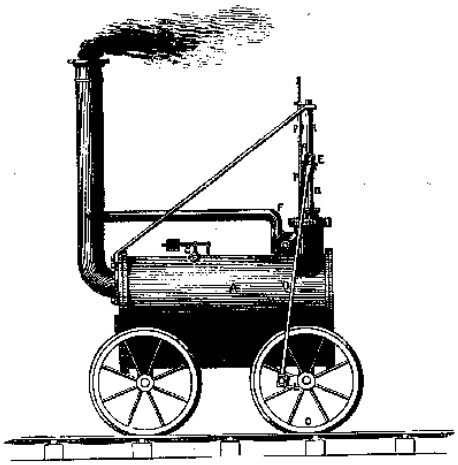
Although Savery and Newcomen were important steam engine technology contributors, they did not make as many contributions as James Watt. Watt is widely considered the most important and revolutionary contributor to the steam engine. His name caused such a reaction, people named a unit measuring electricity a "watt." A Scottish inventor and mechanical engineer, Watt built upon Newcomen's work on the steam engine (Steam Engine History). In 1763, James Watt was sent a Newcomen engine to repair, and while working on it, discovered how to make it more efficient. After working for several months, he produced a steam engine that cooled the used steam in a condenser separate from the main cylinder (Rotaary [sic] Steam Engine). Watt said in his own words, his mind "ran on making engines cheap as well as good" (Rosen). James Watt accomplished just that. The new and efficient Watt Steam Engine was smaller than the Newcomen Engine, and required much less water and coal (Collier 36). In 1769, James Watt patented the separate condensing chamber for the steam engine he designed six years earlier (The Great Idea Finder). On May 8, 1776, James Watt teamed with Matthew Boulton to operate the first of the new Watt Steam Engines at the Bloomfield Colliery, the beginning of a revolutionary era of Watt steam engines that soon powered the world (Collier 31). Matthew Boulton once said "I sell here, Sir, what all the world desires to have-POWER" (Steam Engine Quotes), proving himself to be critical to Watt's business success. This was a revolutionary idea, not because power was a new idea, but because

James Watt (A History of the Growth of the Steam Engine Thurston)

a more efficient power system had been discovered. In 1784, James Watt even patented a crude steam locomotive, opening a gateway for other innovators to pursue steam travel by land (The Great Idea Finder). Aside from a separate condensing chamber, Watt also developed a steam engine indicator that tracked the movement of the engines' pistons (DeFord 19). In 1800, Watt retired from Boulton & Watt, and his patent expired. Other inventors and engineers would improve upon and produce steam engines, but Watt's revolutionary legacy will never be forgotten (DeFord 19).

Other than powering factories and textile mills, steam engines were used to power boats. Most of the first actual steam boats were made by Americans. One of the first attempts at steam navigation was with Blasco de Garay, a Spanish inventor who claimed to use steam to move a vessel in 1543. Although facts of this account are vague, it still held a revolutionary idea for the time (DeFord 27). The credit for the first documented working steamboat goes to John Fitch. This steamboat was tested in 1787 on the Delaware River (Collier 36). In this same year, James Rumsey demonstrated his steamboat on the Potomac River (Collier 36). In 1807, Robert Fulton's *Clermont* was the first steamboat to offer regular passenger service in the U.S., soon serving as an example for other businesses and countries to think about public steamboat transportation (Collier 103). The first transatlantic liner to employ a screw propeller was the *Great Britain* in 1843 (Collier 103). *The Savannah* was the first transatlantic liner to complete a voyage powered entirely by steam, proving to the world that long voyages across ocean were possible with steam engines (Collier 103). These steamboats caused a reaction that meant traveling across oceans was a very simple thing to do.

Steam engines were also used to power vehicles, mainly trains. Around the 1760s, Nicholas-Joseph Cugnot built what many consider to be the first car, powered by a steam engine created to haul artillery guns around a battlefield, but was never put to use because of an accidental crash (DeFord 20). This first "car" sparked the imagination of later inventors and revolutionized traveling long distances across land. Later, in1804, Richard Trevithick successfully operated Trevithick Railway at Pen-y-Darren, in southern Wales, being one of the first railways to be put to use. The first public railway to use steam locomotives, the Stockton and Darlington Railway, began service in 1825 (Collier 102-103). By now, Americans were building long railroads for travelling across their vast country. In 1838, the Great Western Railway opened, and in 1869, the transcontinental railroad was completed, being one of the longest railroads in the world (Collier 104).



Trevithick's Locomotive (A History of the Growth of the Steam Engine Thurston)

One of the main uses of the steam engine (and ultimately the reason it was first created) was for production. As mentioned earlier, producing goods and harvesting food was inefficient, unproductive, and unreliable. With the arrival of steam power, producing everyday items was simple, and more people could get jobs. Steam engines powered wheels that wove fabric in textile mills, and powered conveyer belts in production factories so moving goods was easier (Hills vii). The arrival of this new invention revolutionized production. In the words of Richard Guest, a steam engine author, "It was the application of steam

A factory production room (Revolution, Liberalism, and Nationalism)

power which accelerated the centralization of textile production in factories" (Industrial Revolution). Almost the entire world's economy became based on industrial production, and the steam engine became an indispensable part of this process.

When the first useful steam engines came into production, their popularity exploded, creating a reaction of epic proportions. By 1755, Newcomen's engines were used all over North Africa and Europe (DeFord 13). Between 1790 and 1800, more steam engines were produced than in the entire century before (DeFord 19). When James Watt retired in 1800, there were over 500 "Watt" machines in Britain's mines and factories (Rotaary [sic] Steam Engine). Even the U.S. had 250 companies devoted to producing steam engines by 1838 (DeFord 32).

To this day if we never had the power of steam, we would seem no more evolved than our ancient ancestors. Steam has always been around, but as Ralph Waldo Emerson, a famous writer once said, "Steam is no stronger now than it was a hundred years ago but it is put to better use" (Quotes about Steam and Machine). Through steam's power, nations have been fed, traveling across continents and oceans has been easier, and almost everything necessary for life has been produced thanks to some of the most important minds in history. The steam engine did more than just power engines, it employed the unemployed and reorganized social structure. It had such a reaction on society and thinking, that American scientist Lawrence Joseph Henderson once said, "Science owes more to the steam engine than the steam engine owes to science" (Steam Engine Quotes Henderson). The Industrial Revolution in which steam power was brought to attention didn't just change a nation or an idea; it literally made the modern world. This revolution reformed science, economy, jobs, travel, agriculture, construction; more than any other single idea in history. It took more than one-thousand years for the steam engine to be fully developed, but its reaction on the world will last for all posterity.

Works Cited

Primary Sources

"Industrial Revolution." *Fordham University Ancient History Sourcebook*. N.p., n.d. Web. 4 Feb 2010 <http://www.fordham.edu/halsall/mod/modsbook14.asp
This transcript of Richard Guest's excerpts helped me understand the impact of steam power on textile production in the 1820s.

"Revolution, Liberalism, and Nationalism." *Primary Source Links for the Industrial Revolution*. N.p., n.d. Web. 4 Feb 2012. <http://www.uncp.edu/home/rwb/hst329_p3.html>.
This website gave me a picture of a factory and a quote by Andrew Ure about the revolutionizing idea of replacing muscle with steam, and proved to be very informative.

Savery, Thomas. *The Miner's Friend;or, An Engine to Raise Water by Fire,Described.*. London: Printed for S Crouchat the Corner of Pope's Head-Alley in Cornhill, 1702. eBook. <http://books.google.com/ebooks/reader?id=v_-yJ5c5a98C&printsec=frontcover&output=reader&pg=GBS.PA1>.
This resourceful book was written by Thomas Savery himself who discussed his relationship between English miners and the usefulness and effectiveness of his steam engine.

"Steam Engine Quotes." *Today in Science History*. Boswell's Life of Johnson (1934-50), Vol. 2, 459., 2012. Web. 25 Jan 2012. <http://www.todayinsci.com/QuotationsCategories/S_Cat/SteamEngine-Quotations.htm>.
This website was helpful in my understanding on the importance the steam engine had on the world's power by giving me a quote by Matthew Boulton.

Thurston, Robert H.. *A History of the Growth of the Steam Engine*. D. Appleton & Co., 1878. Web. 25 Jan 2012. <http://www.history.rochester.edu/steam/thurston/1878/>.
This source has been very useful and gave me most of the pictures in my paper, letting me know what machines and people of the industrial revolution looked like.

Secondary Sources

Collier, James Lincoln. *Steam Engines*. 1st. New York City: Benchmark Books, 2005. Print.
This book was extremely beneficial and contained a lot of information on steam boats, trains, and early steam engine engineers.

DeFord, Deborah H. *The Steam Engine*. 1st. Milwaukee: World Almanac Library, 2005. Print.
This book gave plenty of general facts on the development of the steam engine itself and atmospheric pressure.

Hills, Richard L. *Power from Steam, a History of the Stationary Steam Engine*. Cambridge: Cambridge Univ Pr, 1995. Print.
This source has been contributive and provided plenty of broad information on the steam engine.

"James Watt." *The Great Idea Finder*. Vaunt Design Group, 2006. Web. 05 November 2011. <http://www.ideafinder.com/history/inventors/watt.htm>.
This derivation gave me illumination and a better understanding on James Watt.

Kras, Sara. *The Steam Engine*. 1st. New York City: Chelsea House Publishers, 2004. Print.
This source was very helpful to me and gave me all of my information on the way work was done before the power of steam.

Lira, Carl. "A Brief History of the Steam Engine." *Steam Engine History*. Carl T. Lira, 04 F. Web. 04 November 2011. <http://www.egr.msu.edu/~lira/supp/steam/>.
This website gave me limited information on the steam engine.

"Quotes About Steam and Machines." *Steampunkery.com*. N.p., n.d. Web. 4 Feb 2012. <http://www.steampunkery.com/firstera/steamquotes.htm>.
This website has been useful in my understanding on the effect of the steam engine on society by giving me a good quote from Ralph Waldo Emerson.

Rosen, W. *The most powerful idea in the world, a story of steam, industry, and invention*. New York City: Random House Inc., 2010. Print.
This book quoted James Watt and was resourceful by telling me how Watt thought of making his engines.

"Rotaary [sic] Steam Engine." *Spartacus Educational.com*. N.P., n.d. Web. 06 November 2011. <http://www.spartacus.schoolnet.co.uk/TEXrotary.htm>.
This website has been somewhat helpful and gave me a few facts on the rotary steam engine.

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"Steam Engine History." *About.com*. N.P., 2011. Web. 06 November 2011 <http://inventors.about.com/library/inventors/blsteamengine.htm>.
This source proved generally contributive and gave me material on some important individual steam engine engineers.