**HUMANITIES INSTITUTE**

# NORTH AMERICAN SCIENCE

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**Overview** North America has benefitted from the expansionist aspirations of the waves of newcomers who came to the continent, whose goals were to construct a utopia that provided almost unlimited potential for prosperity and self-actualization for all. As a result, scientific investigation, particularly when coupled with innovation of processes and new technologies, has been encouraged, often with stunning results.

## PreHistory

**Clovis culture (18,000 – 8,000 BC):** We do not know much about the scientific knowledge of the Clovis culture, but we do know that they studied astronomy and also were students of animal behavior (which allowed them to be effective hunters).

## Classical

**Southwest Pueblo (1200 BCE – 1300 AC):** The Pueblo Indians studied astronomy and developed complex calendars. In order to survive in an arid climate, they developed many innovative methods of irrigation, including a bar ditch system and aqueducts. They also developed unique hybrid crops, including different types of beans, corn, squash, and chili peppers. They also developed an understanding of geology as they created homes in the mountains, and carved cliff dwellings.

**Eastern Woodlands (1000 BCE – 1000 AD):** The Iroquois, Algonquin and other Indian nations practiced precision farming which allowed them to live in small villages and cultivate fields, where they rotated crops and developed practices such as fertilization and natural pest control.

**Mississippian (800 – 1500 AD):** The great Mound Builders of the Mississippi Valley of North America were masters of construction science as they build ceremonial platforms, irrigation ditches, and also earthworks in the shape of sine waves (the famous “Serpent Mounds.” In addition, they were students of astronomy and had rituals the coincided with positions of the sun, moon, and stars. They also needed to understand geology and civil engineering to be able to construct ceremonial mounds.

## Colonial (Early Modern)

**Samuel Winslow (1641):** From the beginning, perhaps because of its isolation and perhaps because of the aspirational nature of their quest to establish themselves in the New England colonies, there were many innovations and inventions. Samuel Winslow developed a new way of making salt in the 17th century. Later, understanding the value of intellectual property, the new nation created the U.S. Patent Office in 1790, which issued its first patent to Samuel Hopkins (born in Vermont) who developed a new process for making potash.

**Benjamin Franklin:** Franklin was a persistent writer, researcher, and inventor. His inventionsincluded swim fins (wooden), shaped like lily pads and intended for use on the hands. He also invented the Franklin stove, the lightning rod, and bifocals. He also invented the flexible urinary catheter to help his brother when he suffered with bladder stones.

**Thomas Jefferson:** A student of agronomy, Jefferson’s estate at Monticello contains examples of his interest in optimizing crops and being a scientific farmer.

**David Rittenhouse:** Rittenhouse was a student of astronomy and develop telescopes that he used in conjunction with investigations of the stars and planetary bodies.

**Charles Willson Peale**: A truly diversified scholar, Peale was an accomplished painter as well as scientists. He was interested in chemistry, physics, and engineering, and used his knowledge and curiosity to develop a mechanical drawing device 9the physiognotrace). Peale was very interested in natural history, and one of his paintings, "The Exhumation of the Mastadon", is a valuable record of early archeological excavations. It was the world's first fully articulated prehistoric skeleton. It was found near Montgomery, New York.

Charles Willson Peale. "The Exhumation of the Mastadon" (1806). (source: wikipedia)

**Benjamin Rush**: One of the Founding Fathers of the United States, Rush was a practicing medical doctor who was one of the first to believe that mental illness is a disease of the mind and has neurological origins. Rush wrote extensively to support a scientific approach to mental illness and to counter the belief that mental illness was caused by the "possession of demons."

## Nineteenth Century

**First Industrial Revolution:** If we look objectively at the dramatic changes that occurred in North America, we can see that many had as their foundation a few breakthroughs in the understanding of materials, thermodynamics, and electricity, which made it possible to invent the components that went into some of the main mechanical breakthroughs. They were the steam engine, electrical generation, the Bessemer process (steel) and the use of hydropower. With those scientific breakthroughs, the following transformative innovations were possible in the first part of the 19th century.

**Oliver Evans (automatic flour mill):** Automated the mill process by incorporating bucket elevators, screw conveyors, and a hopper to spread, cools, and dry the ground grain meal.

**Robert Fulton:** The steamboat made transportation of people and products along the large river systems of the U.S., primarily the Mississippi, Missouri, and Ohio rivers.

**Samuel Morse:** Using electricity, the telegraph (incorporating Morse code), made it possible to communicate rapidly and thus foster new levels of commercial and social engagement.

**Eli Whitney (cotton gin):** Without the cotton gin, the plantation system of the South would not have been profitable because cotton seeds were notoriously difficult to separate from the cotton boll. Whitney's invention, together with steam-powered farm equipment transformed the American South.

**Tabitha Babbit (circular saw):** First developed for use in a saw mill, Tabitha Babbitt envisioned a round sawblade that would rotate in one place, effectively sawing logs or boards. It made it possible for anyone to saw wood, no matter what their physical characteristic.

**Cyrus McCormick:** One of the steam-powered agricultural equipment inventions, the reaper made it possible to harvest fields without armies of individuals. It made it possible develop a farming economy that did not rely on massive amounts of labor.

**Hiram Moore:** This combine harvester was even more effective because it combined functions in harvesting grains, corn, sorghum, and other crops.

**Elias Moore:** Complementing the cotton gin and the cloth-making textile mills (powered by hydropower), Moore's sewing machine helped create a garment industry in the Northeast and also the South of the United States.

**Second Industrial Revolution:** Characterized by breakthroughs in transportation, communication, medicine, and public health, the Second Industrial Revolution was based on new scientific understanding in the areas of electricity, chemistry, physics, material science, botany, and medicine. The new technology in the area of transportation (the automobile, the bicycle, the airplane, motorcycle, etc.) allowed more mobility than ever. More profoundly, it changed the texture of American life, as infrastructure was designed and constructed, and which actually became the focal point not only of commerce, but also culture.

**Thomas Alva Edison:** Credited for inventing the lightbulb, phonograph, and much more, it is perhaps not fair to give Edison the credit for all the inventions since he actually hired scientists and inventors to work for him, in what was, in essence, a patent farm. He was a brilliant marketer as well as an astute judge of quality.

**Charles Edgar Duryea:** Responsible for the very first combustion engine to be used in a car, Duryea's automobile was an immediate point of fascination and anxiety about the future. His car, which used the internal combustion engine, was very popular, but not mass-produced.

**Nikola Tesla:** Tesla, an immigrant, invented the alternating current (AC), induction motor, polyphase systems for generating electrical power.

**<u>Twentieth Century</u>**

**Overview:** The enabling sciences for the explosion of technological breakthroughs included a better understanding of physics, chemistry, materials science, and mathematics. New abilities to process complex mathematics and to fabricate new materials made inventions possible that totally transformed every aspect of life. Ironically, the same breakthroughs that could have enormous positive impact also

had deadly ones, such as in the case of nuclear physics, and the development of the nuclear bomb, but also nuclear power.

**Vladimir Zworykin**: Known for perfecting x-rays and the cathode ray tube, Zworykin has been credited for developing the early television. Originally from Russia, Zworykin, like many others, moved the U.S. to escape political oppression.

**Niels Bohr:** With other early 20th-century physicists, Bohr made contributions to the understanding of the atom, of subatomic particles, and nuclear physics.

**Medicine:** Understanding in the area of microbiology, anatomy, and also in the ability see (microscopes) and to image (xray, ultrasound, scanning electron images) made it possible to evaluate medical conditions in a new way, and to devise new, ethical experiments and treatment protocols. Great advances were also made in pharmacology, with breakthrough developments in pain management and anesthesia, enabling better surgical procedures. Other breakthroughs in the use of genetics to develop more effective antibiotics and immunizations had dramatically positive effects on the population.

**Edward Teller:** Known as the "father of the hydrogen bomb," Edward Teller advanced theoretical physics to the point that his group at Los Alamos Lab in New Mexico was able to harness nuclear fission and create the atomic bomb.

**Wilbur and Orville Wright:** Often in competition with Curtiss (in upstate New York), the Wright brothers perfected the first flying machine in the U.S., which had its first flight at Kitty Hawk, North Carolina.

**John Bardeen:** Miniaturization and solid-state electronics were key elements in the development of fast, economical super-computing. John Bardeen invented the transistor, which was the first step to miniaturization.

**Space travel:** The scientists at NASA were funded by a U.S. government eager to show dominance in the Cold War. While the U.S. space program achieved remarkable results and fascinated the public, there were also many breakthroughs that benefited the world in unexpected ways. Space travel was accompanied by breakthroughs in plastics, new lightweight materials, electronics, optics, computing, new fabrics, and medicine.

**Medicine:** NIH (National Institutes of Health) led research in molecular genetics, genomics, biochemistry to identify, prevent, diagnose, and treat disease and disability. Combined with a private and well-funded health industry, dramatic breakthroughs occurred in the area of medical imaging (x-rays, acoustic, nuclear/ radiography, magnetic, etc.) laser technologies (surgery, etc.), immunology, public health (vaccinations, women's health), DNA / human genome mapping, improved pharmaceuticals, and more.

**Telecommunications:** Telegraph, telephones, radio and television broadcasts, satellite transmissions are just some of the ways in which a deeper understanding of physics combined with mathematics and computing power have transformed the United States.

Questions:

1. Early cultures used science and technology in conjunction with their social, religious, and commercial lives. Describe how astronomy figured into the religious lives of early civilizations in North America. Then, explain how a knowledge of geology and construction science were necessary in the construction of cliff dwellings, ceremonial mounds, and more.

2. "Gentleman farmers" were important innovators in the English colonies because they grew the crops (tobacco, cotton, indigo, sugar) that made lucrative commerce with the mills of England possible. In order to be able to provide the volume and quality of raw materials needed, the "gentleman farmers" often turned into quite formidable agronomists. Describe three examples of innovations and scientific investigation in the plantations and large farms in the North America.

3. There were two distinct Industrial Revolutions in the 19th century. The first one took place in the first part of the century and encompassed a bit of the late 18th century. The second took place toward the end of the 19th century and spilled into the 20th century. Please describe each, and then compare and contrast them. How did the scientific discoveries, applied science, and technological innovations transform the country?

4. The twentieth century presents a dizzying array of truly society-changing inventions and scientific breakthroughs. And yet, the foundational building blocks upon which these are constructed are few. They include the development of a better understanding of the structure of matter (the atom, etc.), the ability to process vast arrays of numbers (supercomputing), and an understanding of electricity. Select a few examples of the most society-transforming inventions and discuss a) the role of physics, computing, and energy. Then, select one scientific breakthrough of the 20th century and discuss its impact for now and the future.

Readings


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