

How a Few Simple Things Changed History

Class 8

William A. Reader

E-mail: wreader@cox.net

1

What We Will Cover Today

- Clock
 - Consequences of the Clock
 - Clocks & Navigation
 - Watches
- Steamboat/Steamship
- Typewriter
- Air Conditioner

2

Consequences of the Clock - 4

- Gave rise to the concept that time was something that could be saved and used
- Gave rise to the notion of “being on time”
- Once railroads and steamships came on the scene, gave rise to timetables

3

Consequences of the Clock - 5

- The clock created the idea of a numerically quantified and mechanical universe
 - Gave rise in the 18th century to the Deist notion that the universe was analogous to a clock that God wound up at the beginning of time and allowed to unwind in accordance with Newtonian laws
 - Deism provided the first intellectual challenge to Christianity since the rise of Islam

4

Deist God - The overall impact of the deists was to achieve a major transformation in the concept of God. The Deist God was the God of all the universe, compatible, as Alexander Pope said, with the new astronomy and natural science. The Deist God was a law-making and law-abiding deity, identified with the 'unending repetitions and orderly behavior of nature. He did not intervene in nature to perform miracles nor did He become incarnate as a man. Thus, the Deists denied the Trinity, the divinity of Christ, the possibility of divine revelation, Original Sin, and the Bible as the Word of God. Prominent deists included Voltaire, Jean-Jacques Rousseau, Thomas Jefferson, Benjamin Franklin, George Washington, Maximilien Robespierre, and Immanuel Kant.

Impact of Deism

- Led to the alienation of Western intellectuals from traditional Christianity
 - In America, this led to the First Amendment and the separation of church and state
 - In France, it eventually, in combination with other factors, led to the French Revolution
- Eventually led many intellectuals to agnosticism and atheism
 - Some Deists became Unitarians while others reverted back to traditional Christianity

5

In both Europe and America, however, deism eventually foundered and it did so because it fell between two stools. It was too adventurous and too abstract to comfort the devout, the traditional and the orthodox, while at the same time it was seen as too timid to appeal to the truly skeptical. Nevertheless, it served as a sort of half-way house for the most radical change in ideas since the birth of ethical monotheism. Many people could not have gone directly from orthodox belief to atheism. Deism eased the way.

Consequences of the Clock - 6

- Impacted upon Western theology and philosophy
 - Paley used the analogy of a watch implying the existence of a watchmaker to argue that the existence of the universe implied the existence of God

6

The Clock & Navigation

- The clock facilitated ocean-going navigation
 - One problem that led to many shipwrecks was not knowing where your ship was – latitude could be precisely determined but not longitude
 - But longitude could be understood as a function of time – every 24 hours the earth rotates through 360°
 - Each degree of longitude equals 4 minutes of time

7

Determining latitude & longitude - Determining latitude is simple. One simply measures the altitudes of either the sun at noon or (in the northern hemisphere) the constant pole star at night. Already in the Middle Ages, there were astronomical tables showing the height of the noonday sun throughout the year at different latitudes. Sailors could use a sighting instrument such as a quadrant or a cross staff to determine the height of the sun at noon and then, by referring to the tables, be able to fix their latitude within half a degree. Longitude, however, was another matter entirely, and it was longitude that needed to be determined once explorers began to travel out into the oceans in an east-west direction

The Clock & Navigation - 2

- In 1707, 4 Royal Navy ships capsized off the Scilly Isles because of a longitude miscalculation
 - In 1714, Queen Anne offered a £20,000 reward to anyone who found a way to calculate longitude to within half a degree
- What was needed was a clock that could keep precise time at sea
- In 1759, clockmaker John Harrison created a chronometer that could do just that.

8

Scilly shipwreck - After four ships of the Royal Navy carrying 2,000 men capsized off the Scilly Isles in 1707 because of miscalculated longitude, Queen Anne in 1714 offered a £20,000 reward to anyone who could find a way to calculate longitude to within half a degree. The test would be a trip to Jamaica, where the longitude on land had already been determined by astronomical means.

Using a clock to determine longitude – If one knew the time at both your current location and the time at the 0⁰ meridian, you could calculate (or use tables to calculate) your current longitude. The problem was making a clock that could keep precise time at sea upon a ship that rolled with the waves.

Harrison's chronometer – In 1759, Harrison created a 5.2" chronometer designated H.4 which could keep precise time at sea. When it was tested on a trip to Jamaica and back during the winter of 1761-62, it lost only five seconds on the trip out (which translated into a longitude error of only 1.25 nautical miles), and, despite numerous storms on the return trip, less than two minutes for the entire round-trip voyage.

The Clock & Mass Production

- The clock and the gun were the first precision-machined items to be mass-produced
 - In 1806, Eli Terry began mass production of clocks
 - In 1838, the brass clock was invented
- Starting in the late-18th century, the French-speaking Jura section of Switzerland became the world's center of watch manufacture

9

While Eli Whitney was producing precision-machined rifles with interchangeable parts, another Connecticut Yankee, Eli Terry, was doing the same thing with clocks. There are suggestions that the two men met, but it is more probable that word of Whitney's techniques had gotten around. Terry started by making his wooden clock parts with a hand-operated wheel and pinion-cutting engine, but by 1806 he had signed a contract for six thousand clock movements and needed to move on to mass production. By 1820 thirty workmen were using templates to make twenty-five thousand identical wooden clocks a year and Terry was rich. In 1816 he was joined by a young cabinet-maker named Chauncey Jerome, who had been hired to make Terry's clockcases. When his contract with Terry was ended Jerome sold Terry his house in Plymouth for a hundred completely fitted mantle-clock movements, made 114 more, encased them all, sold these 214 complete clocks for a house, a barn and seventeen acres in Bristol, Connecticut, and set up in business.

Brass clocks - In 1838, Chauncey Jerome (or his brother) invented the brass clock. The advantage of brass was that it did not need seasoning as did wood, so no delays were involved in going from raw material to finished product. In 1844 Jerome moved to New Haven to make cases, while in his Bristol factory three workmen continued to turn out all the wheels for 500 clocks per day. A single machine using three cutters performed three sequential operations: simple cutting, rounding off teeth and finishing. By 1850 Jerome had two factories in New Haven turning out 280,000 clocks a year. During its operational life the firm !! exported millions of clocks to Europe, Asia, South America, Australia, and the Middle East.

Swiss watches - There were several factors that led the French-speaking Jura section of Switzerland to become the world's center of watch manufacture in the 18th Century: (

1. the migration of French Protestant clock and watchmakers to Switzerland after the revocation of the Edict of Nantes in 1685 which created the nucleus of a Swiss watch industry.
2. the Jura was not an agriculturally-productive area so there was

Watches

- The railroads created a major market for watches among railroad employees and passengers
- World War I led to the wrist watch replacing the pocket watch since the former was much more useful in a battlefield situation
 - When the doughboys came home, they continued and popularized the practice of wearing wristwatches

10

Railroads & watches - The railroads with their requirements for timetables and exact knowledge of when specified trains were (or would be) at specific times and places created a major market for watches, both among railroad employees and among railroad passengers who needed to know the exact time so they could catch their trains. Trains altered passengers' consciousness of time by opening new opportunities for appointments, for work done within time limits, and for long distance comings and goings

Impact of the Wristwatch

- It enabled individuals to order their life and work in a manner once reserved to the community – where the town clock was visible to all
 - Personalization of time was a major stimulus to individualism
- It made time pieces both a fashion statement and a status symbol
 - A fine watch became a mark of status

11

In the words of David Landes *Revolution in Time*, “The miniaturization of the clock had major consequences for people and culture. Where people had once depended on the church bell or turret clock in the town square or the cry of the night watchman, now they had the time at home or on their person and could order their life and work in a manner once reserved to regulated monastic communities. In this way, privatization (personalization) of time was a major stimulus to the individualism that was an ever more salient aspect of Western civilization. The watch with its minute hand was a measure of time used, time spent, time wasted, and time lost. As such, it was a prod to personal productivity and achievement.”

Impact of the Steamboat & Steamship

12

Definition

- Steamboat = a boat driven by steam power; specifically : a shallow-draft vessel used on inland waterways
- Steamship = a : a ship propelled by steam b : an engine, machine, or vehicle operated or propelled by steam

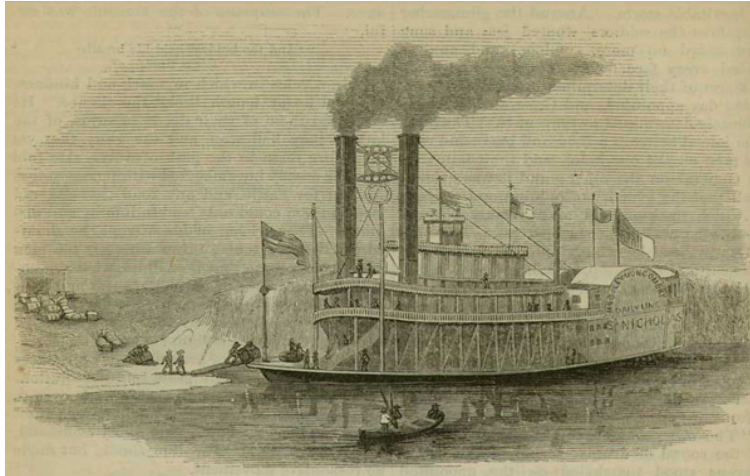
13

Steamboats & Steamships

- The term steamboat is usually used to refer to smaller steam-powered boats working on lakes and rivers, particularly riverboats; steamship generally refers to larger steam-powered ships, usually ocean-going.
- Screw-driven steamships generally carry the ship prefix "SS" before their names, meaning 'Steam Ship', paddle steamers usually carry the prefix "PS" and steamships powered by steam turbine may be prefixed "TS" (turbine ship)

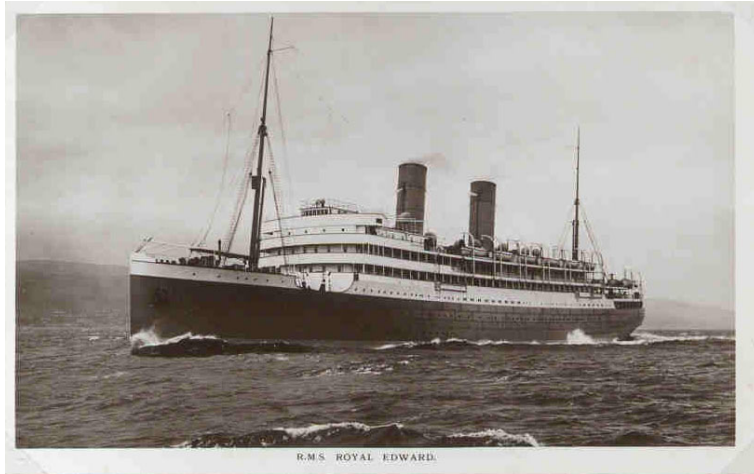
14

Steamboat



15

Steamship



16

History - 1

- The concept of the steamboat was an outgrowth of the steam engine
- The first working steamboat (with rotating paddles) by Marquis Claude de Jouffroy sailed in July 1776
- In the 1789s, James Rumsey and John Fitch both built working steamboats
- In 1802, Patrick Miller & William Symington built the *Charlotte Dundas* which towed barges along the Forth and Clyde canal to Glasgow

17

Outgrowth of the steam engine - In 1736, Jonathan Hulls was granted a patent in England for a Newcomen engine-powered steamboat (using a pulley instead of a beam, and a pawl and ratchet to obtain rotary motion), but it was the improvement in steam engines by James Watt that made the concept feasible.

Marquis de Jouffroy - In France, by 1774 Marquis Claude de Jouffroy and his colleagues had made a 13-metre (42 ft 8 in) working steamboat with rotating paddles, the *Palmipède*. The ship sailed on the Doubs River in June and July 1776, apparently the first steamship to sail successfully.

James Rumsey - From 1784 [James Rumsey](#) built a pump-driven ([water jet](#)) boat and successfully steamed upstream on the [Potomac River](#) in 1786; the following year he obtained a patent from the State of [Virginia](#).

John Fitch - In [Pennsylvania](#), [John Fitch](#) made a model paddle steamer in 1785, and subsequently developed propulsion by floats on a chain, obtained a patent in 1786, then built a steamboat which underwent a successful trial in 1787. In 1788, a steamboat built by John Fitch operated in regular commercial service along the Delaware river between Philadelphia PA and Burlington NJ, carrying as many as 30 passengers. This boat could typically make 7 to 8 miles per hour, and traveled more than 2,000 miles (3,200 km) during its short length of service. The Fitch steamboat was not a commercial success, as this travel route was adequately covered by relatively good wagon roads. The following year a second boat made 30 miles (48 km) excursions, and in 1790 a third boat ran a series of trials on the [Delaware River](#) before patent disputes dissuaded Fitch from continuing.

Patrick Miller & the Charlotte Dundas – Patrick Miller engaged engineer [William Symington](#) to build his patent steam engine into a boat which was successfully tried out on Dalswinton Loch in 1788, and followed by a larger steamboat the next year. Miller then abandoned the project. Ten years later Symington was engaged by [Lord Dundas](#) to build a steamboat. In March 1802, his [Charlotte Dundas](#) towed two 70-ton barges 30 km (19 miles) along the [Forth and Clyde Canal](#) to [Glasgow](#). This vessel, the first tow boat, has been called the "first practical steamboat", and the first to be followed by continuous development of steamboats. Although plans to introduce boats on the Forth and Clyde canal were thwarted by fears of erosion of the banks, development was taken up both in Britain and abroad, including [Robert Fulton's](#) [North River Steamboat](#) of 1807 and [Henry Bell's](#) [PS Comet](#) of 1812.

History - 2

- In 1803, Robert Fulton built a steamboat on the River Seine.
- In 1807, he built the *North River Steamboat* (also known as the *Clermont*) which began regular passenger service between New York City and Albany
- Fulton's success was soon followed by the use of steamboats on major U.S. rivers and also on the great lakes
 - First steamboat on the Ohio and Mississippi sailed in 1811

18

Robert Fulton - [Robert Fulton](#) was the first to operate steamboats commercially. He built and tested an experimental steamboat on the [River Seine](#) in 1803, and was aware of the success of *Charlotte Dundas*. Before returning to the United States, Fulton ordered a [steam engine](#) from [Boulton and Watt](#), and on return built what he called the [North River Steamboat](#) (often mistakenly described as *Clermont*). In 1807, she began a regular passenger service between New York City and [Albany, New York](#), 240 km (150 miles) distant, which was a commercial success. She could make the trip in 32 hours. In 1808, John and James Winans built *Vermont* in [Burlington, Vermont](#), the second steamboat to operate commercially.

River Steamboats - The use of steamboats on major US rivers soon followed Fulton's success. In 1811 the first in a continuous (still in commercial passenger operation as of 2007) line of river steamboats left the dock at [Pittsburgh](#) to steam down the [Ohio River](#) to the [Mississippi](#) and on to [New Orleans](#)

History - 3

- Steamboat traffic including passenger and freight business grew exponentially in the decades before the Civil War.
- First steam-powered vessel to cross the Atlantic was the hybrid steam- and sail-powered SS *Savannah* which sailed from Savannah GA to Liverpool in May-June 1819
- The first steamer to sail the Atlantic was the Dutch-owned *Curacao* which sailed from near Rotterdam to Surinam in 1827

19

Ocean-going steamers - The first steamship credited with crossing the Atlantic Ocean between [North America](#) and [Europe](#) was the American ship [SS Savannah](#), though she was actually a hybrid between a steamship and a sailing ship. The SS *Savannah* left the port of [Savannah, Georgia](#), on May 22, 1819, arriving in [Liverpool, England](#), on June 20, 1819; her steam engine having been in use for part of the time on 18 days (estimates vary from 8 to 80 hours). A claimant to the title of the first ship to make the transatlantic trip substantially under steam power is the British-built Dutch-owned *Curaçao*, a wooden 438 ton vessel built in [Dover](#) and powered by two 50 hp engines, which crossed from [Hellevoetsluis](#), near [Rotterdam](#) on 26 April 1827 to [Paramaribo, Surinam](#) on 24 May, spending 11 days under steam on the way out and more on the return. Another claimant is the Canadian ship [SS Royal William](#) in 1833.

History - 4

- The first regularly scheduled trans-Atlantic crossings by steamer began in 1838 with the SS *Great Western*
- The first East Coast (New York City) to West Coast (San Francisco) steamship service began in October 1848 via Cape Horn
- Steamers with screw propellers began replacing paddlewheel ships in the 1860s-1870s
- The first trans-Atlantic steamer built of steel began sailing in 1879

20

Great Western -The British side-wheel paddle steamer [SS Great Western](#) was the first steamship purpose-built for regularly scheduled trans-Atlantic crossings, starting in 1838. **East Coast to West Coast** - The first regular steamship service from the [East Coast](#) to the [West Coast of the United States](#) began on February 28, 1849, with the arrival of the [SS California](#) in [San Francisco Bay](#). The *California* left [New York Harbor](#) on October 6, 1848, rounded [Cape Horn](#) at the tip of South America, and arrived at San Francisco, California, after a four-month and 21-day journey. The [California Gold Rush](#), trade and U. S Mail contracts to the west coast of the United States brought the steamships of the [U.S. Mail Steamship Company](#) and other lines carrying passengers to the [Isthmus of Panama](#) crossing first by mules later by the [Panama Railroad Company](#) where [Pacific Mail Steamship Company](#) steamers carried them to California.

Screw propellers - The screw (as opposed to paddlewheels) was introduced in the latter half of the 18th century. [David Bushnell](#)'s invention of the submarine ([Turtle](#)) in 1775 used hand-powered screws for vertical and horizontal propulsion. The Bohemian engineer [Josef Ressel](#) designed and patented the first practicable screw propeller in 1827. [Francis Pettit Smith](#) tested a similar one in 1836. In 1839, [John Ericsson](#) introduced practical screw propulsion into the United States. Mixed paddle and propeller designs were still being used at this time (*vide* the 1858 [SS Great Eastern](#)).

In 1848 the [British Admiralty](#) held a tug of war contest between a propeller driven ship, *Rattler*, and a [paddle](#) wheel ship, *Alecto*. *Rattler* won, towing *Alecto* astern at 2.5 knots (4.6 km/h), but it was not until the early 20th century paddle propelled vessels were entirely superseded. The screw propeller replaced the paddles owing to its greater efficiency, compactness, less complex [power transmission system](#), and reduced susceptibility to damage (especially in battle)

Steel - . The first transatlantic steamer built of steel was S.S. "Buenos Ayrean", which started a service in 1879.

History - 5

- Steamships dominated trans-Atlantic passenger travel until the 1960s when jet airplane flights replaced steamships
 - The last scheduled liner voyage to cross the Atlantic was the *Queen Elizabeth 2* in 1986
- In 1884, Sir Charles Parsons devised the marine steam turbine engine.
 - It gradually replaced the traditional reciprocating steam engine due to the turbine's small size, low maintenance, light weight, and low vibration
 - The first steam turbine ship was the *Turbinia*, launched in 1894

21

Trans-Atlantic steamers – The *RMS Titanic* was the largest steamship in the world when she sank in 1912; a subsequent major sinking of a steamer was that of the *RMS Lusitania*, as an act of [World War I](#). Launched in 1938, *RMS Queen Elizabeth* was the largest passenger steamship ever built. Launched in 1969, *RMS Queen Elizabeth 2* (QE2) was the last passenger steamship to cross the Atlantic Ocean on a scheduled liner voyage before she was converted to diesels in 1986. The last major passenger ship built with steam engines was the *Fairsky*, launched in 1984.

Steam Turbine - A steam turbine is a mechanical device that extracts [thermal energy](#) from pressurized [steam](#), and converts it into rotary motion. Its modern manifestation was invented by [Sir Charles Parsons](#) in 1884. It has almost completely replaced the [reciprocating](#) piston [steam engine](#) primarily because of its greater thermal efficiency and higher [power-to-weight ratio](#). Because the turbine generates [rotary motion](#), it is particularly suited to be used to drive an electrical generator – about 80% of all electricity generation in the world is by use of steam turbines. The steam turbine is a form of [heat engine](#) that derives much of its improvement in [thermodynamic efficiency](#) through the use of multiple stages in the expansion of the steam. The first steam turbine merchant ship was launched in 1901. The first steam turbine battleship was the *HMS Dreadnaught*.

Impact of the Steamboat

- Revolutionized domestic transportation by making it easy for boats to travel upstream and do so at much less cost and much greater speed than before
- Created new legal and political precedents that would have immense significance in later years
 - Supreme Court case of *Gibbons vs. Ogden*
 - Legislation that established the authority of the Federal Government to regulate an industry in the interest of public safety

22

Revolutionized domestic transport - The steamboat revolutionized domestic transportation by making it much easier to travel upstream and doing so at much less cost and much greater speed. It took flatboats [*boats with a flat bottom and square ends used for transporting freight on inland waterways*] six weeks to float from Pittsburgh down the Ohio-Mississippi Rivers to New Orleans and four months to make the return trip. In 1819, the steamship *Enterprise* made the trip in 25 days. By 1826, the trip from New Orleans to Louisville KY had been cut to 8 days. The trip from New York City to Albany by 1840 took only 9 hours.

Gibbons vs Ogden - In 1807, Robert Fulton, the most successful of the many inventors seeking a practical steam-propelled craft, ran his boat up the [Hudson River](#) at the speed prescribed by a New York law and thereby acquired a monopoly of steam navigation on the state's waters. Ambitious interlopers challenged this monopoly, which led to lively litigation. One line of cases involved Aaron Ogden, who held a state-required Fulton-Livingston license, and Thomas Gibbons, who held a federal coasting license and ran competing boats between New Jersey and [Manhattan](#). The New York courts repeatedly upheld the monopoly against such competition (*Livingston v. Van Ingen*, 1812, and *Gibbons v. Ogden*, 1820). By 1824 the dispute reached the U.S. Supreme Court on appeal. Chief Justice John Marshall, speaking for the Court, held that the power to regulate commerce, so far as it extends, is exclusively vested in Congress, and no part of it can be exercised by a State; and that the laws of N. Y. granting to Livingston and Fulton the exclusive right of navigating the waters of that State with steam boats, are in collision with the acts of Congress regulating the coasting trade, which being made in pursuance of the constitution, are supreme, and the State laws must yield to that supremacy. A license under the acts of Congress for regulating the coasting trade, gives a permission to carry on that trade. The power of regulating commerce extends to

Impact of the Steamboat - 2

- Subjected their passengers and cargoes in the early years to the dangers of boiler explosions, often with large-scale loss of life
 - This, in turn, led to the first Congressional regulatory legislation and the first regulatory Federal personnel
 - Also led to the precedent of Federal Government research grants

23

Boiler explosions - For all their utility, nineteenth-century steamboats were dangerous. Between 1825 and 1830 alone, forty-two exploding boilers killed 273 people. In 1838, an enormous boiler explosion in Charleston took 140 lives. At the time steamboat boiler explosions became a problem, there was not even a governmental agency that could institute a proper investigation of the accidents. Legal definitions of the responsibility or negligence of manufacturers and owners of potentially dangerous equipment were in an embryonic state. The belief existed that the enlightened self-interest of an entrepreneur sufficed to guarantee the public safety. This theory mitigated against the enactment of any legislation restricting the actions of manufacturers or uses of steam equipment. But the fact of the boiler explosion problem led to a public demand that government act to protect the public from the danger of improperly-built, -used, and -maintained boilers. Congress responded that year with the first federal regulation, warranted the interstate commerce clause. From then on, every steamboat boiler had to bear a certificate from a government inspector. In 1852, it enacted additional legislation relating to the inspection of steamboats.

Government research grants - After the 1830 boiler explosion on the steamboat *Helen McGregor* near Memphis which killed between 50-60 persons, the House of Representatives requested Secretary of the Treasury Samuel D. Ingham to investigate boiler explosions and submit a report. Ingham committed government funds to the Franklin Institute of Philadelphia which was investigating boiler explosions on its own to defray the costs of equipment necessary to experimentally determine the causes of boiler explosions. This was the first research grant of a technological nature made by the Federal Government. In 1836-37, the Franklin Institute submitted two reports -- one on steam boiler explosions and one on boiler construction materials -- that exposed several errors and myths in popular theories on both the nature of steam and the causes of explosions. The reports laid down sound guidelines on the choice of construction materials, on the design and construction of boilers, and on the design and arrangement of appurtenant safety devices such as gages and valves. The

Steamboat Act of 1838

- Provisions
 - Had provisions for the prevention of collisions and the control of fires aboard ship
 - Required the inspection of hulls and the carrying of lifeboats
 - Required federal judges to appoint competent boiler inspectors who would semi-annually inspect every steamboat boiler, ascertain its soundness, certify it with a recommended working pressure, and issue a certificate of navigability
 - Made steamboat owners liable to both criminal penalties and to civil suits for damage to persons or property for a boiler explosion, with the fact of an explosion considered *prima facie* evidence of negligence
- Had little effect in reducing boiler explosions

24

In April 1838, an explosion aboard the *Moselle* killed 151 persons at Cincinnati. This finally prompted Congress to act, and legislation relating to steamboat safety finally became law on July 7, 1838. The law had several sections relating to the prevention of collisions, the control of fires aboard ship, the inspection of hulls, the carrying of lifeboats, and the appointment by federal judges of competent boiler inspectors who would semi-annually inspect each steamboat boiler, ascertain its soundness, certify it with a recommended working pressure, and issue a certificate upon receipt of which a license to navigate was contingent. The law also made steamboat owners liable to both criminal penalties for negligence and liable to suits for damage to persons or property in a boiler explosion -- with the fact of an explosion considered *prima facie* evidence of negligence unless the defendant proved otherwise. The weakness of the legislation was that it set no qualifications for steam engineers, no inspection criteria, and no penalties for the racing of steamboats. Thus, the law had little effect in reducing boiler explosions. Between 1841-1848, there were over 70 boiler explosions that killed some 625 persons.

Steamboat Act of 1852

- Provisions
 - Set maximum allowable working pressures (110 lbs per sq. in.)
 - Required every boiler to be tested yearly at 1 ½ times working pressure
 - Set boiler material construction standards
 - Required all steam engineers to be licensed
 - Authorized boiler inspectors to order repairs
 - Established boards of inspectors to investigate accidents and law infractions, giving them subpoena power
- Did reduce steamboat accident fatalities by about 35%

25

Impact of the Steamboat - 3

- Turned Cincinnati OH into a major hog meatpacking center
 - The presence of a large amount of lard led William Proctor and James Gamble to form a partnership to turn some of that lard into soap
 - This initiated an early replacement of an item previously manufactured in the household by a mass consumer product

26

Meatpacking & soap - The Old Southwest was built around cotton and slavery. The Old Northwest was different, since slavery was prohibited under the Northwest Ordinance of 1787 and this region was too cold for cotton. Most of the early settlers, especially in southern Ohio, Indiana, and Illinois, came from the same Piedmont backcountry area that had supplied so many migrants to the Old Southwest. Often they were called 'butternuts' after the color of their homespun clothing or 'hoosiers' (a term later applied to Indiana residents where so many of the backcountry settlers settled). Generally, these Ohio Valley settlers raised corn and hogs, as many had done in their previous homes. Taking advantage of the river system, they could market their produce in far-off New Orleans, especially after the arrival of the steamboat. As a result, Cincinnati became a meatpacking center where hogs were turned into ham and lard for subsequent shipment by water. In 1837, two brothers, William Proctor and James Gamble, formed a partnership to turn some of Cincinnati's lard into soap, thus initiating the replacement of an item of household manufacture with a mass consumer product

Impact of the Steamboat - 4

- Fostered a demand for Federally-financed internal improvements, especially the dredging of rivers and harbors (as well as the building of roads and canals)
- This demand in turn provoked opposition from those in inland areas who would not benefit from such improvements and from those who feared the erosion of states rights
- These policy differences help define, and became a bone of contention between, the Whigs who favored such internal improvements and the Democrats who opposed them

27

Internal improvements - Early steamboats, with side or rear paddlewheels, navigated rivers, lakes, and the coastal trade. They were built with drafts as shallow as possible to avoid obstacles in the water. The joke ran that they could float on a heavy dew, and it was literally true that one of them could carry eighty passengers with forty tons of freight in two feet of water.³⁴ Even so, the dredging of rivers and harbors became one of the most important kinds of internal improvement that state and federal authorities undertook in this period. Supporters of internal improvements emphasized their practical value in promoting economic growth and the general public welfare. They also saw such improvements as justified by the logical implications of the “general welfare” clause and the power of Congress to “establish post offices and post roads.”

Opposition to internal improvements – Those opposed to internal improvements fell into three categories: 1) Generally poorer farmers who lived far from the rivers or proposed canals and thus would not benefit from their construction but would be taxed to help pay for them, 2) Strict constructionists who argued that the Constitution did not specifically authorize Federally-financed internal improvements, rejecting the concept of implied powers, and 3) Those who feared that if the Federal Government were allowed to legislate on internal improvements, it would create a slide down the slippery slope of allowing the Federal Government to legislate on the subject of slavery. In his novel *Swallow Barn*, John Pendleton Kennedy has his hero Frank Meriwether say concerning the steamboat, “I think, it strikes deeper at the supremacy of the states than most persons are willing to allow. This annihilation of space, sir, is not to be desired. Our protection against the evils of consolidation consists in the very obstacles to our intercourse. The home material of Virginia was never so good as when her roads were at their worst.”

Policy differences & politics – The policy differences over internal improvements led supporters of such improvements into the anti-Jacksonian and later the Whig Party and opponents (who supported Jackson’s veto of bills providing for such improvements) into the Jacksonian Democratic Party. Support or opposition to

Impact of the Steamboat -5

- Fostered a mutually beneficial and symbiotic relationship with the Post Office
 - Steamboats aided in the transport and delivery of mail; the Post Office gave lucrative mail delivery contracts to the steamboat owners
 - Provided a model for the relationships the Post Office developed with the railroads

28

Impact of the Steamboat - 6

- Helped start and facilitate travelling for pleasure
 - Affluent Americans begin to use the steamboat for “nuptial journeys”
 - Wealthy Southern planters begin to come North during parts of the Summer months

29

Traveling for pleasure -- a great rarity under 18th century conditions -- gradually became a favorite amusement among affluent Americans after 1820. Newly-married couples -- if the husband was a professional or a merchant -- began to go on ‘nuptial journeys.’ Wealthy Southern planters came North for part of the Summer months. The declining cost of steamboat travel by the 1830s put one-day steamboat excursions on the Hudson or Connecticut rivers within the reach of city artisans and their families.

Impact of the Steamboat - 7

- Along with breech-loading rifles and machine guns, the steamboat allowed Europeans to penetrate into the interior of China and Southeast Asia
- Along with quinine, the steamboat allowed Europeans to penetrate into the interior of the continent of Africa
 - This allowed commercial and eventually political domination of the African hinterland. Formerly, Europeans avoided the African interior because of the likelihood of being infected with malaria

30

It was the discovery by two French chemists in 1829 that quinine could be an effective prophylactic against malaria which, by 1848, allowed Europeans to penetrate into the interior of the continent without succumbing to the disease. Until then, the death rate among Europeans had ranged from 46%-72% of those infected. The development of the steamboat meant dispensing with expensive overland transportation dependent on scarce and expensive local labor. In 1854, the combination of quinine and the steamboat allowed the *Pleiad* to steam up and down the Niger with no deaths. Thereafter, regular journeys along the Niger allowed British commercial and eventually political domination of the Nigerian hinterland. It was the gun revolution in the form of the breech-loading rifle in the 1870s and the Maxim machine gun at the turn of the century, however, that gave the Europeans overwhelming coercive power

Ocean Steamers

- While steam power was an obvious advantage for boats on rivers and lakes, it was much less of an advantage on ocean-going ships because the amount of fuel that had to carry limited the amount of space available for carrying cargo
 - Thus, early steam-powered ocean vessels were hybrids, using steam to maneuver independently of the wind and sail to conserve fuel

31

Ocean Steamers - 2

- In 1840, Samuel Cunard [Cunard Lines] developed transatlantic commercial steamships that used coal rather than wood (which took up more space)
- Steamers made possible regularly-scheduled transoceanic trips with exact times of departure and scheduled times of arrival at a destination

32

Ocean Steamers - 3

- Steamers were much faster than sailing ships
 - In the 1840s, It took a westward-bound sailing ship an average 34 days to cross the Atlantic; it took a steamship only 14 days to cover the same distance
 - In 1775, it took a sailing ship 36 days to sail from New York City to London; in 1850, it took a clipper ship 14 days; in 1901, it took a steamship 8 days

33

Ocean Steamers - 4

- In comparison with sailing ships, Steam powered ships:
 - Could be constructed of iron/steel rather than wood
 - Could be much larger than sailing ships
 - Could carry more cargo
 - Required fewer men to operate
- As a result, shipping costs dropped, especially as the technologies of the screw propeller and marine steam turbine engine became common
 - Between 1879-1902, the cost of shipping 8 bushels of wheat from Chicago to London fell from an average 11 shillings to less than 3 shillings

34

Steel ships - In the late 1870's, steel began to replace wood as the main construction material in ships. By 1891, over 80% of all ships under construction were made of steel. One reason ships were increasingly made of iron and steel was that wood imposed an inevitable limit on the size of ships -- the longest oak ships were no more than 250' long with the average being much smaller while iron and steel ships could be made of any size and while costs increased with the square of the dimensions, the carrying capacity increased with the cube.

Refrigerated Ships

- By the late-1870s, refrigerated ships had been developed that could transport frozen meat and fish from the U.S., Canada, Australia, and New Zealand to Europe
 - This vastly increased the amount of food that was traded. From the 1850s to 1913, food exports rose from 4 million tons per year to 40 million tons

35

In the 1840's England (with a population of 14 million in 1831) imported only 5% of its food. By 1900, England imported 80% of its grain, 40% of its meat, 65% of its fruits, and 72% of its dairy products

Consequences of Steamships - 1

- Faster, cheaper, and safer transoceanic travel
 - Facilitated the large-scale emigration of Europeans to the United States, Canada, Brazil, Argentina, Australia, New Zealand, and South Africa
- Allowed an international market in wheat, rice, corn, meat, butter, wool, and other commodities to develop
 - This impacted negatively on the landed nobility and aristocracy of Russia, Germany, Poland, and Austria-Hungary

36

Prior to 1810, a voyage from Europe to North America cost the annual income of a European worker and killed 5 percent to 10 percent of voyagers. Another 5 percent to 10 percent died of diseases contracted during the voyage. By the late-19th century, the relative cost of travel had become much cheaper and much safer.

Consequences of Steamships - 2

- The economic decline of the landed aristocracies, both in absolute terms and relative to newly-emerging industrial elites, led many in these aristocracies to espouse Tory Socialism on the one hand and extreme Nationalism, Imperialism, Militarism, and Anti-Semitism on the other

37

Consequences of Steamships - 3

- Ended the centuries-old practice of piracy
 - Steamships were too expensive for pirates to purchase and too fast for pirate-manned sailing ships to capture
 - Only with the development of fast ocean-going motorboats and containerized cargo ships with only a handful of crew members would piracy (in areas of East Africa and Strait of Malacca

38

Impact of the Typewriter

39

Definition

- Typewriter = a mechanical or electromechanical device with lots of keys that, when pressed, cause ink to be printed on a medium, usually paper.
- Typewriter = a machine for writing in characters similar to those produced by printer's type by means of keyboard-operated types striking a ribbon to transfer ink or carbon impressions onto the paper

40

Early Typewriter



41



42

Typewriter

- The typewriter as we know it was Invented by Christopher Sholes
 - Christopher Sholes:
 - Developed a workable typewriter in 1867,
 - Drew in some co-inventors to improve the device
 - Found a manufacturer in small-arms maker Remington
 - 1874 – First Remington typewriter
 - 1876 - Exhibited at the 1876 Centennial Exposition in Philadelphia
 - 1878 - Remington Model 2 typewriter – the manual typewriter as we remember it

43

Christopher Sholes - Christopher L. Sholes, a Milwaukee newspaperman, poet, and part-time inventor, was the main creator of this machine. The Sholes & Glidden typed only in capital letters, and it introduced the QWERTY keyboard, which is very much with us today. The keyboard was probably designed to separate frequently-used pairs of typebars so that the typebars would not clash and get stuck at the printing point. The S&G was a decorative machine, boasting painted flowers and decals. It looked rather like a sewing machine, as it was manufactured by the sewing machine department of the Remington arms company. The initial Sholes-Glidden-Soule design was inelegant. Users could not see their work as they typed. Typebars clashed frequently, having to be untangled. *{The need to prevent tangling of type bars led to the relatively inefficient QWERTY keyboard}*. Initially, the machine was limited to a single typeface. !! Nevertheless, the Sholes design triumphed for two major reasons. First, it could be steadily improved. Second, Sholes' associate, James Densmore found both a market for the typewriter in court reporters and a manufacturer -- the Remington Arms Company -- that was both looking for a product to manufacture and which had expert mechanics who were experienced in the advanced machine shop practice developed at the national armories.

Model 2 typewriter – Unlike the Model 1, the Model 2 allowed the typist to see what he/she typed. It had a carriage return lever on the machine itself and a shift mechanism to allow for printing both capital and lower case letters. By 1882, typewriter sales reached 2,300 a year; by 1892 -- 25,000 a year. By 1886, Remington and other typewriter manufacturers were selling 50,000 typewriters a year. By 1895, the Federal Government had 1,990 typewriters in use -- 80% Remington models

Notes About the Typewriter

- Initially marketed to authors, lawyers, clergymen, and court reporters
 - Court reporters were the first major adopters of the typewriter
- Businessmen saw its commercial potential to speed up correspondence
 - The typewriter found large-scale popularity in the business office, then spread to government, and finally to individual authors and students

44

Business use of typewriter - As Frank H. Palmer noted in 1892, “With one of these machines, a businessman can dictate with ease, and his clerk can neatly print, 60 business letters in a day. It has been demonstrated by many tests that the typewriter, as compared with the pen, saves 40 minutes an hour, or five hours and 20 minutes in a business day. If ‘time is money,’ it is easy to calculate what kind of bargain one makes in purchasing one of these labor-saving machines.”

Authors & students - The typewriter found its initial niche in the business office. It later spread to government offices and then to individual writers and students -- both of whom found that publishing houses and professors found it easier to read (and thus favored) typewritten as opposed to handwritten manuscripts. The typewriter remained an office fixture until the emergence of the personal computer/the computer printer/word processing software at which point it became relegated to the storeroom or unused desk for which it was used only to fill in forms and type in labels. When form-filling and labeling software became common, the typewriter vanished.

Effects of the Typewriter - 1

- Created a demand for typists and stenographers
- Created a separation and specialization of clerical jobs
 - Feminized the clerical work force
 - This opened up a new niche for women, but also confined them to a subservient status
 - Impacted upon female fashion
- Led people to start composing documents on the typewriter

45

Specialization of clerical jobs - With the proliferation of typewriters there also came a separation and specialization of clerical jobs, with traditional secretaries (typically males doing a variety of work and with the potential to rise in the firm) often replaced by typists and stenographers, job categories with narrow and specialized duties that rapidly came to be dominated by females at lower wages and with little chance to rise above that position.

Women in the clerical work force - Since women were considered to have more nimble fingers and better memories than men, the typewriter opened up the formerly all-male office to women secretaries, stenographers, and clerk-typists. In 1870, 4.5% of clerks and stenographers were female. In 1930, 91.8% of typists and stenographers were female.

Female subservience – G.K. Chesterton pointed out both the new niche and the fact of female subservience in his famous comment - "women refused to be dictated to and went out and became stenographers."

Female fashion – In the words of Marshall McLuhan, "The uniform ranks of fashionable female typists made possible a revolution in the garment industry. What she wore, every farmer's daughter wanted to wear, for the typist was a popular figure of enterprise and skill. She was a style-maker who was also eager to follow styles." This was especially the case after Charles Gibson produced his famous illustrations of the Gibson Girls whose "ready-to-wear" clothes (which consisted of a blouse, called a shirt-waist and a skirt which were purchased separately) other women wanted to wear.

Effects of the Typewriter - 2

- Revolutionized the Office
 - Produced text that was more legible than handwriting
 - With carbon paper, produced multiple copies of the same document
 - Revolutionized office filing
 - Multiplied the quantity of office records
 - Created the typewritten form

46

The typewriter along with carbon paper revolutionized the office and office filing. It had the advantage of producing text that was more legible than almost all forms of handwriting and could, with carbon paper, produce multiple copies of the same document.

Office filing - Instead of incoming correspondence bound with red tape and copy or letter press books of outgoing correspondence, the typewriter made possible manila folder case files that combined all documents relating to a particular case, transaction, event, or person in which original incoming documents and carbon copies of outgoing documents were all interfiled -- case files that were easily retrievable by resort to typed index cards. Prior to the case file or project file, the typical office would have a file of incoming correspondence that was usually filed chronologically or alphabetically and a separate file of hand-copied or letterpress copies of outgoing correspondence together with an index book that listed the name & date of all incoming correspondence and the number or date of the related outgoing correspondence. In addition, the typewriter could easily be used to type data into forms to create uniform-type data for many types of transactions.

Records – One consequence of the typewriter and the case file was the proliferation of records, especially as carbon copies of outgoing correspondence were often circulated to higher levels or other offices dealing with the same subject. To take the Federal Government as an example, the Federal Government from 1774 to 1861 accumulated 100,000 cubic feet of records. From 1861 to 1916, it accumulated 1, 600,000 cubic feet of records.

Effects of the Typewriter - 3

- Revolutionized the Office (cont)
 - Changed the furniture of the office
 - The roll top desk with pigeonholes gave way to the modern “Efficiency Desk” (created in 1915 for the Equitable Life Assurance Company) which was a flat-top table containing 4 or 7 shallow drawers underneath
 - Divided correspondence into official (typed) and personal (handwritten)

47

Office furniture - To accommodate the typewriter, office furniture was changed -- the roll top desk with its pigeonholes gave way to the tabletop desk with underlying drawers. Along with the telephone (women were considered to have more pleasant voices and thus considered to be ideal telephone answerers and screeners), the typewriter opened up the formerly all-male office to women secretaries, stenographers, and clerk-typists. It also led to a division of correspondence into business or official (which was typed) and personal (which was still handwritten. Combined with the telegraph and later the telephone in the form of the teletypewriter and later the fax machine, it speeded up communication of messages

Effects of the Typewriter - 4

- Created a demand for carbon paper
 - Allowed the typewriter to create an attractive original and several acceptable copies
- Led to the development of vertical file cabinets to store (and facilitate the retrieval of) documents and case files created by the typewriter and carbon paper

48

Carbon paper - It took two inventions working together to begin displacing the copying press as the world's foremost device for reproducing routine office correspondence. The first was carbon paper, invented in 1806 by Englishman Ralph Wedgwood, a relative to both Josiah Wedgwood of porcelain fame and Charles Darwin. While carbon paper found some uses, it didn't really flourish until it was paired with the typewriter, which struck paper with enough force to create an attractive original and several acceptable facsimiles. Since it could produce up to 10 duplicates without an intermediate step and economically performed all of the same functions as the copying press, the copy press eventually disappeared not only from offices but also from the collective memory of the world. Prior to the typewriter and carbon paper, copying of outgoing correspondence, reports, and other documents had been done by hand in bound blank books. By the mid-nineteenth century, U.S. firms began to replace hand copying with letter press copying.³⁸ This process used special ink, moisture, and a mechanical press to take an impression of a document on a page of a bound volume. While messy, inconvenient, and generally limited to a single readable copy, this process was faster than hand copying and could be done by unskilled office workers. With the growing production and widespread adoption of the typewriter in the closing years of the century, carbon paper, an older technology heretofore used only in very limited ways, was adapted to a major new application. Using carbon paper, a typist could make several (unbound) copies at the same time the original was created.

Vertical file cabinets - vertical filing, first presented to the business community at the 1893 Chicago World's Fair (where it won a gold medal), became the accepted solution to the problem of storage and retrieval of paper documents.⁴⁴ From the beginning, vertical files were presented as a way of combining all documents (incoming, outgoing, or internal) in a single system organized by subject, location, or any categorization appropriate to the business. Filing technology included not just file drawers and folders to hold papers; it also included the bureaucratic technique of organizing the papers into folders and the folders into drawers by an appropriate and accessible filing system. Both the filing system and the office equipment and supplies to house it had roots in the library world. The first

Effects of the Typewriter - 5

- Led manufacturers of consumer machinery to establish distribution and repair networks
 - As an early piece of machinery often in need of repair, the typewriter created the need for a distribution network to provide instruction, repair, service, and technical assistance functions
- Impacted on how individuals were recruited into, and trained for, the legal profession
 - Reading law in a law office was replaced by law school as a means of educating and recruiting lawyers

49

Distribution networks - Manufacturers of consumer and agricultural machinery, such as Singer Sewing Machine, Remington Typewriter, and McCormick Harvesting, established distribution networks by the 1880s. Only people who could explain to prospective buyers how the machines worked and provide instruction, service, repair, and technical assistance to customers could sell their products.

Educating 19th century lawyers - In the 19th century, it was very common for aspiring lawyers to become a clerk in a law office doing routine work, such as filing and making handwritten copies of documents, in exchange for the opportunity to “read law”. With the law growing more complex and with woman typists and stenographers becoming available to perform the routine work, law offices no longer needed to hire young men who would spend much of their time reading law books. Instead, law offices began hiring law school graduates who could perform professional legal work and thus bring income into the law firm. Law school enrollments increased sixfold in the three decades after 1890; by 1910, according to one estimate, two-thirds of those admitted to the bar had graduated from a law school.

Impact of Air Conditioning

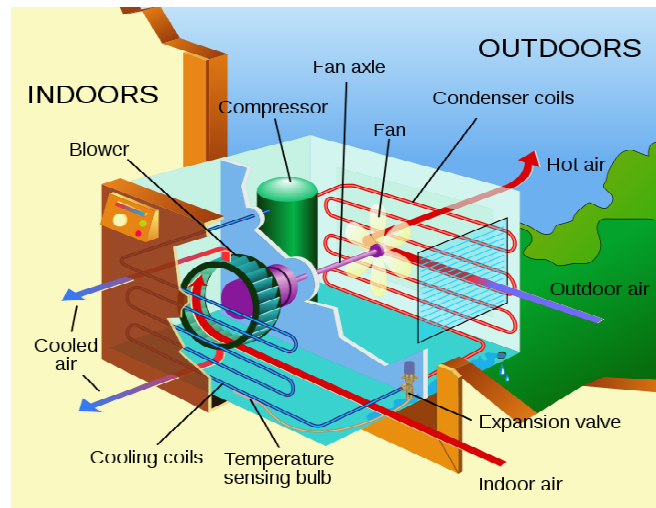
50

Definition

- Air Conditioner = a home appliance, system, or mechanism designed to dehumidify and extract heat from an area. The cooling is done using a simple refrigeration cycle. In construction, a complete system of heating, ventilation and air conditioning is referred to as “HVAC”. Its purpose, in a building or an automobile, is to provide comfort during either hot or cold weather.

51

Air Conditioner



52

Willis Carrier

- Air conditioning began in 1902 when Willis Carrier designed a system that provided temperature, humidity control, and removal of dust and lint for the Sackett-Williams printing plant in Brooklyn NY to stabilize the registry of multicolor prints
- The term “air conditioning” was coined in 1906 by a textile engineer, Stuart Cramer, who patented a device for humidifying the air inside textile mills

53

Using two developing technologies -- refrigeration and electricity -- Willis Carrier built his first air-conditioning apparatus in 1902. The Sackett-Wilhelms Lithography Printing and Publishing Company in Brooklyn was printed, was having trouble with its color registration during the summer months. The paper, it seemed, was absorbing moisture from the air and expanding, so that colors printed on humid days did not line with ones laid down in drier weather. Carrier was called in to solve the problem. Carrier went on to air-condition the first paper mill in New York in 1906, the first pharmaceutical plant in Detroit in 1907, the first celluloid-film plant in New Jersey in 1908, the first tobacco warehouse in Kentucky in 1909, the first candy manufacturing establishment in Milwaukee in 1910, the first bakery in Buffalo in 1911, the first hospital ward (the premature baby ward) at Allegheny General Hospital in Pittsburgh, and the first home air conditioning unit in 1914. In 1915, Carrier was able with financing from a group of associates to form the Carrier Engineering Corporation in 1915.

Willis Carrier - 2

- Air conditioning, however, did not take off until after World War I. There were several reasons for this:
 - The thermodynamics of air and water vapor mixtures was not fully understood until 1911
 - Early air conditioners were large, bulky, expensive to install, expensive to operate, not fully reliable, and used toxic refrigerants (usually ammonia or carbon dioxide)

54

It was not until 1911 that Carrier fully worked out the scientific principles of psychrometry (the study of the thermodynamics of air and water vapor mixtures). In that year, he presented a historic paper, called "Rational Psychrometric Formulae," to the American Society of Mechanical Engineers. He had also made significant improvements in the design of his air-conditioning apparatus

Willis Carrier - 3

- In 1922, Carrier invented a centrifugal compressor that used a safe refrigerant – dichlorethylene [$C_2H_2Cl_2$]
 - This reduced the size of the air conditioning units and made them easier to install and use
 - It made possible commercial “comfort air conditioning” as distinct from industrial “process air conditioning”

55

Centrifugal compressor - Carrier's earlier units had used reciprocating compressors, which basically moved back and forth like the pistons on a locomotive. In 1922 he switched to a centrifugal model, which compressed the coolant with a rapidly spinning rotor. The centrifugal pump greatly reduced the size of his machinery and made it easier both to install and to use.

Refrigerant - Carrier also sought nontoxic and nonflammable refrigerants that could improve on carbon dioxide. His initial choice was dielene (dichloroethylene, or $C_2H_2Cl_2$), which required lower pressures and hence was easier to use. It was readily available commercially since it was also used as a cleaning agent

Process Air Conditioning – Initially, Air conditioning systems were developed to meet the needs of factories to control the level of humidity for uniform production. Many factories processed hygroscopic materials that absorbed moisture from the air. These hygroscopic materials included textiles, tobacco, pasta, sausage, black powder, chewing gum, candy, photographic film, chocolate, and flour. Changing humidity levels within the factory meant that materials changed their size, appearance, and handling characteristics. Thus, cigarette machinery jammed, chocolates turned gray, and cotton thread broke. Since “process air conditioning” began when the technology was rudimentary and the scientific principles behind not fully understood, early air conditioning systems were too expensive to be installed outside facilities where they did not meet an obvious production or life-saving need.

Air Conditioning

- In 1922, Carrier installed an air conditioning system at Grauman's Metropolitan Theater in Los Angeles
- In 1924, the Rivoli Theater on Broadway decided to install a centrifugal compressor air conditioning system
 - The air conditioned Rivoli opened Memorial Day weekend in 1925. Result: ticket sales went up \$100,000 over the previous summer

56

Grauman's is generally considered to be the birthplace of theater air conditioning, although the real test came three years later at the Rivoli Theater in New York. Centrifugal refrigerating systems had been installed in a number of Texas theaters in 1924 -- the Palace in Dallas and the Texan and the Iris in Houston -- revolutionizing the picture-show business there, but until the new system played on Broadway, it could not really be considered a success. In the fall of 1924, after word of mouth about the Texas installations reached New York, the Rivoli Theater on Forty-ninth street and Broadway decided to rip out its ventilating system and replace it with a centrifugal refrigerating apparatus. Carrier quickly realized how important this showcase would be for future sales. !! When city safety inspectors denied the theater a permit because the refrigerant, dielene, had not been approved for commercial use, he took matters into his own hands. He marched into the safety chiefs office, poured some dielene into a container, and lit it with a match. The safety chief. Carrier later recalled, was furious and a bit scared; but as the chemical slowly burned, without flare-up or explosion, he became convinced that it was not hazardous and granted the permit. THE AIR-CONDITIONED Rivoli Theater opened Memorial Day weekend, 1925. After the show Adolph Zukor came downstairs and approached Carrier. The movie had been silent, but the studio chief was not. "Yes," he said, "the people are going to like it." The box-office grosses at the Rivoli during the next three months proved Zukor correct: ticket sales were up \$100,000 over the previous summer -- more than the cost of installation itself. During the next five years Carrier air-conditioned over three hundred theaters around the country.

Air Conditioning - 2

- Effects of Air Conditioning Theaters
 - Saved Hollywood films from the summer doldrums
 - Created a demand for air conditioning in other environments
 - Persuaded members of Congress to air condition the Capitol
 - House of Representatives air conditioned in 1928
 - Senate air conditioned in 1929

57

Air Conditioning the Capitol - It took the air-conditioning of movie theaters to persuade some members of Congress in 1928 to finally do something about the oppressive conditions in the Capitol. Until then the idea that people should be cool while they worked was considered somewhat fanciful. Most Americans, including their elected representatives, sweated through the summer months. Congress first looked into the possibility of cooling the House and Senate chambers in the early 1920s, but like so many other proposals on Capitol Hill, this one got bogged down in committee. Some members objected to the cost of installing such a system -- over \$300,000 -- insisting, in public at least, that it was a luxury they could do without. As late as 1927 the idea was voted down. Then, early in 1928, a panel of experts that included members of the Public Health Service issued a report recommending that Carrier air-condition the Capitol. Dr. Leonard Greenburg, a member of the panel, testified before a subcommittee of the House Appropriations Committee, saying that the quality of the air in summer months was impairing the health and mental faculties of the nation's legislators. This time the vote went in favor of the appropriation and Carrier was called in to do the job. By the end of the year his machines were pumping cool, dry air into the House chamber, and the following summer a similar system was operating in the Senate.

Air Conditioning - 3

- Spread of Air Conditioning
 - Government
 - In 1930, air conditioning was installed in the West Wing of the White House
 - In 1931, the Supreme Court building was air conditioned
 - In 1935, the National Archives building was opened with air conditioning to preserve the records stored within

58

White House - During the winter of 1929, after a Christmas Eve fire destroyed the old office wing of the White House, Herbert Hoover approved the installation of a \$30,000 air-conditioning and heating unit in the renovated West Wing. Hoover was delighted with the results.

Supreme Court - Not to be outdone, the Supreme Court followed suit in 1931, air-conditioning most of its building, even though the Court was not in session during the summer months

Air Conditioning - 4

- Spread of Air Conditioning – 2
 - Commercial Office Buildings
 - 1926 – An 8-story office building in Fresno CA
 - 1928 – The 21-story Milam Building in San Antonio TX

59

Air Conditioning - 5

- In summary, the 1920s & 1930s laid the groundwork for home air conditioning by
 - Exposing people to air conditioned theaters, department stores, hotels, and office buildings
 - Inventing the room air conditioner (1930)
 - Discovering chlorofluorocarbons – refrigerants that were stable, non-flammable, non-toxic, odorless, and inexpensive to produce

60

Refrigerants - The ideal refrigerant must vaporize within the right temperature range, liquefy by compression within the right temperature range, and must absorb large amounts of heat as it vaporizes. Ammonia, ether, methyl chloride, sulfur dioxide, and similar chemicals met these requirements. Unfortunately, they either decomposed, were fire hazards, were poisonous, or smelled horrible -- sometimes all of these. Looking for an answer to concerns about toxic and explosive refrigerants, Thomas Midgley -- the developer of tetraethyl lead -- and Albert Henne, of the Frigidaire Division of General Motors, considered compounds that had desired boiling points. Since most known compounds were eliminated as impractical, they decided to explore the possibility of chlorofluorocarbons. !! They found that these CFCs admirably fulfilled all the technical requirements of a refrigerant and were also very stable, non-flammable, non-toxic, nearly odorless, and inexpensive to produce. At a 1930 meeting of the American Chemical Society, Midgley poured some liquid CFC into an open container and as the refrigerant boiled, he put his face in the vapor, opened his mouth, and took a deep breath. Turning to a previously lit candle, he slowly exhaled the CFC, extinguishing the candle flame. CFCs were the perfect refrigerants. Their ozone-destroying and global warming properties would not be discovered until decades later.

Air Conditioning - 6

- By 1940, air conditioning had made inroads into factories, movie theaters, department stores, office buildings, ocean liners, Pullman cars, hospitals, funeral parlors, and hotels
- In the 1950s & 1960s, air conditioning finally began to make inroads into the home
- By the 1990s, most one-family homes had central air conditioning

61

There were two major reasons why air conditioning did not make inroads into the home market until the 1950s-1960s.

Price - The first was price. It cost at least \$1,500 to air condition a home in the 1930s and \$400 to buy a portable room air conditioner. In terms of 2010 prices, this meant that it cost **\$23,222.25** to air condition a house and \$6,192.60 to air condition a room.

Consumer Need - The industry had not yet convinced people they actually *needed* air conditioning in their homes. As early as 1931, a Chicago magazine called *The Aero-logist* had published an editorial headlined, "Wanted, an Air-Conditioning Flivver." advocating the mass production of an inexpensive home cooling unit that :would make air conditioning more of a necessity than the radio or even the automobile... ." But Carrier was no Henry Ford; and his first home units were bulky, expensive, difficult to install, and likely to break down. The company sold only a thousand of them over a three year period and lost \$1,300,000 in the venture. In the wake of this failure, the Carrier Corporation retreated to the industrial and commercial market, all but abandoning its effort to develop a reliable Model-T air conditioner for the home. !! Even as late as 1948, in a confidential study of the potential of the residential air-conditioning market, company officials concluded that the profit potential was weak. As a result, the market was abandoned to the giant consumer electrical appliance and automobile companies like General Electric, Westinghouse, and Chrysler. All this was to change dramatically in the early 1950s. Within just five years of Carrier's assessment, the demand for home air conditioning increased more than tenfold, and the company that started it all was left out in the cold. Sales of room air conditioners jumped from 74,000 units in 1948 to 1,045,000 in 1953. What accounted for this sudden surge was the arrival, at long last, of the air-conditioning flivver -- a simple, dependable, self-contained box that could be plugged

% of New One-Family Homes with and without Air Conditioning

	1960	1970	1980	1990	1995
With Central Air Conditioning	22.5%	34.0%	63.0%	76.0%	80.0%
Without Central Air Conditioning	77.5%	66.0%	37.0%	24.0%	20.0%

62

Consequences of Air Conditioning - 1

- Created a new summertime reality that led to the decline of such traditional summertime customs and lifestyles as:
 - Spending the summer outdoors
 - Camping, sleeping outdoors, sitting on the front porch or front steps, hanging out on the street corner
 - Spending the evening at the drive-in movie, the outdoor theater, or the concert under the stars
 - Spending the days at the community swimming pool
 - Driving a convertible with the top down
 - Wearing white or light-colored summer suit or dress
 - The afternoon nap
 - Leaving the city in July/August for the beach or mountain cabin
 - Frequenting the ice cream parlor, the soft drink fountain, the lemonade stand, & the Good Humor truck

63

Another part of traditional summertime reality were such cooling tricks as frequent showers; putting ice cubes on one's wrists; getting a tee shirt wet, putting it over oneself, and drying it with a fan; sleeping in the basement or outdoors in the yard. For young people, one way of coping with summer was getting a job as a lifeguard or even better, a job as a worker in an ice house or ice rink.

Consequences of Air Conditioning - 2

- Led to the development of new summer customs and lifestyles such as:
 - Living life in air conditioned spaces – from the air conditioned house to the air conditioned car to the air conditioned office to the air conditioned mall back to the air conditioned home
 - Wearing of year-round suits and dresses in summer
 - Summer vacations at partially air conditioned theme parks
 - Disneyland, Sea World, Busch Gardens

64

Consequences of Air Conditioning - 3

- Created an introverted family-centered, work-centered, and school age-group-centered lifestyle
 - People socialize with relatives, fellow workers, & schoolmates rather than next-door neighbors (whom they now often don't even know)
 - People watch television or go on-line or play computer games in their air conditioned living rooms

65

Consequences of Air Conditioning - 4

- Changed the architectural patterns of office buildings and houses
 - Completely-sealed office buildings with windows that do not open
 - Disappearance of the front porch, the window awning, the veranda, and the ceiling fan
- Led to greatly increased usage of electricity in summer
 - Summer replaces winter as the peak season of electricity usage
 - Concomitant expansion of electrical generating facilities, leading to the increased emission of air pollutants and greenhouse gases

66

Consequences of Air Conditioning - 5

- Increased summertime work productivity
 - No seasonal layoff of workers in hot factories
 - No relatively-common early dismissal of office or factory workers when the temperature & relative humidity reaches a certain level
 - Less fatigued summer workforce
 - More comfortable working conditions

67

Consequences of Air Conditioning - 6

- Facilitated population shifts from the colder Northeast and Midwest to the warmer Sunbelt
 - Turned places like Houston TX, Dallas TX, Phoenix AZ and Las Vegas NV from sleepy towns into bustling metropolises
- Created a new industry based on the production, installation, and repair of air conditioning systems

68

Consequences of Air Conditioning - 7

- Led to the large-scale production of chlorofluorocarbons which served to deplete the ozone layer
- Helped foster the rise of a big Federal Government
 - Changed the way Congress operates
 - Made the Federal bureaucracy more efficient
 - Facilitated the creation of “iron triangles”

69

Changed the way Congress operates - Prior to the air conditioning of the House and Senate and the arrival of commercial jet aircraft, Congressmen, when Congress was in session, spent their time in Washington DC, did not travel back to their districts, and finished their business before the end of June so they could escape the Washington summer and get back to their cooler districts. Since air conditioning and commercial jet air flights (especially out of Reagan National), Congressmen spend most of the year in Washington DC, work a 3-day Tuesday-to-Thursday work week (flying out to their home district on Friday and returning on Monday), and do not adjourn until it is nearly Christmas. Meanwhile, living most of the year in the Washington Metropolitan area led the vast majority of Congressmen to bring their families here and buy houses in the Washington suburbs (or in Georgetown, Capital Hill, or Spring Valley) so they commuted to work each morning and returned to the suburbs at night, seeing little and socializing even less with their Congressional colleagues (as opposed to their own staffs). Before air conditioning, their families generally lived in the home district and the Congressmen lived in hotels or boardinghouses or rented quarters that they shared with fellow Congressmen – often of the opposite party – with whom they partied and socialized. Being continually in Washington, Congressmen become ever more responsive to the demands of both Federal agency bureaucrats and corporate lobbyists.

More efficient bureaucracy & “iron triangles” – As noted earlier, air conditioning made workers (including Federal bureaucrats) more productive in summer. It also made living and working in Washington DC more appealing to both prospective bureaucrats and corporate lobbyists – factors which facilitated bureaucratic expansion (a la Parkinson) and the creation of “iron triangles” of congressional committees, Federal programs, and constituency groups and contractors that are the beneficiaries of Federal programs and contracts.