Teacher Guide

CONNECTIONS 3

For Grades 7-College

Teacher's Guide by: Bill Roberts

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INSTRUCTIONAL NOTES

It is suggested that you preview the program and read the related information. By doing so, you will become familiar with the materials and be better prepared to adapt the program to the needs of your class. You will probably find it best to follow the programs in the order in which they are presented in this Teacher's Guide, but this is not necessary. It is also suggested that the program presentation take place before the entire class and under your direction. As you review the instructional program outlined in the

Teacher's Guide, you may find it necessary to make some changes, deletions, or additions to fit the specific needs of your students.

CONNECTIONS[3]

History is filled with discoveries and inventions that although seemingly unrelated are connected in some of the most surprising ways. In these ten half-hour stories created for the Discovery Channel, writer and host James Burke explores the origins and effects of those inventions that shape the modern world we live in. Building on the success of the series he originated for the BBC and PBS, he invites viewers on journeys that begin in the present day and travel through history to bring to life the extraordinary, associative nature of change.

Each episode is approximately 25 minutes long

1. **Feedback**
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PROGRAM 1: Feedback

Teachers are encouraged to preview the film before showing it in class

In this episode, James Burke looks at the use of feedback in the twenty-first century raising some serious questions about our personal privacy in the future. We learn how the concept of feedback originated in the vineyards of France and how the Humane Society, drowning, shipping, a new diet, and Kellogg's Corn Flakes are all integrally related.

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Contributors mentioned in this program:

Claude Bernard
Matthew Maury
Washington Allston
Alexander Ball
Adrmiral Horatio Nelson
Dr. James Graham
James Watt
William Morris
George Bernard Shaw
Ellen White
Grace Darling
Samuel F. B. Morse
Samuel Taylor Coleridge
Napoleon Bonaparte
Emma Hamilton
Dr. Joseph Black
Smithson Tennant
Karl Marx
Annie Besent
John Harvey Kellogg

Significant technological advances and events:

The "connections" in brief:

• The Sri Lankan village was 100 miles from the nearest telegraph 50 years ago and 50 miles from a phone in the 1970's. *What is its "connectability" today? What will it be by 2020?*

• Most of the world is interconnected by the Internet now. *Will having everybody in the world instantly connected to everybody else by cell phones be good?*

• *Cell phones are everywhere today, especially in Europe. Why have they become so popular and what problems are they causing within the family? Should they be banned in restaurants and for*

drivers in moving cars?

• *What about privacy if a computer contains an electronic version of you? Privacy is not guaranteed by the Constitution though courts suggest it is implied. Might we be <u>required</u> to be "connected" at all times someday?*

• *How much about you do you think that is known by the Government, mail order houses, banks, and lending agencies? What do you want known? How secure are you from hackers?*

• *How did the system of "predictors" work in the interception of missiles?* Look up "Kentucky windage". *Is this the biological equivalent of the intercept predictors?*

• *How many individual examples of "biofeedback" can you think of that your body uses?* Define "homeostasis".

• The Anti Vivisection League was formed in the early 1800's. *What was its purpose then and by what names and in what areas is it active today? What is meant by "animal rights"? How far down the species should the rights extend?*

• *Just how scientific is putting dates and locations in a bottle and throwing them into the ocean? What were the biggest contributors to the growth of maritime commerce in the 1800's?*

• *Why is Nelson considered Britain's greatest admiral? Where were his victories and what were their results? What happened to Emma after Nelson was killed?*

• Look up the ingredients in the bleach we use today.

• *What was the "Arts and Crafts Movement" that Morris led?. Who were the "Pre-Raphaelite" painters of the time? What were these groups reacting to? What did they want? What of their work is undergoing a resurgence today?*

• *How is Scotch whisky different from other whiskeys?* Look up the steps in the distilling process. What is "single malt?

• "Family Planning" was considered the height of immorality, and leading to the destruction of the family in the 1800's. *How have attitudes changed today and with what groups?*

• Marx comes up in this film. *Since he was a German, what was his connection to Lenin and the Russian revolution of 1917? Who was Friederich Engles?*

PROGRAM 2: What's in a Name

Teachers are encouraged to preview the film before showing it in class

A good breakfast leads to corn cob garbage—which isn't garbage at all. It is used for "furfan", which creates resin for bonding. Learn how this led to the creation of the tractor and the diesel engine and surprisingly, the Smithsonian Institution in Washington, D.C.

Contributors and terms mentioned in this program:

Johann Wolfgang von Goethe
Columbia Exposition, 1893
Thomas Alva Edison
Louis Comfort Tiffany
Ben Holt
Rudolf Diesel
the Rhur Valley, Germany
Royal Statistical College
Charles Babbage
Isambard Kingdom Brunel
Cyrus Field
Wolfgang Döbereiner
George Westinghouse
Edward Goodrich Atchison
San Joaquin Valley, CA
Gustavus Augustus Busch
Friedrich Alfred Krupp
Otto von Bismarck
Trinity College, Cambridge
Brittania Bridge
"Great Eastern"
Matthew Maury

Royal and Ancient Golf Club, St. Andrews, Scotland

Charles Mcintosh	*cudbear*
John Roebuck	*Dr. Joseph Black*
Lord Henry Cavendish	*the Royal Society*
James Macie	*Duke of Northumberland*
David Dale	*New Lanark, Scotland*
Robert & Robert Dale Owen	*New Harmony, Indiana*

James Smithson (original James Lewis Macie)

Significant technological advances and events:

The "connections" in brief:

• **Döbereiner** discovered **furfan** but has no use for it.

• **Quaker Oats** discovered a use for furfan as an solvent which is used as a resin for bonding abrasives.

• **Atchison** fired coke and clay at high temperatures creating silicone carbide (carborundum), hard enough to cut diamonds.

• Silicone carbide is used as bullet-proof lining against armor-piercing ammunition which was developed to penetrate tanks.

• **Holt** adapted tank tracks to tractors which made America the "bread basket" to the world. Tractors are run by diesel engines.

• **Diesel** developed his fuel-efficient engine to run on cheaper coal fuel instead of petroleum-based gasoline.

• **Krupp** acquired diesel engines to run his steel works to produce his machinery to run his railroads, shipyards and munitions plants. He built a manufacturing empire with a social welfare approach to business; with benefits, health care, good working conditions, pension plans, and company towns. *What was Krupp's involvement in Germany's involvement in the two world wars? What can you find out about Krupp today?*

• **"Probability math**" was developed and became a foundation for the Royal Statistical Society which used population data as a means to help industry control workers.

• **Babbage** used the new French standardized weights and measures (metric) and automated his "difference engine" with punch cards, which helped Stephenson build bridges and **Brunel** to build the "Great Eastern", the largest ship afloat.

• **Field** used the ship to lay the first Transatlantic Cable whose wires were insulated with gutta-percha which was also used to make cheap golf balls for the new leisure class.

• A way was developed for Scottish low-grade coal to burn evenly which boosted Scotland's manufacturing economy and helped **Watt** to develop his steam engine.

• **Dale** developed the **New Lanark** community for underprivileged youth, attracting Owen who founded New Harmony, IN.

• Owen's son connected with **Macie**, a descendent of the illegitimate son of the Duke of Northumberland. Macie, changed his name to **Smithson** and converted his inherited fortune into gold bullion in order to found the **Smithsonian Institution**.

PROGRAM 3: Drop the Apple

Teachers are encouraged to preview the film before showing it in class

With his discovery of calamine, James Smithson, the benefactor of the Smithsonian Institution, did a lot for sunburns, poison ivy and diaper rash. Calamine is one of the most useful and unusual minerals because it gives off electricity. The secret is in the shape. We discover how the use of this electricity led to Einstein's theory of relativity.

Contributors and terms mentioned in this program:

James Smithson
Wilhelm Konrad Roentgen
"Jeremiah O'Brien"
"Patrick Henry"
Nicolaus Copernicus
Napoleon Bonaparte
Madras, India
Chauncey Jerome
Tom Thumb
La Scala Opera, Milan, Italy
Caliph of Egypt
Thomas Cook
Malta
Ismailia
Ferdinand deLesseps
Auguste Comte
Albert Einstein
Pierre & Marie Curie
Paul Langevin
Franklin Delano Roosevelt
Jean B. L. Foucault
Louis J.M. Daguerre
Bernard Courtois
Eli Whitney
Phineas Taylor Barnum
Jenny Lind
Guiseppe Verdi
Abdul Aziz
Suez Canal
Port Said
Cairo
Henri Saint Simon
Ernst Mach

Significant technological advances and events:

The "connections" in brief:

• **Smithson** gave $2 billion to the U.S. to create Washington's Smithsonian Institution to "spread the light of knowledge".
• He discovered calamine from crystals which give off an electrical charge making possible an electricity gauge.
• The gauge was used by the **Pierre and Marie Curie** to read radioactivity (discovered by **Roentgen**) from pitchblende, thereby discovering radium and winning for them the **Nobel Prize** in 1911.
• Their assistant, **Langevin**, created a crystal "sandwich" which made sonar possible, thus saving many World War II "Liberty ships". Instead of being riveted they were welded together.
• **Oxyacetylene** welding is possible through the discovery of carbon arcing by **Foucault**, who also created the inertial pendulum which measures Earth's rotation and proves **Copernicus**.
• This helped astronomers regulate telescopes and photograph the stars using the new photographic process of **Daguerre**.
• Photography depends on iodine vapor discovered by **Courtois** who also made gunpowder containing saltpeter made from wood ash (potash), lime and sulphur. Potash is also used to de-grease raw cotton.
• Cotton production was speeded up and made cheaper by the invention of the cotton gin by **Whitney** who later developed the process of making interchangeable parts for muskets.
• Interchangeable parts make mass production of **Jerome's** clocks possible. Jerome was financed by **P. T. Barnum**.
• Barnum created the three-ring circus, whose early stars were the "Swedish Nightingale", **Jenny Lind,** and **Tom Thumb.**
• Lind sang in many of the operas by **Verdi** whose compositions were often political, which is why he was commissioned by the Caliph of Egypt to compose his most successful opera, "**Aida**", commemorating the opening of the Suez Canal.
• One of those who first suggested the Canal took a scientific view of history giving rise to the science of sociology, in which there are no absolutes, only the points of view of individuals.
• **Mach's** principle is that all is relative, everything being affected by everything else—ergo **Einstein.**
• Einstein finds that light rays are bent by gravity, this program concluding then with ***a knowledge***

of light.

PROGRAM 4: An Invisible Object

Teachers are encouraged to preview the film before showing it in class

Travel five hundred years into the past to connect mysterious black holes in space with modern fast food, via thrills and spills on the Pony Express and to the capture of Joan of Arc. Learn how a gift from Catherine de Medici led to modern techniques for pasteurization, and eventually to the first vending machine.

Contributors and terms mentioned in this program:

Edwin Hubble (telescope)	*Discovery (space shuttle)*
thrusters	*hydrazene*
Medoc region, Bordeaux	*agribusiness*
Fungus	*fungicide*
Aphids	*phylloxera*
Henry Wells & William Fargo=American Express	
St. Louis, Mo	*Sacramento, CA*
"Buffalo Bill" Cody	*Annie Oakley*
Vaudeville	*Joan of Arc (Jean d'Arc)*
Spanish Inquisition	*Tomas de Torquemada*
Suleiman the Magnificient	*Cyprus*
Rhodes	*Topkapi Palace, Istanbul*
Knights of Malta	*anesthesia*
Andreas Vesalius	*Titian (Tiziano Vecelli)*
Pope Paul III	*Holy Roman Emperor, Charles V*
Augusburg, Germany	*King Henry V (of France)*
Catherine De Medici	*migraine*
Logarithms	*Christian Huygens*
Louis Pasteur	*autoclave*
Franco-Prussian War	*Karl von Linder*

Significant technological advances and events:

The "connections" in brief from the present to 1431:

• The **Hubble** telescope looks at the beginnings of the universe from the most distant objects, possible because **Einstein** discovered that light has weight making it bounce and reflect at light speed.

• **The Space Shuttle** is fueled by hydrazine discovered by French wine makers to kill a *downy mildew* imported on American vines which were brought in to kill aphid-causing **phylloxera** which was also brought in on earlier American vines to kill *powdery mildew.*

• **American Express**, an outgrowth of **Wells Fargo**, developed the crime-proof system of transferring money internationally.

• Wells Fargo initiated the **Pony Express** whose most famous rider later became **Buffalo Bill**, a pioneer in "vaudeville", a word derived from 16th century French.

• **Joan of Arc**, fanatically religious, answered a prophecy to lead the French army, finally driving the British out of France. She was burned as a witch by the English after the church, threatened by her populist appeal, turned her over to them.

• Populist uprising against church dogma and the growth of Protestantism led to the **Inquisition**, most flagrant in Spain under the **Grand Inquisitor**, **Torquemada**.

• Jews especially suffered for not accepting Catholicism and were driven out in 1492 by

Ferdinand and Isabella. Many settled in Turkey and other Muslim countries helping make rulers wealthy enough to threaten expansion into Europe again.
• They were stopped by an alliance of Europeans, the **Knights of Malta**, who advanced medicine to treat wounded by using anesthetic and studying the anatomical work of Vesalius, whose texts were illustrated by **Titian**.
• Jewelers in Augsburg invented metal screws for jewelry worn by Queen **Catherine de Medici** who advanced the use of tobacco imported from new English colonies in America.
• **Pasteur** found that germs caused food spoilage, leading to pasteurization and safer foods in winter**. Von Linder's** invention of the refrigerator led to safer foods in summer,

PROGRAM 5: Life is No Picnic

Teachers are encouraged to preview the film before showing it in class

Explore the connection between soluble coffee consumed during World War II and nineteenth century theories of evolution through the invention of nylon and *The Star Spangled Banner.* Discover how a new method for calculating astronomical dates and the death of Descartes led to the creation of the Royal Society, and how the jellyfish made Charles Darwin famous.

Contributors and terms mentioned in this program:

Nestlé Company
K-rations
military Jeep
cracking, as in refinery
DuPont Corp., Wilmington, DE (E.I. Dupont de Nemours)
acetylene
neoprene
nylon
Luddites
Lord Byron (George Gordon, 6th Baron of Rochdale)
libertarian
Istanbul, Turkey
Santa Sofia
Blue Mosque
Suleiman the Magnificent
Topkapi Palace
USS Chesapeake
War of 1812
Baltimore, MD
Fort McHenry
Star Spangled Banner (tune from "To Anacreon in Heaven)
Francis Scott Key
King Gustavus Adolphus
flintlock musket
René Descartes
Sir Christopher Wren
shareholder bank
Pierre A. C. de Beaumarchais
Frederick W.J. von Schelling
Charles Darwin
Henri Estienne
Wheelock pistol
King (Queen) Christina
Thomas Willis
St. Paul's Cathedral, London
John Law (Duke ofArkansas)
Jacques Necker
Thomas Henry Huxley
William Wilberforce

Significant technological advances and events:

The "connections" in brief:

• World War II American soldiers' need for quick portable food lead to Nestlé's development of instant coffee for **K-rations**.

• Overwhelming need for gasoline generated an increase in "cracking" refineries. Describe the process of cracking from crude oil to gasoline.
(crude>gasoil>kerosene>naptha>gas)

• Further "squeezing" process produces **methane** from which comes **acetylene** from which

comes **neoprene** (synthetic rubber, also needed in World War II). **DuPont** refined it further to produce nylon.

• **Luddites** in Britain rebelled against the Industrial Revolution which put many poor out of work. **Lord Byron** defended them

• During the Napoleonic Wars many British sailors deserted their warships for Americans'. Britain's retaliation against the American navy lead to the War of 1812.

• In 1814 Key observed the bombardment of **Fort McHenry** and was inspired to write The Star Spangled Banner, a poem which was later set to an English drinking song tribute to a Greek poet, "Anacreon in Heaven".

• The Renaissance saw a heightened interest in Greek literature as well as science and warfare. Military technology was advanced by **King Gustavus Adolphus** .with great success.

• **Descartes** studied the workings of the body's fluids. Willis was the first to aggressively study the brain. His book was illustrated by **Wren** who designed **St. Paul's**, fifty other churches and buildings after the great London fire of 1666.

• **John Law** conceived of shareholder banks and the use of paper money in France. One of his overseas investment schemes resulted in **New Orleans** but when the scheme went bust investors and the French government were bankrupted.

• To help with their war with Britain, France provided assistance to the American colonists in their war for independence.

• **Von Behr**, an embryologist, classified things from general to specific, theories popularized by **Huxley** whose own studies of sea life lent support to Darwin's theory.

PROGRAM 6: Elementary Stuff

Teachers are encouraged to preview the film before showing it in class

We join Burke on a journey that begins with miracles and spiritualism and ends with the greatest detective of them all. Some of the clues connect nineteenth century thought-transference and radio with banana republics and postage stamps. Learn how Scottish rebels and North Carolina pine trees revolutionized the French navy, and how contextual perception led to Sherlock Holmes.

Contributors and terms mentioned in this program:

Charles Darwin and Origin of the Species
Alfred Russel Wallace — *natural selection*
mental telepathy — *Reginald Aubrey Fessenden*
James Watt — *Guglielmo Marconi*
Radio waves — *modulated, modulation*
Dominican Republic — *United Fruit Company*
"Punch" — *Houses of Parliament*
August Pugin — *gothic architecture*
Johann Gottfried von Herder — *Riga, Latvia (form. Prussia)*
Gaelic — *James Macpherson*
tartan — *highlander (Scotland)*
Ossian Epic — *Battle of Culloden, 1746*
Prince Charles Edward Stuart (Bonnie Prince Charlie)
Corsini Palace, Florence It. — *Flora Macdonald*
Cape Fear River, NC — *"Tarheels"*
resin — *turpentine*
King Charles II — *lacquer ware*

Pontypool, Wales, japanning (linseed oil, iron oxide, umber)
Jean Baptiste Colbert *Piti Palace, Florence*
Grand Duke of Tuscany, Italy *Galileo Galalei*
Evangelista Torricelli *Robert Boyle (Boyle's law)*
Pierre & Charles Perrault *Jonathan Swift*
George Berkeley *Thomas Young*
Rosetta stone *heiroglyphics*
Nicholas Conté *Gen. George McClellan*
Allan Pinkerton *the Molly Maguires*
James McParland *Sir Arthur Conan Doyle*

Significant technological advances covered in this program:
The "connections" in brief:
• Darwin's theory of "**natural selection**" may have been preceded by **Wallace**, who was also interested in the spirit *world. Research the debate about evolution vs. creationism.*
• **Fessenden** turned electrical impulses into radio waves which made possible a rapid organized delivery system of bananas and other fruit from the Caribbean and Central America by **the United Fruit Co**. *Check their influence on politics in the area.*
• International postal protocols were established in Switzerland in 1874. Stamps and postcards were introduced around then.
• **Pugin** designed **Parliament** with Gothic architecture borrowed from the Germans who were developing a national spirit, and the superior race notion, encouraged by **Herter** who was inspired by **McPherson's** poem. *(How did the Holy Roman Empire become Germany? When? Under whose leadership?)*
• Scottish culture had been crushed by their defeat at **Culloden** in the ill-fated attempt to put **Prince Charlie** on the throne of Britain. The prince was later saved from capture by **Flora Macdonald** who escaped with other Scots to North Carolina. *(Charlie is still a Scottish national hero. Look up the history of the Stuart risings and the reasons behind them.)*
• **Colbert's** navy helped Napoleon invade Egypt where his troops found the **Rosetta Stone** which allowed **Young** to crack Egyptian hieroglyphics. Young also discovered light rays.
• **General McClellan** employed balloons, first used by Napoleon, in the American Civil War and later hired **Pinkerton** to patrol the Illinois Central railroad. Pinkerton created the first detective agency and brought in **Molly Maguires** using a spy inspiring **Doyle's** Sherlock Holmes story, "Valley of Fear".

PROGRAM 7: A SPECIAL PLACE

Teachers are encouraged to preview the film before showing it in class

Journey four hundred years into the past to connect *fa*mous sleuths and popular destinations through Dutch wind tunnels and aristocratic World War I fighter aces. Discover how Caribbean smugglers and bird painters led to Russian skullduggery, and ultimately to a final beauty spot where hundreds of Americans get drenched every day.

Contributors and terms mentioned in this program:
Prof Sir Alec Jeffries, Leicester University, England
DNA profile *radioiactive tagging*
schlieren photography *Teodor von Karman*
shedding vortices *Tacoma Narrows Bridge*
sympathetic vibrations *virtual reality*
The Red Baron, Manfred *Frieherr von Richthofen*
Antony Fokker *Ferdinand von Richthofen*

chorography	*chorology*
Johann Gottfried von Herder	*"psychobabble"*
Pompeii	*Mount Vesuvius*
neo-classical	*David Garrick*
Drury Lane Theater	*argon*
Dominican Republic	*Hispaniola*
War of Jenkins' Ear	*scurvy*
camera obscura	*Johannes Kepler*
John Donne	*Isaac Walton*
Chateau Yquem	*Montaigne (Michel Yquem)*
Johann Bernouli	*capillary action (attraction)*
Stephen Hailes	*Edward Jenner*
John James Audubon	*Spencer Fullerton Baird*
Ferdinand Hayden	*William Henry Jackson*

Significant technological advances and events:

The "connections" in brief:

• **Professor Jeffries** isolated the DNA profile in 1984. *Explain in your words how this is done.*

• **Von Karman** used **schlieren** photography to develop aircraft and rockets which will not be susceptible to vibrations.

• **Fokker** developed the interrupter gear in 1915 allowing machine guns to fire through airplane propellers aiding the **Red Baron** to become World War I's most successful ace. *How many planes did he bring down? What was his fate?*

• His great uncle, a geographer, invented chorography and chorology, sciences dealing with inter-relationships, inspiring **Herder,** who in turn, inspired the romantics of the day with the notion that artistic experiences are physical experiences.

• The unearthing of **Pompei**i in 1762 generated an interest in classical Greek and Roman history, architecture and art.

• Actor **David Garrick** invented in the 1740's the "modern" theater with realism, movable scenery and reflected brighter lighting, aided by **argon lights**, which improved lighthouse effectiveness—a boon to ships.

• This was a period of growth in marine commerce, and a growth in smuggling. The Spanish in the Indies, losing wealth to smugglers, created a coast guard to protect their ships.

• Most English sailors died of scurvy rather than action, leading to the discovery that limes would prevent it, hence "limeys".

• Heightened interest in medicine led to an increased study of anatomy with doctors paying grave robbers to deliver bodies. Books of anatomy were illustrated with the help of **Kepler's camera obscura**. Kepler also found that planets had elliptical orbits suggesting that the sun's gravity was responsible.

• Skepticism led to advances in other sciences like astronomy and mathematics, putting them at odds with the church. **Jenner** discovered the vaccine for smallpox. (from "vaca"= cow)

• In a shady land deal America acquired Alaska from Russia (Seward's Folly). **W. H. Jackson's** photos of the West inspired Congress to establish the first national park**—Yellowstone.**

PROGRAM 8: Fire From the Sky

Teachers are encouraged to preview the film before showing it in class

From Iceland's majestic geysers to the World War II firebombing of Hamburg—by way of Stonehenge, the mystical Cabalists, Martin Luther, Ozeander, Tycho Brahe, Mary Queen of Scots, the magnetic North Pole, a gin and tonic, and Sri Lanka, where rubber helped save the Allies.

Contributors and terms mentioned in this program:

tectonic plates *magma*
fata morgana—from Morgan le Fay (King Arthur's sister)
Camelot *Stonehenge*
Cassiopeia *Wittenberg*

Significant technological advances and events:

The "connections" in brief:

• A German geologist, **Alfred Wegener**, observing ice floes in Iceland, devised the theory of **continental drift**.

• Popularity of the **King Arthur** legend, resulted in a code of chivalrous behavior which exerted an important influence of medieval and renaissance literature.

• In medieval Europe **Cabalists** developed an occult theosophy based upon an esoteric interpretation of Hebrew scripture. The "**Way of Cabala**" (or Kabala) which was grounded in a numeric relation to the Hebrew alphabet was supposed to reveal strange truths and bring endless peace.

• The Italian, **Giovanni Pico della Mirandola**, claimed that Cabalism was the only way to understand Christ which enraged to church and led to the burning of Hebrew literature.

• **Philipp Melanchton**, a theologian, professor of Greek, and associate of **Martin Luther**, developed the first organized school system in Germany.

• **Giralomo Cardono**, an Italian doctor and author of a text on algebra, worked out the first laws of probability. His asthma patient was the Scot...

• **Archbishop John Hamilton** who was a supporter of the Catholic **Mary, Queen of Scots**, whose claim to the English throne led to her imprisonment and execution by Queen Elizabeth in 1587. Hamilton had annulled the marriage of James Hepburn, **Earl of Bothwell**, so that he could wed Mary. Following her capture Bothwell fled to Denmark where he was imprisoned in a dungeon in which he went mad and died.

• **Tycho Brahe**, a Danish astronomer, observed the stellar and planetary positions precisely in the 16th century.

• Brahe's assistant became map maker to the **Dutch East India Company** in 1602, at a time when Dutch merchantmen were the masters of the seas. Exploration and colonization of the Indies (now Indonesia) brought them riches in the trade of spices such as cinnamon from **Sri Lanka.**

• **Gerhardus Mercator**, a Flemish cartographer, developed a map projection where parallels of latitude and longitude cross at right angles, a boon to navigators.

• **Samuel Pepys**, best known as a diarist, was secretary to the British admiralty where he devised a system of signal flags which is still used today. The **semaphóre**, a visual signaling apparatus, replaced the flags on windless days.

• Food, kept in bottles by Napoleon's army to preserve it, was later canned and used by **John and James Ross** in their search for the Northwest Passage in the New World during which the latter discovered the **magnetic north pole**. Their expeditions were financed by **Felix Booth**, distiller of gin.

• **Quinine** which was used to combat malaria in the tropics was too bitter to drink until mixed with sugar water—tonic water.

• Japanese invasions of the Indies in 1942 cut off the supply of rubber to the Allies. They then depended heavily upon the supply from Sri Lanka. It was found that mixing rubber and gasoline would produce incendiary bombs which were used to firebomb Germany and Japan.

PROGRAM 9: Hit the Water

Teachers are encouraged to preview the film before showing it in class

Burke takes the viewer from interdiction warfare in Viet Nam back to a commando raid in Norway in World War II touching along the way upon margarine, ocean currents, sound physics, French opera, the British Museum, the Protestant Reformation, ballet, gymnasiums, blood typing, and the Red Cross.

Contributors and terms mentioned in this program:

Humboldt Current	*Lady Mary Montague*
harim, concubine	*Coldstream Guards*
Sir Isaac Newton	*Admiral Graf Spee*

Significant technological advances covered in this program:

The "connections" in brief:

• Japanese invasion of the East Indies led to the search for synthetic rubber which assisted the development of napalm.
• In France margarine was developed of beef suet and milk because of the high cost of butter. It was improved by the Dutch who substituted palm oil from **Sri Lanka**.
• **Kieselguhr**, made front the shells of plankton, was used to harden the oil when mixed with nickel. Hydrogen atoms stuck to the oil molecules creating the **hydrogenation** process.
• Study of plankton led to the discovery of wind currents' effect upon ocean currents.
• The pitch of a sound rises as the sound approaches and falls as the sound departs—The (**Christian) Doppler Effect**. This also occurs with approaching or departing light rays which is applied to the age of stars from their brightness.
• **Armand Fizeau** computed the speed of light which, combined with the color of light rays from stars made possible the measurement of astronomical distance.
• **Georges Bizet** stole his story for the opera "**Carmen**" from the French author **Prosper Mérimée** who saved many French monuments and buildings,. including Notre Dame.
• The large collection of **Hans Sloane's** books and his grant of funds were used to begin the library of the British Museum.
• Turks discovered innoculation of children from smallpox.
• The Swiss naturalist, **Conrad Gessner**, who classified plants by structure also developed a system for classifying books.
• **Ulrich Zwingli**, a follower of Luther, broke from the Catholic church and converted much of Switzerland to Protestantism.
• The Swiss ceased providing mercenary troops to the French army which then developed a permanent professional army with battlefield maneuvers, combat clothing, pensions, and hospitals. They also began marching to music, the first marching band being organized by King Louis XIV's music master who also wrote ballets for male dancers, and later, women.
• The first marriage of music and drama was "**The Beggars' Opera**" written by **John Gay**. It was modernized in the 1930's as "The Three-penny Opera" by *Kurt* Weill,
• The late 18th century saw a rapid growth of scientific advance**. Lazaro Spallanzan**i discovered that microorganisms in the air, a finding mostly ignored until Pasteur a century later.
• **Hoffman** kicked off an interest in gymnastics in nationalist Germany, The first U.S. gym was developed at Harvard. The YMCA picked up the interest and it spread worldwide.
• Heavy casualties and the lack of medical support at the **Battle of Solferino** in 1859 led to the **Geneva Convention** of 1864 where the Red Cross was proposed by **Henri Dunant**.
• In the early 1900's blood types were discovered and the Frenchman, **Alexis Carrel**, first sutured blood vessels.
• Aviation pioneer **Charles Lindbergh's** blood pump assisted transfusions and allowed for organ transplants.

• Nazis built the "pocket battleship" to avoid a naval treaty.
• In 1940 the Nazis invaded Norway in part to produce **heavy water**, necessary in the development of an atomic bomb. Their facilities were destroyed in a raid by British commandos.

PROGRAM 10: In Touch

Teachers are encouraged to preview the film before showing it in class

An American scientist ponders the problem of nuclear fusion in 1951. This unleashes a series of connections that encompass superconductors, the Eiffel Tower, the Statue of Liberty, King George III, modem oceanography, the Versailles Gardens, Pagoda mania, and handwriting analysis to arrive at the Global Net. Through this chain of unexpected connections, you, the viewer, can stay in touch.

Contributors mentioned in this program:

Heike Kamerlingh-Onnes
Emma Lazarus
Lawrence Oliphant
Sir Thomas Lawrence
André Lenôtre

Significant technological advances covered in this program:

The "connections" in brief:

•**Lyman Spitzer** theorized that by fusing deuterium (isotope of hydrogen) and tritium (rare hydrogen isotope used as a tracer) that a great amount of energy could be generated from a tiny amount of water. The steam generated would drive turbines to produce electricity. At one million° F. the gas becomes **plasma**, so hot that only a magnetic field can hold it. A magnet cooled to -100° becomes a **superconductor** with no resistance to electricity thereby requiring no electrical boosters.
• **Louis Cailletet** accidently discovered that squeezing oxygen over and over dropped its temperature until it became liquid.
• **A. Gustave Eiffel's** studies of iron tracery led to the building of the **Eiffel Tower** (984 ft. high) in 1889. This also made possible the construction of the **Statue of Liberty**, a French gift.
• **Zionism** was a centuries-old plan or movement for Jewish peoples aimed at the re-establishment of their hereditary homeland in Palestine (now Israel).
• **Lord Elgin** carried off fallen sculpture from the **Parthenon** to be re-constructed at the British Museum (where it still is) giving rise to the Greek's lament, "The Greeks have two enemies, the Turks and Lord Elgin." His son substituted opium for money to pay China for tea which led to massive drug addiction and the "Opium War" of 1841-42.
• **John Hunter**, who opened a medical school in the late 18th century and authored a text on dental disease, treated **King George III**, for mental illness caused by porphyria. This was dramatized in the film, "The Madness of King George".
• **Benjamin Franklin** charted the path of the **Gulf Stream** by taking water temperature using the thermometer invented by **Gabriel Fahrenheit** which standardized temperature settings.
• **Jean Picard**, in building the fountains at **Versailles** for **Louis XIV,** designed the instrument for measuring land elevation.
• **William Chambers**, an architectural author and chief royal architect to King George III, build **Somerset House** in London and designed the king's coronation coach.
• Chambers' stonemason, **Thomas Telford**, in the early 1800's constructed a series of roads, bridges and harbors in Scotland in an attempt to encourage Scots to return after they had been driven out by the **Clearances** of fifty years before.
• **Thomas Young**, British physicist, physician and Egyptologist, calculated the size of blood corpuscles and, in 1803, discovered light rays.
• **Heinrich Hertz** found that electricity also travels in waves.

• **Baron Hermann von Helmholtz**, German physician, mathematician and philosopher, calculated in experiments with frogs the speed of electric nerve impulses.
• **Ludwig Klages**, a leader in the **Vitalism** movement, developed the theories of body language and **graphology** (handwriting analysis) which were used in job interview screening and were to carried to extreme by the Nazis in the selection of the dreaded SS (Schutzstaffel) members.
• **Zip codes** were developed to read otherwise unreadable addresses using **optical character recognition** technology.

Ambrose Video Publishing, Inc., 145 W. 45th Street, Suite 1115, New York, NY 10036
Phone: 1-800-526-4663 ◆ www.ambrosevideo.com