Teacher Guide

CONNECTIONS 2

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^2

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 approximately25 minutes long

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PROGRAM 1: Revolutions

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

Discover the secret side of inventor James Watt's life, which is NOT about the steam engine. It IS about what Watt did to modern office work, fertilizers, Italian cemeteries, safety matches, the landing on the Moon, X -rays, imitation diamonds and the coming revolution in genetics.

Burke strings together a series of events in a kind of vertical continuum that, while something of an oversimplification, contains the saga of the way each invention or technological advance builds upon those of the past.

It is interesting to speculate about what the result might have been if any of these events had not occurred, or how the discoveries might have been made through other means.

Students might want to develop their own historic event lines, justifying their own conclusions.

Contributors mentioned in this program:

James Watt
Justus von Lebig
Thomas Alva Edison
Phillip Lenard
David Mushet
Wilhelm Roentgen
Cyrus P. Dalton
Alexander Graham Bell
George Goodyear
Sidney George Brown
Edward G. Acheson
Gottleib Daimler

Significant technological advances covered in this program:

1. The steam pump was developed for use in the mines of Southwest England.

2. The steam pump was adapted to drive machinery. What were some of the industries that were thereby revolutionized? What sociological changes resulted from factory relocations?

3. Developments in printing led from the letterpress and inks made of lamp black and paraffin wax to word-processing on computers. How many printing and copying devices and practices have been rendered obsolete by microcomputers?

4. Widespread use of phosphorus ranged from printing to growing food. Where does phosphorus come from now?

5. Watt's best-known invention, the steam engine, powered locomotives from the early 1800's. How did the steam train affect demographics, family size and structure, and the economy?

6. Lighting the cities at night by gaslight, and later by electricity resulted in what changes in working conditions and women's roles?

7. The telephone linked the production-distribution network across the U.S.A. What did this mean to a Kansas farm family?

8. Describe the process of magnifying sound in the telephone. Why was carbon black important? Where else is it important?

9. The automobile greatly changed 20th century life. How did carbon black and paraffin oil make the automobile possible? What were the contributions of Ford, Goodyear and Daimler.

10. Phosphorus turns up again as a major contributor to the other most influential invention of this century-TV. How?

11. Trace X-rays' progress from its discovery to its contribution to the discovery of DNA and genetic engineering.

12. What have been the positive and negative affects of each of the technological advances listed in this film? Do you think the good has always outweighed the bad?

PROGRAM 2: Sentimental Journeys

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

What has Freud got to do with maps? Or prison reform with blue dye? Or shock treatment with a Bunsen burner? Or disease with the Russian Orthodox church? Or a perfect glass with surveying? Or the inside of a star with the Himalays 100 years ago? This program journeys the length of India to find the answers.

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Contributors mentioned in this program:

Sigmund Freud
Gall &. Spurzheim
Charles Darwin
Paul Ehrlich
Joseph von Fraunhofer
Friedrich Mesmer
Jesse Ramsden
John Gorrie
Robert Wilhelm Bunsen
John Dollond

Significant technological advances covered in this program:

1. The process of hypnosis was introduced in 1776. Who was Svengali? Was he real or fictitious? What was "animal magnetism"? What would you call it today?

2. In the 1880s' Freud developed the science of psychotherapy in treating depression in women. What did he believe about the meaning of dreams?

3. Theories arose in the late 1880s' about how we thought and behaved. What was their rationale for electric shock? Is it still used today? What was the "vital fluid" theory?

4. Phrenology was endorsed by many notables, particularly Queen Victoria. What did it suggest? What similar theories are being practiced today?

5. Darwin introduced the theory of evolution. What were the experiences that led to his conclusions? What geologic discoveries reinforced them? How did his theory fit with the thought of the time? How well are his theories accepted today? Research the "Monkey Trial" in Tennessee in the 1920s.

6. That the brain is composed of cells was an accidental discovery. How and by whom? How is staining of cells with artificial dye used?

7. Phrenology named control centers in the brain. What have we since learned about control centers? What are they called?

8. What is spectroscopy? How is it used in identifying elements, especially in the composition of the distant stars?

9. The discovery that matching concave and convex lenses sharpened images by adjusting focal length. How did this improve telescopes and lead to the sextant and theodolite?

10. Explain how the Indian surveyors measured accurately the height of Mt. Everest from so great a distance.

11. While not a part of this film's program, the Taj Mahal, considered by many to be the world's most beautiful building, is featured. Who built it and why? What is its significance?

PROGRAM 3: Getting It Together

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

Burke examines the various facets of a SWAT team mission ranging from artillery to air rescue to anesthesia used in the ambulance and how specific historical events led to the development of these technologies. For example, the development of anesthesia was a direct result of a Frenchman who was interested in hot air ballooning. Other technological advances with roots in ballooning include car engines, aspirin and the turbine fan.

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Contributors mentioned in this program:

Joseph &. Jacques Montgolfier
Dr. Paul Bert
Wilhelm Maybach
Gottleib Daimler
Philo Remington
Joseph Lister

Significant technological advances covered in this program:

1. The Montgolfiers launched their famous hot-air balloon in Paris in 1783.

2. "Laughing gas" was developed two years later. What is it composed of and what effect does it cause?

3 Explain how the relationship between laughing gas and air pressure worked to produce an anesthetic.

4. In 1795 Joseph Montgolfier developed the use of air pressure to produce the hydraulic ram. Did you notice in the film the difference in pressure it produced from processes used in the drilling of tunnels previously?

5. The process was later adapted to create the atomizer in which carbolic acid and ether were sprayed as an antiseptic in disinfecting hospital rooms.

6. From where did aspirin first come? In 1899 it was first produced in a laboratory. Has aspirin changed since that time? What is buffering? What do other common over-the-counter pain relievers contain?

7. How was the atomizer process adapted for use in the automobile engine, where, and by whom?

8. Soviet development of atomic weapons in 1949 and their launching of the first space satellite in 1957 set off a technological frenzy in the U.S. What was the D .E. W. line and how was its alert system controlled?

9. What technological revolution of the late 20th century did it help jump start?

10. What is a paisley pattern? Where can you find other applications of the paisley punch-paper tape process that are still in use?

11. How did Remington's typewriter and IBM's punch card technology lead to binary data entry? How are they similar or different?

PROGRAM 4: Whodunit

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

This is a detective story. Who stole a set of billiard balls in 1902 and why was he the most famous crook in history? Some clues: money from the Dominican Republic, the rock samples from Mont Blanc, Emperor Charles V's debts, the Caribbean island of Hispaniola, French mirrors, charts from the East Coast in 1775, and Charles Darwin's cousin and the FBI.

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Contributors mentioned in this program:

Georg Bauer (Agricola)
Anton Fugger
Charles II of Spain
Phillip II of Spain
Elizabeth I of England
Louis XIV of France
John Hadley
Charles Darwin
Francis Galton

Significant technological advances covered in this program:

1. Burke spoke of a "Renaissance man". What does that mean? What was the Renaissance and when did it occur? Can you think of any present Renaissance men, or women? Is one possible any more?

2. How is copper turned into bronze? What part did Leonardo da Vinci and Michaelangelo play in the wars of their time?

3. The wars of the 16th through the 19th centuries contributed to the development of Europe's great banking houses. Research the houses of the Rothschilds. Who did they finance?

4. Spain's colonies in the New World made her the richest power in the world in the 16th century. A century later she had lost her position. How did her kings contribute to her demise? How were the English navy, Portuguese explorers and the Dutch also involved?

5. Burke, an Englishman, gives total credit for the defeat of the Spanish Armada to the English navy, but there were other contributors. What were they?

6. Development of purer and clearer glass and mirrors made more accurate navigation a reality. What other scientific advances depended upon smooth clear glass and distortion-free mirrors?

7. How did the discovery of marine fossils high in the Swiss Alps support Darwin's theory of evolution?

8. "Laws" about heredity led to the belief in eugenics. What was eugenics all about? The film states that they also supported ethnic immigration laws and the Nazi's "master race" ideas. To what extent do those ideas still exist, where, and with whom?

9. How was the notion that fingerprints were individually unique arrived at? Is it possible that two people could have the same prints? How about matching DNA? How do mathematicians compute the probability tables to support the chance?

10. The film began with a cue ball. For fun, what is the difference between snooker and billiards?

PROGRAM 5: Something for Nothing

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

How something impossible that happened 400 years ago would take us into outer space, thanks (en route) to pigeon lovers, the Pope, the Black Sea hurricanes, 18th century experimental vicars, electric Italian frogs, train crashes, Victorian lavatories, and battleships.

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Contributors mentioned in this program:

Evangelist Torricelli
George Westinghouse
Stephen Hales
Alessandro Volta
John McAdam
Nikola Tesla
Luigi Valvani

Significant technological advances covered in this program:

1. In the middle ages the church said that there was no such thing as a vacuum. How did Torricelli's experiments challenge church dogma? What other scientific advances in the 16th century challenged the church? How did the church respond?

2. How does a vacuum pump work? What effect did it have on mining operations?

3. How does a barometer work? What does Burke mean that the barometer was a Protestant project?

4. McAdam invented the blacktop road surface in the mid 1800s'. What was its composition? What demographic consequences did it have?

5. During that same period the London sewer system was developed. How was sewage disposed of before then? Why is it considered polite for men walk on the outside edge of a sidewalk and women on the inside when they are walking together?

6. Though he is not mentioned in the film, you might want to find out who Thomas Crapper was and what he contributed to the world's sanitation.

7. Why was ceramic tile considered a great boon to sanitation?

8. Few inventions have as many applications as compressed air pressure. How has it affected transportation in the last 100 years? How many current applications can you name?

9. How does an electric motor work? How does it depend upon water? How did it lead to the invention of the gyroscope?

10. How is electricity measured? What instruments are used in its measurement?

11. How did plant growth lead to the measurement of blood pressure? How is your pressure measured?

12. How do storage batteries and solar-powered batteries work? What is the major deterrent to battery-powered automobiles?

13. Burke's "trail" to the space shuttle leads through weather forecasting, ceramic tile, electric motors, and the gyroscope. How does each contribute to space flight?

PROGRAM 6: Echoes from the Past

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

Burke ponders over the secret of the universe. On his way to finding the secret, he introduces us to the Buddhist tea ceremony and explains what that has to do with Florentine architecture, international spies, Lincoln's assassination, Swiss grottoes, Roman ruins, radio-telephones on luxury liners, imitation porcelain, and steam turbines.

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Contributors mentioned in this program:

Josiah Wedgwood
Robert Adam
Leon Battista Alberti
Giovani Battista Piranesi
William Thomson Kelvin
Jean B. J. Fourier

Significant technological advances covered in this program:

1. Dutch imports of tea and china from Asia contributed immensely to the economic wealth of 17th century Holland. How was so small a nation able to cut into the seafaring power of England and Spain? Which were the other cities that made up the Hanseatic League and the Cinque Ports? What held them together?

2. More that Wedgwood was affected by the outburst of interest in classical Greece and Rome in the late 18th century. How was it reflected in dress, the arts and architecture? Who were Jacques Louis David, Ingres, Palladio, and Inigo Jones?

3. What is the Rosetta Stone? What is its importance? How did it get where it is? What are the Elgin marbles? Why are the Greeks so upset about their present location?

4. What is Free Masonry? How did it come about and spread so quickly? What does it subscribe to? Why might you find one of its symbols in your pocket?

5. Does Kelvin's theory about his absolute theory still hold? What was his hottest temperature?

6. How did scientists compute the rate at which the universe has cooled since the "big bang"?

7. Codes have fascinated men and children for centuries. What were the Enigma and Purple codes of World War II? How are codes created today? Is an unbreakable code possible today? Try to develop a message using a code based upon the one shown in the film.

8. How are astronomers able to measure the static that heat from distant stars gives off?

9. Listening for intelligent life emanating from radio signals from space has received much attention in recent years. If you wanted to communicate in this way, what signal would you send to indicate a level of intelligence here? (*In the film "Encounters of the Third Kind" five musical notes were used and repeated. In a contest conducted many years ago, the winning entry was a signal, sent as radio and light pulses in this order: •, ••, •••, and then repeated.*)

PROGRAM 7: Photo Finish

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

The LeMans 24-hour race is the day-and-night backdrop for this story, about how the winner will be photographed winning. The reason why he wins is because of the way photography and bullets, relativity and Hollywood movies, the railroads and gaslight, raincoats and blimps, telegraphs and solar power. . . all make hot-rod driving that much easier.

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Contributors mentioned in this program:

George Eastman
Albert Einstein
Thomas Alva Edison
Charles Goodyear
John Wesley Hyatt
Lee DeForest
James Mackintosh
Count von Zeppelin

Significant technological advances covered in this program:

1. In the late 1800s' Eastman invented the film roll. Before Eastman, how were photographs produced?

2. In 1869 celluloid was developed as a substitute for ivory in billiard balls and was adapted to film. Is celluloid still used as the base for photographic film?

3. Exploding billiard balls gave rise to gun cotton. How does it differ from gunpowder, from dynamite?

4. Why do we hear the bullet's shock wave breaking the sound barrier before we hear the gun's discharge? What is the speed of sound? Does an airplane passing the sound barrier experience a shock? Does it create one?

5. At what altitude was the atomic bomb detonated over Hiroshima? Why was altitude important?

6. Can you cite examples from your own experience where you perceived events to be occurring faster or slower than they actually are?

7. Einstein said that the faster you went, the more time slowed down. What effect would this have on future space travelers if they were able to travel really fast?

8. DeForest invented the vacuum tube in the early 1900s', How many applications can you think of that have utilized it in your lifetime. Borrowing from Longfellow he eventually called it, "DeForest's prime evil". What do you suppose he meant?

9. In time film has largely been replaced by videotape and now by digital technology. How do these technologies differ?

10. The film suggests that gaslight changed people's behavior. How? How has home entertainment reversed that change?

11. How did Goodyear improve Mackintosh's rubber solution?

12. The dirigible began with von Zeppelin and virtually ended with the Hindenburg disaster of 1937. Are any still used? What were their advantages and disadvantages?

PROGRAM 8: Separate Ways

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

The program follows two trails that begin with the split over slavery in the 18th century and finally come together in the modern world. One route features such major events as nail making, the Brooklyn Bridge, the Wild West, and trouble with tin cans. The other connects rum with steam engines, coining money, electroplating and television. Both end with the greatest threat to peace in the modern world.

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Contributors mentioned in this program:

Adam Smith
Washington &: John Roebling
Sampson Lloyd
Matthew Boulton

Michael Farraday *George P. Thomson*

Significant technological advances covered in this program:

1. The 17th century saw the beginning of the slave trade because of the need for cheap workers on Caribbean sugar plantations. What brought them to the U.S. South but not the North?

2. The Abolition movement began in England, heavily funded by Sampson Lloyd, a maker of wire and nails. For what is Lloyd much better known?

3. Rum became a major Caribbean islands export. Research the triangular trade in slaves, sugar and rum. How did it work?

4. The slave trade ended in England and America in 1807 after twelve and a half million were imported. From the film's statement about profit and loss, how many died en route?

5. In 1860 the galvanizing process was developed. What is it and what is its value? Is it still in use; if so, where?

6. The Homestead Act was passed in 1854 to encourage expansion to U.S. West. What did the popular term "manifest destiny" mean? Who was Horace Greeley and what did he contribute to the migration?

7. Burke says that the development of barbed wire in 1874 meant the end of the West and the cowboy. Why? Why is there still conflict in the West about cattle grazing rights?

8. In 1883 the Roeblings built the Brooklyn Bridge. Why has it always been so famous?

9. Transferring designs by pantograph was brought to coin making for the Boulton Company in 1824. Where is the pantograph concept used today in conjunction with computers?

10. In 1883 Farraday discovered the electroplating process. Are all metals able to be plated? How has the process made formerly very expensive items affordable to the masses?

11. What are isotopes? What is mass spectrometry and how is it used to science and medicine today?

12. How do cadmium rods control nuclear fission?

PROGRAM 9: High Times

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

Unwrap a sandwich and you're on a path to World War II defense radars, French neo-impressionist painters, tapestries and Versailles, 16th century traders in the Far East, lacquer furniture, whaling off Spitzbergen, the greatest painter in Renaissance Europe, and the most famous clock in the world.

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Contributors mentioned in this program:

Michel Eugene Chevreul
the Gobelin family
Christophe Plantin
Gerardus Mercator
George Graham
Georges Seurat
Henry Hudson
Phillip II of Spain
Galileo Galilei

Significant technological advances covered in this program:

1. The "Battle of Britain" in 1940 which saved England from certain invasion was won because Britain had radar. Why was radar so important and how was the accidental discovery of plastic cling wrap responsible?

2. Look up Winston Churchill's famous speeches he made just before and just after the two-month air battle.

3. Of what were early and present day soaps made? What kind should you look for if you have oily or dry skin? How is detergent different from soap? What does it do?

4. Examine a book about color to see how simultaneous contrast plays tricks on your perception of color. Look through a magnifying glass at the colored comic pages of your newspaper. How many different colors can you see?

5. How is the color printing process similar to tapestry weaving but different from oil or watercolor painting?

6. Find out the difference between "additive" and "subtractive" colors. Ask a printer what CMYK means and a television store owner what RGB means.

7. How did accurate maps aid the Dutch in avoiding the Portuguese and Spanish ships and to colonize the East Indies?

8. What were the "Counter Reformation" and the "Spanish Inquisition"?

9. In the 15th and 16th centuries the Catholic Church sought to ban secular books, replacing them with religious books which brought great wealth to the Dutch printers. Why are books banned in the first place? What books were burned by the Nazis in the 1930s'? What do you see of book-banning today?

10. Mercator drew some of the earliest flat maps, giving his name to a particular kind of map projection. Research other kinds of flat map projections. Why are all of them inaccurate?

11. Why was Galileo such a threat to the church? How did their struggle end?

PROGRAM 10: Dèjá Vu

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

Learn how history repeats itself when Pizzaro beats the Incas, the first stock market opens in 18th century Belgium, pirate treasure is discovered, and the army drill is invented. German philosophy goes to South America, environmentalism bores Napoleon, the Queen of England salutes a Mexican cactus beetle, and Hitler's plans misfire.

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Contributors mentioned in this program:

Francisco Pizarro
Frederick the Great
Immanuel Kant
William Dampier
Alexander Humboldt
Nathaniel Wraxall

Significant technological advances covered in this program:

1. How did the Spanish Conquistadores, or Columbus for that matter, justify taking land and riches from the native peoples of the New World?

2. What was Spain's position in the power struggles in Europe in the 16th century?

3. What effects on Spain and the Catholic church of the 16th century did Martin Luther, John Calvin, King Henry VIII, and Queen Elizabeth I have?

4. The film does not explain why the Spanish allowed the Dutch and Belgians to take over so much of the trade in the 16th and 17th centuries. Why, do you think, did they not follow up on the advantage they had achieved by being first in the New World?

5. How did colonization make some European nations so rich? What parts of the world were colonized in the 16th to 19th centuries by England, France, Spain, Portugal, and the Netherlands? What products and resources were taken from them? How many are still colonies today?

6. Who were Drake, Morgan and Frobisher and how did they get away with what they were doing?

7. Why do you think the islands of the West Indies were so crucial to trade in those days? What countries colonized which islands? Which of them are still colonies?

8. Look up the voyages of Humboldt and list the discoveries he made. What did Kant espouse that influenced Humboldt?

9. The film says little about Frederick the Great, one of history's most intriguing monarchs. What did he accomplish which affects us today?

10. What does the German word "lebensraum" mean? How did Hitler use it to justify his territorial aims? How did his persecution of the Jews help him realize his ambitions?

11. Hitler's "supermen" were to be of pure Aryan descent. Where did Aryans originate and why did they appeal to him?

PROGRAM 11: New Harmony

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

Had it not been for the discovery of cobalt used to dye Ming vases blue, we might not have computer chips today. Did microscopic bugs inspire the novel "Frankenstein" which aided the birth of utopian socialism in a community in Indiana? From medieval Byzantium to Italy, Portugal, Brazil, Holland, Scotland, the American Midwest, and some other places-plus strange goings-on by English poets in Switzerland.

Places and contributors mentioned in this program:

William Bradford Shockley
Pedro Alvares Cabral
Baruch Spinoza
the Ozark Mountains
Robert and Robert Dale Owen
George Gordon (Lord Byron)
Percy Bysshe Shelley and Mary Wollstencraft Shelley
Suleiman the Magnificent
Constantine the Great
Nicholas of Cusa
germanium
Anton von Leeuwenhoek
Santa Sophia (la Sophie)
Prince Henry the Navigator and Martines

Significant technological advances and ideas contained in the program--some questions and possible investigations:

1. Why do we call ceramic dinnerware "china"?

2. There have been several attempts to create utopian communities in America, particularly in the 1800s. Look up some of them to see what really significant contributions, like those attributed to New Harmony,

have lasted. What practices or beliefs, like outlawing private ownership of land (New Harmony) or celibacy (the Shakers) caused them to completely or nearly disappear? What was the public attitude toward them?

3. The 1960s saw a renaissance in community living projects. What were they and what happened to them? Are there any in existence today? What principles are practiced in them that run against popular culture and almost certainly doom them?

4. Why is the transistor so important? What did it replace?

5. Where was the Silk Road? When was it opened? By whom? What were the political and economic effects upon European taste, the growth of cities, and the spread of knowledge?

6. It has been called Byzantium, Constantinople and Istanbul. Why to name changes?

7. How did it come about that the center of the Roman world shifted from Rome to Constantinople? What was Constantine's role in this political transfer and his affect upon the growth of Christianity? What are some of the differences between Roman and Eastern Orthodox Christianity?

8. Review why an accurate clock was so important in establishing longitude. Why were the explorations by the Portuguese so important in the 16th century? What did they discover and what effect did they have on other European nations?

9. Why did Lord Byron and the Shelley's travel to the Mediterranean and Switzerland? Read how their interest in science led to Mary's writing of the Frankenstein story?

10. Why did the development of lens grinding lead to the rapid advance of science?

11. Why did the work of Leeuwenhoek. Spinoza, Galileo, and others put them at odds with the church?

PROGRAM 12: Hot Pickle

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

Burke reveals the connections between a cup of tea, Chinese opium dens, the jungle adventurer who founded the London Zoo and a switch that releases bombs. The tale shows how spices launched ships, how fighting Napoleon led to drug addiction, and explores the connections among coal, cotton, and God's plan.

Places and contributors mentioned in this program:

Baron Carl Auer Yon Welsbach
neodymium
Sir George Stephenson
colonization
Singapore
Port Royal
Sir Stafford Raffles
Sir Humphrey Davy
John Erickson
Straits of Malacca
Monitor & Merrimac
Sir William Paley
Java

Significant technological advances and ideas contained in the program-some questions and possible investigations:

1. The chant heard in the beginning of the film is "sung" by a *muezzin*. What is his role and where and how often does he perform it?

2. The conquest of Constantinople in 1453 is one of the most famous dates in the history of the Middle East. What famous leader completed the conquest? From whom?

3. The introduction of spices to Europe a thousand years ago was certainly one of the most important by-products of the Crusades. What other monumental effects in Europe were unforeseen by-products?

5. What were the Crusades all about? How many were there and when did they occur? What were their individual results and the overall result of all that bloodshed?

6. How would you characterize the opium-tea trade in terms of greed, exploitation and victimization? What were the "opium wars" and their results?

7. Why did Singapore become so important in British colonialization and economics? The fall of Singapore in 1942 marked one of Britain's worst defeats. How was it accomplished? How is Singapore governed today?

8. Java is part of what country today? Who colonized it and its neighboring islands originally? How did the riches of these tropical islands lead to Japan's attack upon Pearl Harbor?

9. How, would you say, did Paley presage Darwin?

10. The London Zoo was developed to collect specimens in order to study the structure of nature, not just to amuse visitors. Is your local zoo involved in research and study today? How?

11. Erickson failed in one endeavor but went on to succeed in another. Can you think of other examples? How important was the battle between the Monitor and Merrimac? Was the Monitor the first submarine?

12. The rare earths, neodymium, along with cerium and thorium, played an important role as shown in the film. They "returned" in World War II and the Cold War for another role. What was it?

13. How many uses are there for fiberglass around your house?

PROGRAM 13: The Big Spin

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

The greatest medical accident in history starts a trail that leads to the search for Helen of Troy, police blotters, seventeenth century flower-power and insurance statistics that help a Yale professor to invent soda pop and his son find oil, that triggers work on microfossils and the kind of World War I bangs that started earthquake detection.

Places and contributors mentioned in this program:

Johann Blumenbach
Heinrich Schliemann
Francis Bacon
penicillin
Richard Price
seismometer
Joseph Priestley
Alexander Fleming
Benjamin Silliman
Troy (and Helen of)
Boris Golitzen

Significant technological advances and ideas contained in the program-some questions and possible investigations:

1. Burke claims that the discovery of penicillin was the greatest medical discovery of all time. Do you agree? What others might rank up there?

2. Before disease was linked to cells, where did people think that diseases came from? What did they think *phlogiston* did?

3. It is hard to explain but interesting to study the resistance by the medical and scientific professions to discoveries about diseases and their treatment in the mid-1800s. The famous Hungarian doctor, Ignaz Philipp Semmelweis, eventually went mad attempting to get other doctors to wash their hands before delivering babies. How did he prove his hypothesis? What was "childbed fever" and what were its effects?

4. Schliemann spent a career looking all over western Turkey for the fabled city of Troy. What was its story and who told it? But the Trojans did not build the horse; who did?

5. The 200 years between the mid-l600s and mid-1800s saw a great interest in the classification of things-people, plants, animals mentioned in the film. What others can you think of that we study in chemistry, geology, genetics, astronomy, etc.?

6. How did the Nazis leap from Blumenbach's classification of skull characteristics to their persecution of the Jews? Look up *herrenvolk* and the *Aryan Race,*

7. What is statistical analysis? How many ways can you list that it affects your life today? What sorts of professions depend upon it?

8. What are actuarial tables? Why do they make you pay more for automobile insurance than your parents and your parents pay more for life insurance that you would?

9. Who or what requires us to have a census? Why are accurate census data important and how do they effect you?

10. What did Priestley discover that made "fizzy" water? Soda fountains have just about disappeared today. What were they and how did they effect social life in their day? What today can be compared to them?

11. Explain how the discovery of certain fossils can predict where oil fields might be?

12. How does a seismometer work? What is the "ring of fire"? What is the likelihood of earthquakes where you live?

PROGRAM 14: Bright Ideas

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

A Baltimore man invented the bottle cap to keep tonic water fizzy, which led to the invention of razors, and clock springs, which eventually enabled the Hubbell telescope to measure the universe. Along the way we look at a gin and tonic, the proper way to eat peas, how steel is made hard. keeping lighthouses from falling over, and a host of other things.

Places and contributors mentioned in this program:

Edwin Powell Hubbell
the Herschels: Sir John, Sir William (father) and Caroline Lucretia (sister)
Johann Heinrich Pestalozzi
Benjamin Huntsman
Sheffield
Jacob Schweppes
Bandung
King Camp Gillette
John Wilkinson
Johann Friedrich Herbart

Significant technological advances and ideas contained in this program-some questions and possible investigations:

1. And we thought that the British developed gin. How and where did they become so enamored with it? What is distilled to make it?

2. Why was malaria such a curse for European colonists? In what countries?

3. Quinine in Schweppes tonic water helped prevent malaria. What is used today?

4. How is carbonated water made? The unsuccessful materials that were tried for keeping carbonation in a bottle included cork. Yet cork is used today for wine and especially champagne. How come?

5. The film points to bottle caps as disposable pollutants. Since then aluminum cans have replaced many bottles. What other of the newer containers have become major pollutants?

6. In Medieval times a guest carried his eating utensil with him. It was his hunting knife. Utensils have been around for less than 300 years, knife, fork and spoon in that order. What, do you suppose, did they do about liquids before the spoon?

7. Why were all of the specialized utensils, and the etiquette surrounding them, come to be employed? What did they, and other social customs, have to do with bridal registers?

8. What is contained in clay and why can it withstand much hotter temperatures than metals? What is coke and what is its role in creating steel?

9. Gillette's and others' safety razors have been around for only a century or so. How did men shave before? Can you think of other products where a basic item is virtually given away in order to sell its accompanying consumables?

10. What is rifling? How did it effect gunnery?

11. Can you explain the law of the just noticeable difference in personal examples?

12. Also, can you clarify, in your own terms, how the magnitude of stars can be measured and how they can be used to calculate their distance?

13. Hubble's discovery was seen as a paramount milestone in the science of astronomy. What recent important exploratory device has been named for him? What is its promise?

PROGRAM 15: Making Waves

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

Hairdressers, Gold Rush miners, English parliamentarians, Scotsmen, Irish potato farmers, Revolutionary War loyalists, and innovative printers are among the characters host James Burke connects together.

Places and contributors mentioned in this program:

John (Johann) August Sutter
John Marshall
Judge Charles Lynch
Charles L. Nessler
Jacob Perkin
Nova Scotia
Yankee clipper
Jean Baptiste Colbert
Coloma
Roland Hill
Abraham Cundars
Acadia/Acadian

Significant technological advances and ideas contained in this program-some questions and possible investigations:

1. Discuss the importance of the $20 billion cosmetics industry, the effect of its advertising, vanity, and the socio-economics associated with it. How far back into history does all this reach?

2. Much of this film deals with sea transportation. Before the 1950s the great ocean liners were devoted to transportation; now it is to recreation. What caused the change? Investigate the great international luxury liner races of the early 1900s and the stories of some of the great liners; Titanic, Mauritania, Queen Mary, Lusitania, Bremen, Normandy, United States, and others. How are the liners different today?

3. The 1840s was a tumultuous decade in California; growing immigration by Americans, brave pioneers like the Donner Party, the war with Mexico, the gold discovery, and statehood in 1950. What was California like before and after the 1840s?

4. Discuss the advantages and disadvantages of the three routes from the East to the gold fields; overland, via the Isthmus of Panama, and around Cape Horn.

5. Who really prospered from the gold rush? How did mining and miners change in a few years? Examine other mineral “rushes” that followed in the 1800s; silver in Nevada, Copper in Arizona, gold in Colorado, South Dakota and Alaska. What are some of the famous stories and books to come out of Angel’s Camp, Deadwood, Leadville, and Tombstone?

6. British addiction to tea and the opium trade are covered in other films in this series. Review this trade story. How were the “Yankee Clippers” different and why did they take over much of the tea and spice transport? How did enterprising Americans also come to dominate whaling in the mid-1800s? Why were Hong Kong, Singapore, Gloucester, and Lahaina important?

7. The Irish potato famine was one of the most disastrous events in history. How did Britain first exacerbate the problem and later try to solve it? How was the U.S. affected by it? Can you or any of your friends trace ancestry to Irish immigrants? Where did they land and how were they treated?

8. What were the Scottish clearances? Who caused them and who profited? Where did the displaced go?

9. Many French loyalists were driven out of Acadia after the French and Indian War. Where did they go and what culture exists today that is named for their former home? Read Longfellow's epic poem about them, *Evangeline*.

10. What happened to the English loyalists who stayed in the U.S. after the American Revolution or to those who fled? Where did they go? What happened to their property?

PROGRAM 16: Routes

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

A sick lawyer in eighteenth-century France changes farming and triggers the French Revolution and new medical research into sensory perception that ends up inventing the first radio after which cosmic rays are discovered with the aid of tree rings and the American weather forecaster who does it all turns his particle adding machine into the first computer.

Places and contributors mentioned in this program:

Laissez faire
Johannes Peter Muller
Victor Franz Hess
Guglielmo Marconi
Annie Jameson
Jethro Tull
Jean Jacques Rousseau
Hermann von Helmholtz
Heinrich Rudolph Hertz
Beziers
ENEAC
the BBC

Significant technological advances and ideas contained in this program-some questions and possible investigations:

1. Find out the state of development of in-car computer mapping. How successful is it; how detailed is it; and what does it cost?

2. How did Jethro Tull's observations revolutionize farming? How does crop rotation operate and why is it important?

3. Why was it important that the cost of bread in Britain was considerably less than in France?

4. Who said, "Let them eat cake"? Why was this such an inflammatory statement? What happened to this person?

5. What were the underlying causes of the French Revolution? What part did the American Revolution play? What were the contributions of Voltaire, Rousseau and Locke to both revolutions? How did Thomas Paine play a part in both? What followed the Revolution for the next 25 years?

6. The principle of *laissez faire* means what? This principle has been the basic point of argument between liberals and conservatives about economic direction for centuries. How did it work for Britain in the 18th century but against the French who failed to apply it?

7. From the time of Jefferson and Hamilton American liberals and conservatives have argued about *laissez faire* vs. control. Where do they stand today? Where did Jefferson and Hamilton stand in the 1790s; where might they stand today?

8. What is meant by "social contract"?

9. Combining the discoveries of Muller, Helmholtz and Hertz amounts to a revolutionary approach to the way the human sensory systems works and to our perceptions. Why?

10. How do sound waves travel in straight or curved lines? Why do radio AM waves carry farther than FM? What about telephone and television?

11. What is ionization and how does the sun make layers in the atmosphere? What are cosmic rays?

12. Why does the eleven-year sun spot cycle relate to the corresponding tree ring cycle?

13. Look for a picture of ENEAC. When was it built? What makes today's tiny pocket calculator a more powerful and faster device than so huge a device?

PROGRAM 17: One Word

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

One medieval word kicks off a trip via Istanbul and the invention of the small print in books that an outlawed English church uses to trigger the industrial revolution with chemicals from a Swede which leads to the discovery of a strange language that produced folk stories for the Brothers Grimm and the investigation into different cultures with the same stories that finally end in the development of cultural anthropology.

Places and contributors mentioned in this program:

Filioque
Istanbul (also Byzantium and Constantinople)
Aldus Manutius
Jons Jakob Berzelius
Jakob & Wilhelm Grimm
herrenvolk
italic (which this is)
Oxford University
Santa Sophia
James Watt
Karl Friedrich Gauss
selenium
sanskrit
Thomas Bodley
Harvard University

Significant technological advances and ideas contained in this program-some questions and possible investigations:

1. Burke says that Christianity (and Islam and Judaism, for that matter) is simpler because of one God. Can you support that? How many gods did the Roman and Greek pantheon have?

2. Why did the Eastern Orthodox church's dropping of *filioque* cause a 400-year rift between them and Roman Catholics?

3. Note the style of calligraphy when *filioque* is written in the film. It is *Carolingian* from the 8th-10th centuries. Find examples of the development of letters from Roman times to the present. Note the attempts to "speed up" writing. What does *italic* (from "Italy") look like today?

4. Why has that city in Turkey had three names? Why was 1453 so important in its history and the history of Islam?

5. What are *manuscript* and *cursive*? Which are you most comfortable with? Research shows that neither is faster.

6. What is a *muezzin*, the tower he is chanting from, and the purpose of his chant?

7. Where had the Greeks acquired all that knowledge that helped trigger the Renaissance in Italy?

8. What would a library be like without a catalog of its holdings? Ask your librarian how the catalog has changed from *Dewey*, to *Library of Congress* to *online*.

9. In Burke's little rhyme about Berzelius' symbols, what is the difference between those two chemical solutions?

10. Many large dictionaries will contain a chart of languages which have evolved from Proto Indo-European of some seven centuries ago including Sanskrit which Gauss and Grimm discovered as a base for many. Trace English back to that point.

11. What was it about their geography and history that caused Germans to try to find a source for their heritage in the 1800's? What was *Aryan Race* and *herrenvolk* about and what kind of behavior did all that lead to in this century?

12. Can you think of folk tales that are common in America which are the same or similar in another culture? What are some of the most famous of the Brothers Grimm tales? How violent and frightening are some of them?

PROGRAM 18: Sign Here

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

Dutch piracy starts international law and French probability math, which leads on to a religious revolutionary, shorthand, phonetics and Victorian séances with light mills that trigger the aerodynamics to help Wright Brothers get off the ground with an engine using the kind of bearings that end up in modern ballpoint pens.

Places and contributors mentioned in this program:

Lloyds of London
Blaise Pascal
JansenismlCornelis Jansen
Samuel F.B. Morse
Alexander Graham Bell
William and Orville Wright
esperanto
Isaac Pittman
Osborne Reynolds
Straits of Malacca
Amnesty International
Thomas Johann Seebeck
Edward Miner Gallaudet
Sir William Crookes
colonialization
probability math
Amos Kendall

Significant technological advances and ideas contained in this program-Some questions and possible investigations:

1. Was there a real Murphy? What other "laws" are attributed to him?

2. How do insurance companies figure degrees of risk? Whose money is being risked when Lloyd's writes a policy?

3. Locate the Straits of Malacca. Why would it be the world's busiest shipping lane? How could the Dutch justify their act of piracy against a Portuguese ship in 1604, or the English against the Spanish in the late 1500s and 1600s?

4. How did the Pope divide South America? Why?

5. What does international law cover today? Who enforces them and how?

6. Burke stood in front of a sign that read, "Amnesty International". What does that organization do?

7. Where are the lines between territorial waters and international waters today? What happens when the body of water is so narrow that territorial boundaries overlap. Locate the Spratly Islands. Why are they so important that six countries may possibly be at war someday over which one owns them?

8. Why did the law of probability upset the church?

9. What is *conscience* anyway? What governs yours? What is the concept of *situational ethics*, especially as it affects the behavior of teenagers? Where would a Jansenist come down on this concept? How is society split over it?

10. Review the trail from Morse to Kendall to Gallaudet that led to sign language. How do the deaf know that their pronunciation is correct today?

11. Does anybody use *Esperanto* today? What comes closest to an international language now? How do nations feel about their own language? Should English be established as our national language? What do the citizens of Quebec want? The French?

12. Who was *Pygmalion* in Greek mythology and how did he wind up in "My Fair Lady"? Who is Eliza based upon?

13. How many things you use depend upon ball bearings? How is a wind tunnel related to Reynolds numbers?

PROGRAM 19: Better than the Real Thing

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

How the zipper started with boot-making machines that used technology Jefferson picked up in Paris during a row about Creation that triggered the discovery of bugs with lenses and polarized light you could use to analyze autumn colors and help cure eye diseases by dietary deficiency that milk drinking rats revealed to be lack of vitamins.

Places and Contributors Mentioned in this Program:

Isaac Merrit Singer
Baron G. W. von Leibnitz
Christian Huygens
Amelia Bloomer
William Withering
Henry Clifton Sorby
Christiaan Eijkman
Eli Whitney
Anton van Leeuwenhoek
carotene
Ernest Fox Nichols
Icelandic spar
John Masson Gulland
Thomas Jefferson

Significant technological advances and ideas contained in this program-some questions and possible investigations:

1. Talk to an old timer. Was food really blander and more monotonous when he was your age? How has transportation affected what we eat?

2. Compare organically-grown fruits and vegetables with most of those beautifully displayed in your supermarket. Is there a difference in their relative nutritional value? How much are we affected by appearance?

3. Look at fashions and manners before 1910 and after 1930. What changes do you see? What effect did World War I and the Jazz Age of the 1920s have on them?

4. Why were boots so hard to put on before the zipper?

5. What can you say about Sundbach who was four times a bigamist and yet invented the zipper to save effort for women?

6. Or what can you say about Singer who beat his wife but gave women one of the greatest labor-saving machines in history and a plan to make it possible for them to own it?

7. What were the advantages of interchangeable rifle parts for the army? How did Henry Ford capitalize on the idea?

8. How is cloth measured and graded? Why are some fabrics so much more costly than others?

9. What was Jefferson doing in France in the 1780s? Do you think French attitudes have changed about things American? What about EuroDisney and American technical terms?

10. Why might the "great chain of being" idea have caught on and how would it have made Darwin more acceptable?

11. Where did the first magnifying lenses come from? What recent scientific advances have been made because of our increasing development of lenses?

12. Can you explain, in your own terms, how wave lengths show the composition of material? How are they used to determine the composition of stars?

13. Why do mothers tell their children to eat their carrots?

14. What are the vitamins that prevent beriberi? Rickets? Pellagra? Scurvy? What symptoms do their absences produce? Why were British sailors called "limeys"?

PROGRAM 20: Flexible Response

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

Robin Hood starts us on a trail from Medieval showbiz to tapestries to land drainage by a Dutchman who invents decimals that end up in U.S. currency thanks to the guy who started the Erie Canal, that the railroad ruined with the kind of management that also started department stores and advertising which led to robots. The trail ends in a Tornado fighter-bomber.

Places and Contributors Mentioned in this Program:

Gouverneur Morris
Erie Canal
Quaker Oats
Simon Stevin
Flanders
homeostasis
Harrod's & Jenner's
Norbert Wiener
feedback

Significant technological advances and ideas contained in this program——some questions and possible investigations:

1. It has been said that the generals "...are prepared to win the last war." Explain that.

2. Following the collapse of the USSR our military preparedness shifted from what kind of strategy to what kind of a more flexible response? Compare the atomic bombing of Hiroshima to the recent surgical strikes in Tunisia and Iraq.

3. What was the effect of the longbow on the battles of Crécy and Agincourt? When? How did other military innovations-rifling in the mid-1800s, machine guns in World War I, airpower in World War II, nuclear power in the Cold War, and computers and satellites in the Gulf War change warfare?

4. What is the famous Robin Hood legend which has appeared in so many stories and films? Why, do you suppose, it got transported in time from his 15th century to the 12th, the time of King Richard and Prince John, and included the maid Marian from another country and century?

5. How does the Maid Marian tale in the film compare with the real story of Eva Peron ("Evita") in 1940s Argentina?

6. What is the process by which wool got from the sheep to the tapestry? Besides being decorative or documentation, tapestries had a more functional purpose; what?

7. Wool growing and weaving made the English and Dutch rich in the 16th and 17th centuries. What else did the Dutch do to produce their wealth? Define *guilds* and the *Hanseatic League*. Look at wealthy Dutch merchants in Rembrandt's paintings, *Cyndics of the Cloth Guild* and *The Night Watch*.

8. Do you encounter decimal fractions in your daily life? Besides accounting, in what other activities are they common?

9. The decimal system of coinage in America was much simpler than the British system we inherited. What do the British use new? Who is still using non decimal systems of measure?

10. Discuss the effect upon the settlement of the American West of the railroad and the telegraph. How did it give rise to Montgomery Ward and Sears and Roebuck? What was *Goode's Ladies' Book*?

11. What is "motivational research"? What does a "human resources director" do? What is "cost accounting"?

12. Besides following the digestion, what other important function does Cannon's "barium meal" perform in the stomach?

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