

**A Brief History of Electronics**  
**(Using Graphic Organizers to Present The History of Electronics)**

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### Overview

Today in the twenty first century, many consumer, military, and recreational products are made with electronic devices. Perhaps, in the future we will see even more uses of electronics as time passes. Almost all phases of modern technological society use electronics, even this computer that is being used to type this script. The home, car, or the workplace all use electronics. We all use electronics but very few know the complex history behind electronics. The intent and purpose of this paper is to explain the historical development of Electronics.

The secondary purpose is to demonstrate how graphic organizers can be used to present this scientific history. Furthermore, the use of graphic organizers can help students visualize language, show relationships, improve verbal language, explain the relationships between important ideas, and explain logical connections.

Finally, graphic organizers will be presented as a tool to present information for any discipline not just the abovementioned subject.

### Rationale

It is important to know the History of Electronics (technology) so students better understand their electronic gadgets they use everyday on an increasing bases. That is, cell phones, ATMs, calculators, cars, fax machines, computers, copiers, radios, TV, etc. To understand the interesting history of these electronic devices helps explain why science and technology are important, too. Without these technologies our status in the world community would be diminished, therefore it is important to study the history of science and technology.

The historical approach to electronics is a cumbersome task because of the tremendous amount of material that must be sorted through. It takes a very narrow approach, electronics, in a vast sea of scientific information. This interdisciplinary (History and Science) approach requires a greater knowledge base. But, it makes teaching much more interesting and more exiting for students.

From a historical approach, one can see the evolutionary connections between the jumps in technology. For example, if one looks at the Industrial Revolution from this

perspective (the development of Electricity), one can understand how this post-Industrial Revolution continues today in many ways.

It is especially important to study electronic technology because in the last 55 years (the invention of the transistor in 1948) electronics has completely changed communications, information methods, medicine, warfare, and our day-to-day lives. Students should know how radio, television, radar, CD's, lasers, computers, and other electronic gadgets evolved. Moreover, students must understand how electronics has influenced other new sciences such as Microbiology and Genetics. Electronics has even helped improve social Sciences such as Psychology and Sociology. Many of these improvements in these disciplines can be accredited to the development of the computer microprocessor (electronics).

The ideas of this paper, looking at the History of the Electronics Era, one can also see how the discoveries and innovations in this period have revolutionized our modern society. By using this Historical approach one can trace the roots of electricity to the Greeks, but very little is done until the Industrial Revolution in Europe and its spread to America in the mid 1800's. Here again, it is during the Industrial Revolution, a teacher, using this interdisciplinary approach could trace the any current technology and find its roots. I have focused on electronics; one could just as easily focused on transportation, manufacturing, militarism, energy sources or any technology that had its roots in the Industrial Revolution of the Mid-Eighteenth Century.

Certainly, this Brief History Approach could be used to introduce basic principles in Physical Science like electricity. Electricity could be considered the "precursor" of electronics. A whole unit could be developed on electricity itself. This unit on electricity might include the fundamentals of electricity, insulators and conductors, switches, charge, circuits (both series and parallel), batteries, how to current is measured, electromotive force, how electromotive is measured, resistance, and Ohm's Law.

Continuing with this Brief History Approach, one might logically introduce a unit on the magnetism another part of Physical Science. Again, magnetism could be thought of a "precursor" of Electronics, too. The unit around magnetism might involve subjects such as: What's magnetism? How can magnetism be explained? What's a magnetic field? How are planets (Earth) like a magnet? Can magnetism be destroyed? Can magnetism be made with electricity? Can electromagnets be made stronger? Can electricity be made with magnets? How do electromagnets induce electricity? What are transformers?

By showing the relationship between electricity and magnetism one can understand the beginnings of electronics, too. This Approach, seeing the symbiotic relationship

between two Physical Sciences (magnetism and electricity) can be used to analyze other such symbiotic relationships involving the Physical Sciences.

As we look at the development of electricity (electronics) in the past 100 years, one can see it expand into all aspects of society (consumer goods, medicine, and even electronic warfare). As teacher in the Pittsburgh Public Schools high schools (an old industrial city in the eastern part of the USA) it is important to impart to the students the great contributions Pittsburgh has made to the Industrial Revolution of late 1800's. The large industries of this period 1870-1980 (steel, railways, and shipbuilding) have declined. The declining industries of this region must change over to light industries based on electronics.

Electronic knowledge requires much more education (training) in order to develop a light industry. Many cities and countries have progressively taken up this understanding to develop a light electronics industry. That is, electronics is still a developing field, which creates employment. But, the future employee (today's students) must have some technological background in order to be a value to an industry such as electronic technologies. Countries (Japan for instance) have targeted electronics as a viable industry that has created great wealth for their nation. It is necessary to understand electronics in order to be a competitive society. In fact, it is a necessity to study technology.

Furthermore, by using Graphic Organizers to illustrate these points, students can better understand some complex ideas more easily.

In a letter suggested by Helen S. Fasion to Fellow dated February 28, 2003, item number 3, page 2. "Design concept maps for each of the investigations undertaken for the use as teaching throughout the module." I have chosen to use this suggestion in presenting "A Brief History of Electronics (Using Graphic Organizers to Present the History of Electronics).

- 1. Graphic organizers have many purposes; they can be used for curriculum planning, helping student's process information and pre- or post assessment tasks. Determine which types of graphic organizers are best for each purpose.
- 2. Graphic organizers are a performance-model of assessment and make excellent artifacts for inclusion in a portfolio. Decide which concepts in your discipline are best represented by the use of these organizers.
- 3. Use graphic organizers to help students focus on important concepts while omitting extraneous details.
- 4. Use graphic organizers as visual pictures to help the students remember key ideas.
- 5. Use graphic organizers to connect visual language with verbal language in active learning settings.

- 6. Use graphic organizers to enhance recall of important information.
- 7. Use graphic organizers to provide student motivation and relieve student boredom.
- 8. Use graphic organizers to show and explain relationships between and among varied content areas.
- 9. Use graphic organizers to make traditional lesson plans more interactive and appealing to the visual learner.
- 10. Use graphic organizers to break down complex ideas through concise and structured visuals.
- 11. Use graphic organizers to help students note patterns and clarify ideas.
- 12. Use graphic organizers to help students better understand the concept of part of a whole.
- 13. Emphasize the use of graphic organizers to stimulate creative thinking.
- 14. Make sure there is a match between the type of organizer and the content being taught.
- 15. Make sure that using a graphic organizer is the best use of time when teaching a concept.
- 16. Use a wide variety of graphic organizers and use them collaboratively whenever possible. (Std-Based Science Graphic Organizers 1-16)

## Introduction

People have known about static electricity for thousands of years. (Microsoft Corp)  
 Biblical references to lightning were a reflection of God's wrath. (Canby) Science did not make concern itself until the 1700s. (Microsoft Corp)

## Early ideas

The Greeks, as early as 600 BC, rubbed amber and thought it had properties, also lodestone was thought to hold some type of attraction. (Canby) But, for almost 2000 years very little was done until the 1600s, Wm Gilbert discusses magnetism and amber's attraction. (Canby) In 1745 Dutch person, Prof Musschenbroek, invents the Leyden jar, a crude capacitor. (Dummer) Ben Franklin discusses his theory electricity and in 1752 Franklin is credited with the first lightning rod. In 1772 iron dust filings reveal the magnetic lines of force, which lead to inductors or a beginning of a solenoid. (Dummer and Canby) In 1774, Lesage installs a primitive telegraph at Geneva, using 24 wires and glass tubes. (Canby). In 1775 Volta, invents electrophorus, and later the voltmeter. (Canby). In 1785, Colomb proves the inverse sq. law. (Canby). In 1786, Galvani electrifies frog legs. Again, Volta in 1796 invents the first battery. (Canby) Oersted, in 1820 discovers that a current can create a magnetic field. Also in 1820 Ampere develops terminology for electric current. In 1821 Faraday establishes the fact that a charge on the outside of a conductor produces

no electric field. (Canby) In 1827 Ohm's law is published. (Microsoft) All these great ideas, inventions, and more can be put on to graphic organizers by chronology, brainstorming, logical connections or just connections with no logic. See the attached graphic organizers (Appendix B) and pick the one that suits the situation(s).

### The Start of Electronics

As mention in the beginning of this abstract Electricity and Electronic have a shared beginning. The two-shared phenomena are static electricity and magnetism. To physicists before the 19<sup>th</sup> century, electricity, magnetism and light seemed like entirely distinct phenomena. By the early 1800's, work by Galvani, Oersted, and Faraday on galvanism, electromagnetism, and electromagnetic induction opened up a new field of experimental work which ultimately paved the way to present day electronic. (Dummer) In 1865 James Clark Maxwell publishes his paper "A Dynamical Theory of Electromagnetic Field." These two great ideas were put together (Canby).

The early 1800s was a time of great progress in theories and inventions. (Dummer) Infrared and ultra-violet radiation was discovered. Dalton's atomic theory is put forward in 1808. Thermoelectricity, electrolysis, and the photovoltaic effect were all discovered before 1840. Work on low-pressure discharge tubes, glow discharges, new types of battery and the early microphone took place in the 20 years. (Dummer) So, between 1800 and 1875 basic physical phenomena were discovered, culminating in the practical applications of the telephone, phonograph, microphones and loudspeakers. Towards the end of the 1800s, wireless telegraphy, magnetic recording, and the cathode-ray oscillograph were all developed. (Dummer)

As corporations started to develop, one can see a shift from the individual to the industrial organization of the development of electronics. (Antebi) The great individuals such a George Westinghouse, Nikola Tesla, and Thomas Edison, to mention these few, begin to submerge to the collective of corporate organization. (Antebi)

As the 20<sup>th</sup> century begins we see Marconi's wireless transatlantic radio signal. (Canby) Rutherford's atomic model in 1911 and Bohr's 1913 electron orbital theory corresponded to various permissible energy levels. (Dummer)

The early 1900s also saw the beginnings of the present-day electronic technologies. The 3-electrode valve opened the way to radio broadcasting and the Campbell-Swinton theory of television. But, it is WW1 that accelerates the pace for the development of electronics. (Dummer)

- WW1 marked the impetus to develop radio communications with components such as resistors and capacitors. (Dummer) In 1920, Pittsburgh's KDKA broadcast the 1<sup>st</sup> scheduled radio program for Westinghouse Corp. In 1925, Bell Telephone Lab invents a mechanism for recording sound electrically. (Canby) But, it is WW2 that had tremendously effect on components since the War was to be fought in climates all around the world. WW2 requirements were of the following nature:
  - 1. Standardization-for faster production
  - 2. Miniaturization-for aircraft, submarines, etc
  - 3. Reliability-no component failures
  - 4. Maintainability-quick replacement
  - 5. Transport hazards-an ability to handle shocks
  - 6. Mechanical shocks-impact of shells and parachute landing
  - 7. Storage-long periods of use
  - 8. Hot and cold temperatures
  - 9. Humidity-tropics
  - 10. High Altitude-high flying aircraft
  - 11. Combined environments-8, 9, and 10 above
  - 12. High Powers- increase range radio and radar
  - 13. Radiation resistance- to withstand nuclear environment (Dummer)

Perhaps one of most important developments of the WW2 started before the War that is RADAR. It had tremendous effect on the War and should not be overlooked. (Dummer) Using radar the "Battle of Britain 1940" was won. Moreover, with the British using radar in its night bombing it hastens the end to the War. (Dummer)

After the WW2, many Europeans came to the USA bringing their ideas. This brain drain led to increased inventions in the USA that would continue until the 1960s. Furthermore, in 1946 printed circuit began to be used with miniature tubes. But, again in 1948, Bell Labs invented the transistor, which replaced the vacuum tube. (Dummer)

Integrated circuits appeared in the early 1950s. (Dummer) Resistors such as nickel chromium film is developed in 1957. (Dummer) The solid electric capacitor was developed in 1956. (Dummer)

### Recent Developments

The development of the integrated circuits has revolutionized communication, information handling, warfare, and computing. Integrated circuits reduce the size of devices and lower manufacturing costs, while providing speed and reliability. Digitalization even further reduces size, increases speed, and lower costs. (Microsoft)

Electronics improves medicine with use of MRI and the CAT. (Microsoft)

Magnetic Resonance Imaging (MRI), medical diagnostic technique that creates images of the body using the principles of nuclear magnetic resonance. A versatile, powerful, and sensitive tool, MRI can generate thin-section images of any part of the body—including organs such as the heart, lungs, arteries and veins for any angle and direction, without surgical invasion and in a cross section of the human body. These maps give basic biomedical and anatomical information that provides great help in diagnosis. (Microsoft)

MRI is possible in the human body because the body is filled with small biological “magnet,” the most abundant and responsive of which is the proton, the nucleus of the hydrogen atom. The principles of MRI take advantage of the random distribution of protons, which possess fundamental magnetic properties. Once the patient is placed in the cylindrical magnet, the diagnostic process follows 3 basic steps. First, MRI creates a steady state within the body by placing the body in a steady magnetic field that’s 30,000 times stronger than Earth’s magnetic field. Then MRI stimulates the body with radio waves to change the steady-state orientation of protons. It then stops the radio waves and “listens” to the body’s electromagnetic transmissions at a selected frequency. The transmitted signal is used to construct internal images of the body. (Microsoft)

The CAT scan, or computed axial tomography, is medical technology that uses X-rays and computers to produce three-dimensional images of the human body. (Microsoft)

The CT scanner contains an X-ray source, which emits beams of X-ray; an X-ray detector, which monitors the number of X rays that strikes various parts of its surface; and a computer. The source and detector face each other on the inside of the scanner ring and are mounted so they rotate around the rim of the scanner. Beams from the X-ray source pass through the human and are recorded on the other side by the detector. As the source and detector rotate in a three hundred sixty degree circle around the patient, X-ray emissions are recorded from many angles. The resulting data are sent to the computer, which interprets the information and translates it into images that appear as cross-sections on a television monitor. (Microsoft)

Both, the CT and MRI are used to create diagnostic images for better treatment of internal problems. (Microsoft)

Today’s research is used to increase speed, reduce size, and improve reliability. Very-large-scale integrated (VLSI) circuits that contain several hundred thousand components on a single chip have been developed. Superconducting circuits using

Josephson junctions that operate at temperature near absolute zero will replace very-high-speed computers. (Microsoft)

### Strategies

One can use any history or scientific ideas, even all the abovementioned and put them on graphic organizers. The attached graphic organizers are provided to do so.

Moreover, lesson and activities can be designed to fit the National Teaching and Learning Standards that were adapted for the state of Pa. (See Appendix A)

### Classroom Activities

One can choose any of the graphic organizers provided (See Appendix B) and do various sections of this “Brief History of Electronics.” Or, one may choose only certain time period(s) or specific invention(s) for a chapter, unit, or a constant practice of integrating graphic organizers in all lessons.

## Bibliography

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## Appendix A Standards

This curriculum unit focused on the following Standards that are used by Pittsburgh Public Schools.

### Science and Technology (ST)

1. All students explain how scientific principles of chemical, physical, and biological phenomena have developed and relate them to real world situations.
2. All students demonstrate knowledge of basic concepts and principles of physical, chemical and biological and earth sciences
4. All students explain the relationships among science technology and society.
5. All students construct and evaluate scientific and technological systems using models to explain or predict results.
6. All students develop and apply skills of observations, data collection, analysis, pattern recognition, prediction and scientific reasoning and conducting experiments in solving technological problems.
7. All students evaluate advantages, disadvantages and ethical implications associated with the impact of science and technology of current and future life.
8. All students evaluate the impact of current and future life of the development and use of varied energy forms, natural and synthetic materials, production and processing of food and other agricultural products.

### Mathematics (MA)

1. All students use numbers, number systems, and equivalent forms to represent theoretical and practical situations.
2. All students compute, measure, and estimate to solve theoretical and practical problems using appropriate tools, including modern technology such as calculators and computers.
3. All students apply the concepts of patterns, functions and relations to solve theoretical and practical problems.
4. All students formulate and solve problems and communicate the mathematical processes used and the reasons for using them.
5. All students understand and apply basic concepts of algebra, geometry, and probability and statistics to solve theoretical and practical problems.
6. All students evaluate, infer, and draw appropriate conclusions & charts, tables and

graphs showing the relationship between data and real world situations.

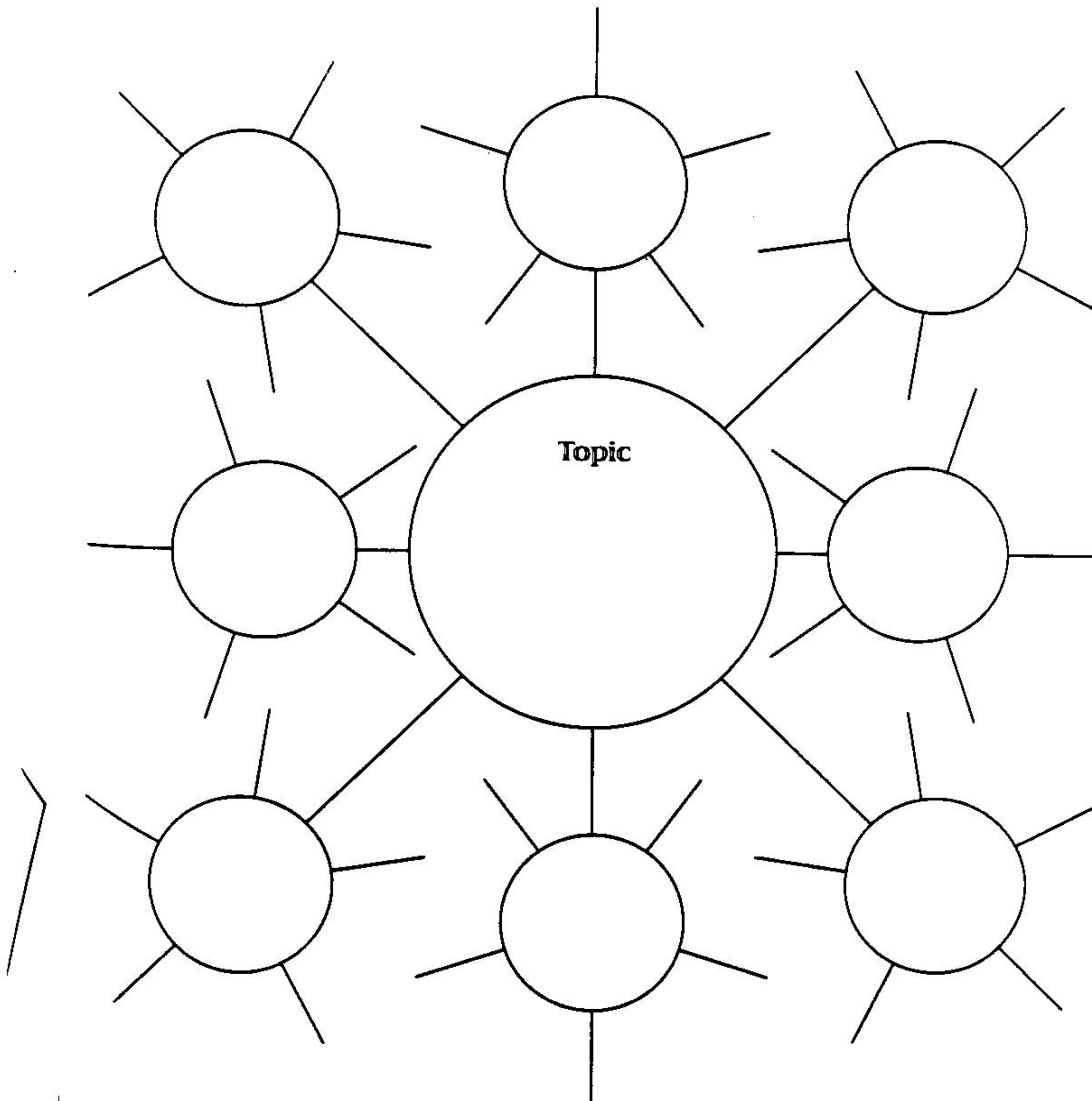
#### Communications (CO)

1. All students read and use a variety of methods to make sense of various kinds of complex texts.
2. All students respond orally and in writing to information and ideas gained by reading narrative and informational texts and use the information and ideas to make decisions and solve problems.
3. All students write for a variety of purposes, including to narrate, inform, and persuade, in all subject areas.
4. All students analyze and make critical judgments about forms of communication, separating fact & from opinion, recognizing propaganda, stereotypes and statements of bias, recognizing inconsistencies and judging the validity of evidence.
5. All students exchange information orally, including understanding and giving spoken directions, asking and answering questions appropriately, and promoting effective group communications.

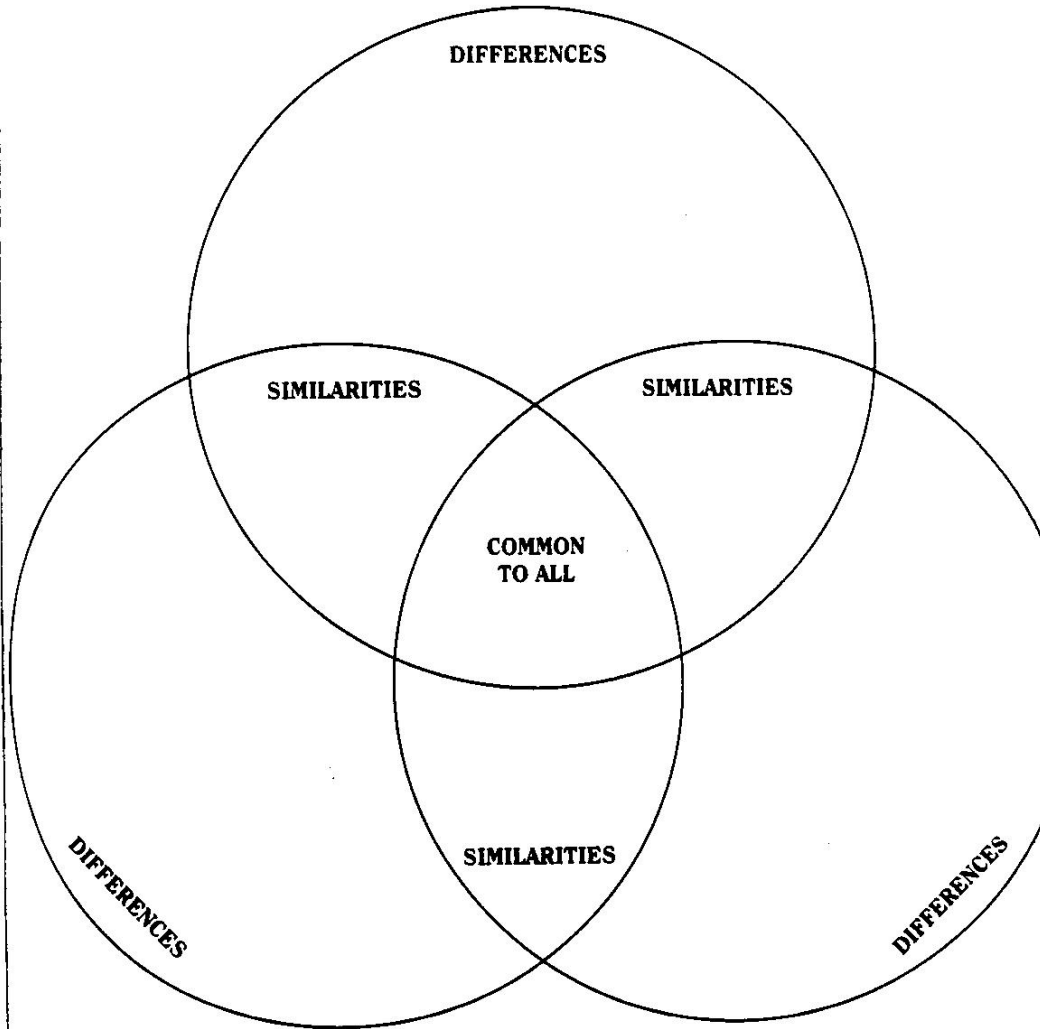
Appendix B

Graphic Organizer

**Scientific Categories  
and Their Relationships**



Venn Diagram



### Cause/Effect Fishbone Map

