It's Electric! An Exploration into the World of Electrical Engineering!

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IMPACT II is a program of The Broward Education Foundation

Summary:

As our country moves to a common core curriculum it is essential that we incorporate college readiness activities into our curriculum. This module serves to expose students to the engineering problem solving process, expose students to electrical engineering and to generate excitement for careers in engineering. The unit is designed to be relevant to the real world, reflecting the knowledge and skills that are needed for success when entering engineering programs in college.

The project was developed to promote electrical engineering in the classroom. A requirement of the Research Experience for Teachers Program at Embry-Riddle Aeronautical University was to develop teaching modules that could be implemented in the K -12 classroom setting. The original module is published online. As I implemented this module I expanded on the topics and included a survey component to collect data and student feedback.

This module can be used in grades 6 -12 to expose students to electrical engineering. The module begins with an interactive power point presentation that examines how technology has developed and changed over time. It demonstrates how computers and computer parts have been compressed in volume and integrated over the past 50 years. Students will then use examples of circuit board and integrated circuit to create a Venn diagram.

Next, students learn about how signals are used for communication. Students are introduced to the binary number system and its significance in digital communication. Students then complete an online binary code activity. Utilizing an online tool, students translate words and phrases into binary codes and vice versa.

Students then compile all the information that they learned from the various activities to create a compare and contrast essay that examines how signal transmission has evolved and developed over time. Students combine their personal research with the concepts taught in class. They are required to explain the signal transmission process and the binary code. Students will also describe their own ideas about how wireless communication will develop in the years to come.

The culminating activity is the online exploration and circuit-building lab. As preparation, students learn the essential electricity vocabulary through illustrations that include words, definitions, sentences and pictures. Then they use three websites to build circuits, beginning with simple circuits and quickly progress to complex ones. Working alone or in groups, students will experiment with many different circuit configurations. The online format allows them to be exposed to electrical engineering activities in an inexpensive and fun way, and allows them to build circuits at home as well. The students also applied what they learned to create projects using snap circuit sets.

Materials and Facilities

This project was completed in a regular classroom using laptop computers with the students working in pairs. I also used chart paper, copies, and notebook paper. Snap circuit sets were used as the culminating activity. The students obtained used circuit boards from items around their house.

Goals:

- Expose students to electrical engineering and engineering problem solving techniques.
- Stimulate excitement for STEM disciplines.
- Incorporate knowledge of engineering and technological innovation from the research lab into the classrooms to positively impact classroom teaching practices.
- Utilize the engineering design process, and research activities that are used in universities.
- Bring knowledge of engineering and technological innovation from the research lab into classrooms to positively impact classroom teaching practices.

Objectives:

- Translate words and phrases into the binary code.
- Identify ways computers use the binary code to store, interpret and send information.
- Compare and contrast ways technology has evolved over time.
- Utilize online technology to research ways cell phones, GPS and computers transmit information.
- Analyze, compare and contrast ways that signals were sent in the past with how they are sent now.
- Write an essay that compares and contrasts the ways that signals were sent in the past with how they are sent now that incorporates information obtained from their online research and class work.
- Create a vocabulary illustration for each electrical circuit vocabulary word.
- Design and build electrical circuits ranging from beginning to complex while utilizing various online programs and circuit building kits.

Standards:

SC.8.N.3.1 Select models useful in relating the results of their own investigations.
** CCSS Connections: MACC.K12.MP.4: Model with mathematics.

SC.7.P.11.2 Investigate and describe the transformation of energy from one form to another.

SC.6.P.11.1 Explore the Law of Conservation of Energy by differentiating between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa

CCSS.ELA-Literacy.CCRA.R.10 Read and comprehend complex literary and informational texts independently and proficiently.

CCSS.ELA-Literacy.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

CCSS.ELA-Literacy.CCRA.R.10 Read and comprehend complex literary and informational texts independently and proficiently.

CCSS.ELA-Literacy.SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

CCSS.ELA-Literacy.SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

CCSS.ELA-Literacy.SL.8.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

CCSS.ELA-Literacy.L.8.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

CCSS.ELA-Literacy.W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-Literacy.W.8.2a Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

CCSS.ELA-Literacy.W.8.2b Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

CSS.ELA-Literacy.W.8.2c Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.

CCSS.ELA-Literacy.W.8.2d Use precise language and domain-specific vocabulary to inform about or explain the topic.

CCSS.ELA-Literacy.W.8.2e Establish and maintain a formal style.

CCSS.ELA-Literacy.W.8.2f Provide a concluding statement or section that follows from and supports the information or explanation presented.

CCSS.ELA-Literacy.W.8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

CCSS.ELA-Literacy.W.8.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

CCSS.ELA-Literacy.W.8.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas efficiently as well as to interact and collaborate with others.

CCSS.ELA-Literacy.W.8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-Literacy.W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

CCSS.ELA-Literacy.W.8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

Course Outline:

Activity 1 How Technology Has Evolved Over Time PowerPoint that includes a movie clip and Venn diagram assignment (See Attached)

Activity 2 Signal Transmission and Reception PowerPoint which including two movies clips and quiz (See Attached)

Activity 3 Can you CRACK the binary code?

Activity 4 Mini Research Assignment

Activity 5 Part 1: Create a graphic organizer to compare and contrast ways that signals (information) were sent in the past with how they are sent now.

Part 2: Write a compare and contrast essay describing the ways that signal sending has progressed over time.

Activity 6 Essential Electricity Vocabulary

Activity 7 Vocabulary Illustrations Worksheet

Activity 8 Pre lab Worksheet

Activity 9 Online Exploring Circuit Lab

Activity 10 Snap Circuit Building Lab

Activity 1 How Technology Has Evolved Over Time PowerPoint which includes a movie clip and Venn diagram assignment (See Attached)

Movie Clips: Bill Nye Communications Video

—http://player.discoveryeducation.com/index.cfm?guidAssetId=57742D4C-420F-4A2E-B324-B6CED8B5A547&blnFromSearch=1&productcode=US

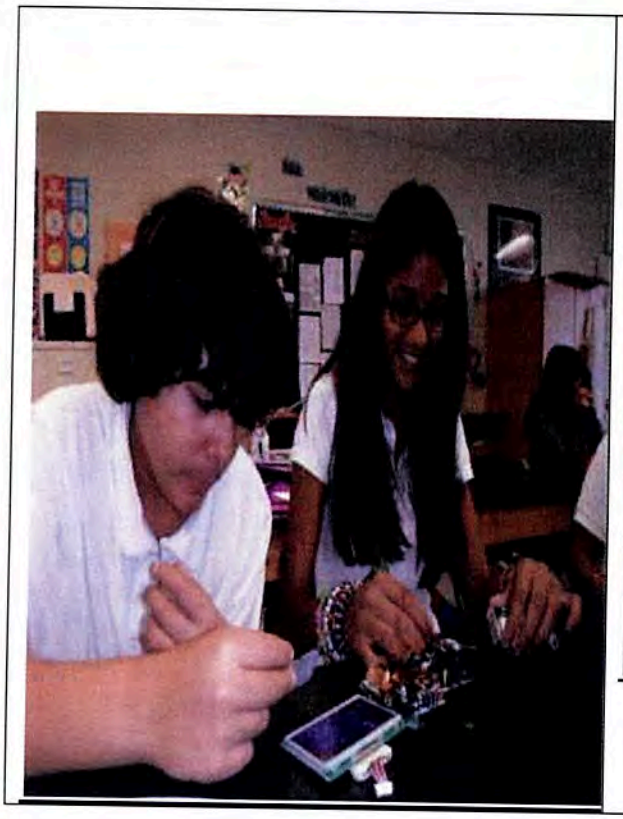
The venn diagram activity can be completed on the smart board or on chart paper as a class.

Activity 2 Signal Transmission and Reception PowerPoint which including two movies clips and quiz (See Attached)

WATCH ON DISCOVERY EDUCATION

EXAMPLE 2: BINARY NUMBER SYSTEMS -IT'S ELECTRIC

EXAMPLE 3: BINARY NUMBER SYSTEMS



Computer Rules

1. **Do not damage or move the computers around.**
2. **You must be doing the assigned work on the assigned website.**
3. **If you have a question or issue, please raise your hand and do not get out of your seat.**
4. **Talk in inside voices with your partner.**

Consequences

AUTOMATIC REMOVAL FROM COMPUTER AND YOU WILL BE GIVEN AN ALTERNATIVE ASSIGNMENT.

Date/ #	Names	Computer Issues

Activity 3 Can you CRACK the binary code?

Name
Date
Period

Can you CRACK the binary code?

Go to http://textmechanic.com/Binary-Code-Translator.html

Directions: For this section use the "text to binary" button and record your answers. Be sure to include the spaces.

Text	Binary Code
Dog	
Cat	
Your name	
Your friend's name	
What color is your hair?	
Why did you pick a dog?	

Directions: For this section use the "binary to text" button and record your answers.

Binary Code	Text
01101100 01101111 01110110 01100101	
01110000 01100101 01100001 01100011 01100101	
01110000 01100101 01100001 01100011 01100101	
01001000 01000101 01001100 01010000	
01001000 01000101 01001100 01010000	
01001001 00100000 01100001 01101101 00100000 01100100 01101111 01101110 01100101	

Teacher Answer Key

Can you CRACK the binary code?

Go to http://textmechanic.com/Binary-Code-Translator.html

Directions: For this section use the "text to binary" button and record your answers. Be sure to include the spaces.

Text	Binary Code
Dog	
Cat	
Your name	
Your friends name	
What color is your hair?	
Why did you pick a dog?	

Directions: For this section use the "binary to text" button and record your answers.

Binary Code	Text
01101100 01101111 01110110 01100101	Love
01101101 01100101	Me
01110000 01100101 01100001 01100011 01100101	Peace
01001111 01101111 01101111 01110000 01110011	Ooops
01001000 01000101 01001100 01010000	HELP
01001001 00100000 01100001 01101101 00100000 01100100 01101111 01101110 01100101	I am done

Activity 4

Mini Research Assignment

Student will work in small groups to research on the internet the following questions.

1. How does GPS work?
2. How do cell phones work?
3. What frequency is GPS on?
4. What frequency are cell phones on?
5. Why do cell phones drop calls?

The information the students acquire will be utilized to start a class discussion about how receivers receive information and transmit it to another source.

Activity 5 Compare and Contrast Essay
Name
Date
Period

Directions Part 1: Compare and contrast ways that signals (information) were sent in the past with how they are sent now. You may utilize any graphic organizer of your choice. You may also break it up into categories. Be sure to include pictures where necessary. You will use this information to create your essay. You may do additional research if necessary. Here is a sample to get you started.

Extra Credit Option: How do you think signals will be sent in the future?

	Past	Similarities	Present	Future
Internet				
Satellites				
Computers				
Cell Phones				

Directions Part 2: Utilize the chart you created to create a compare and contrast essay describing the ways that signal sending has progressed over time. The beginning paragraph should explain signal transmission and the binary code. Extra credit will be provided for describing what you think the future will bring.

Activity 6 Essential Electricity Vocabulary

Electricity - A form of energy produced by the movement of electrons.

Current – a measure of the amount of electrical charge transferred per unit time. It represents the flow of electrons through a conductive material.

Voltage - a representation of the electric potential energy per unit charge.

Wire – Metal in the form of a usually very flexible thread or slender rod

Resistor – Changes the amount of current flowing in the circuit

Battery – A container consisting of one or more cells carrying an electric charge and used as a source of power

Light bulb – An electric light in which a filament is heated to incandescence by an electric source

Switch - A device for making and breaking the connection in an electric circuit

Circuits – A configuration of electrically connected components.

Ammeter – Measures how much current is flowing

Voltmeter – Measures the voltage between the points

Activity 7 Vocabulary Illustration Worksheet

Create a vocabulary illustration for each vocabulary word. This can be done on the computer or by hand. You need to have to the word, definition, sentence and picture.

This can be done on the attached worksheet. This can also be done on notebook paper. I have them fold their paper into four sections. They do four words on the front and four words on the back. I also allow them to combine some words into one box if they are related.

Activity 7 Vocabulary Illustration Worksheet

Name
Date
Period

Directions: Complete the chart using the assigned vocabulary words and definitions.

Word	Definition	Sentence	Picture

Activity 8 Pre lab Worksheet Answer Sheet

Online Circuit Preparation Worksheet

Directions: This worksheet must be completed in order to complete the online lab.

Go to: http://gwydir.demon.co.uk/jo/elect/index.htm

Click on information for teachers and answer the following questions.

1. Read Setting up the circuit.
   a. What is a complete circuit? *Wire must connect the battery to the components and back again.*
   b. What causes an incomplete circuit*? The wires are not connected completely.*
   c. What would happen in real life if you experienced a short circuit? *This would burn out the battery!*
   d. What do you need to do when you complete a circuit? *Click on the switch and the light should light up.*
2. Read Changing the circuit.
   a. How do you avoid a short circuit? *Use all the correct components.*
3. Read Components.
   a. What is the role of a resistor? *A resistor changes the amount of current flowing in the circuit, which affects other components.*
   b. The higher the resistor has how much more power? *The high resistor has twice the resistance.*
4. Read The Science Bit
   a. What is Ohm's Law? *The fundamental formula for electricity is Ohm's Law, which states* $V = I R$ *which stands for Voltage = Current x Resistance.*
   b. Will current flow without a battery and why? *No. because the battery provides the current.*
   c. What are the four levels of current? *high = bright (yellow) medium = medium (orange) low = dull (red) none = no light (grey)*
5. Search and find.
   a. What does the voltmeter measure? How many places does it need to be set up at? *It needs to be set up in two places. It measures the voltage drop between the points.*
   b. What is the quickest way to print your work? *Use the Print Button*

Activity 9 Online Exploring Circuit Lab

Obj. Students will utilize an online resource to create simple circuits.

http://gwydir.demon.co.uk/jo/elect/intro.htm

http://www.playkidsgames.com/games/circuitGame/default.htm

http://www.classzone.com/books/ml_science_share/vis_sim/emm05_pg41_circuits/emm05_pg41_circuits.html

Rules:

1. You may use as many wires as you wish.
2. Create the circuit any way that you desire.
3. You must use the websites provided.

Procedures:

1. Go to each website and play with them for 10 minutes total.
2. Create the following circuits any way that you want. Record the circuits you create on graph paper and the results.

Battery	Light bulbs	Results	Add Resistor(s)	Results
One	One			
Two	One			
Three	One			
One	Two			
One	Three			
Two	Two			
Two	Three			
Two	Two			

   a. OK. Now try to create it in a series and try to reverse the polarity of the circuit. (Make it go in the opposite direction.)
   b. Create 3 complete circuits of your choice and record your results.

Analysis

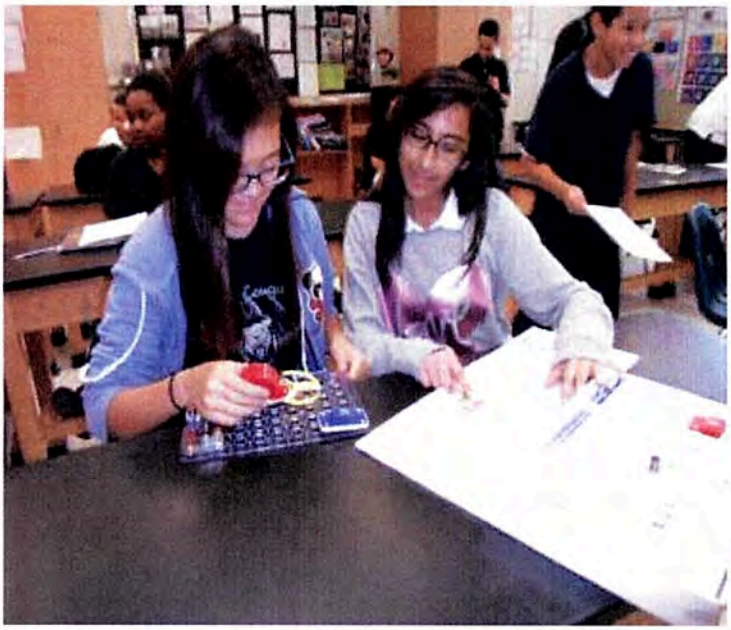
1. What did you observe about the relationship between the number of light bulbs and the number of batteries?
2. When did the light bulb get the brightest?
3. What happened when you added the resistors?
4. What was your favorite part of the activity?

Teacher directed class discussion about the lab.

Activity 10 Snap Circuit Kits

1. Provide the students with snap circuit kits and allow them to explore.

2. Complete the circuit lab follow up worksheet.



Circuit Lab Follow Up and Evaluation Form

1. What projects did you design?
2. What was your favorite project and why?
3. What did you discover about electricity while creating your project?
4. What problems did you encounter and how did you solve them?
5. Do you want to become an electrical engineer as a result of this project?
6. What did you learn about electrical engineering while building your circuit boards?
7. Did you have anything else that you wanted to add?
8. Should we continue this module in the future and why?
9. Did this project motivate you to want to learn more about building circuits?
10. Do you plan to buy the circuit building kit to build circuits at home?
11. Did this project make you more excited about learning Science?
12. As a result of this project are you more motivated to do better in school?
13. As a result of this project will you work harder in school so that you can be prepared to go to college?

Supplemental Materials

Item	Where Purchased	Price
I pad 	**Walmart.com**	**$399.00**
Snap Circuit Kits SC-300 by Elenco	**Amazon.com**	**$46.16 each**
Batteries AA Maxell 723443 LR6 AA Cell 48 Pack Box Battery	**Amazon.com**	**$12.93 for 48 pack**
Chart Paper Melissa and Doug Easel Pad Paper	**Amazon.com**	**$9.98 each**

Online Teaching Module in Electrical Engineering for K – 12 classes

Danielle Thomas/ Thomas Yang

Presentation at 2012 ASEE SE Section Annual Conference,
April 2012, Starkville, MS

About The Presenter

- Danielle Thomas
- 7th Grade Science Teacher
- Glades Middle School
- Miramar, Florida
- Contact Information:
  danielle.j.thomas@browardschools.com

NSF Funded RET Project at ERAU

- Six-week summer program at ERAU campus
- Each participant (K-12 science or math teacher) paired up with an ERAU engineering faculty member
- Participants conduct research under mentors' supervision
- Teaching materials are developed for participants to incorporate into their teaching practice

Grant and Sponsorship

- Broward Education Foundation
- Disseminator Grant Winner
- Award for original and innovative teaching ideas.

Module Creation and Overview

- Electrical engineering with Thomas Yang ERAU faculty
- Uses an online format
- Overall goal is to inspire students to pick careers in Engineering through curriculum exposure in middle school
- Currently being implemented with 120 7^{th} grade students

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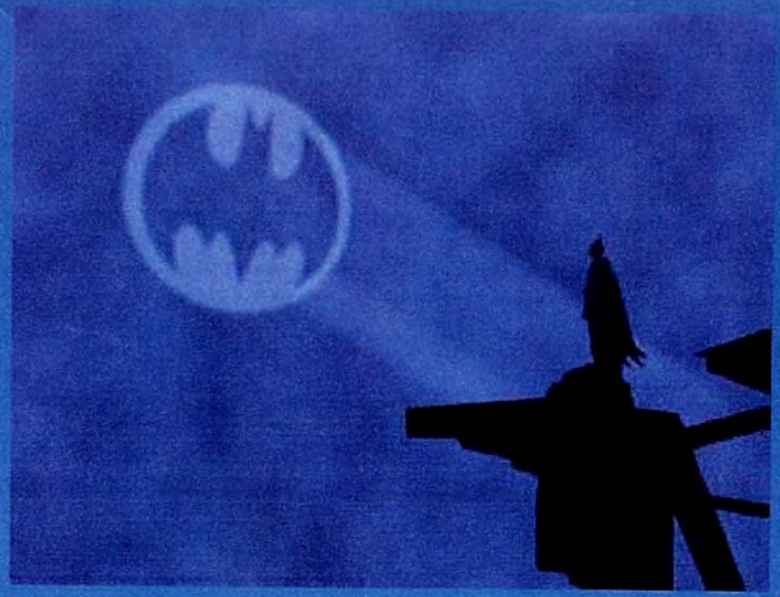
STACK:



Signal Transmission and Reception

Module One

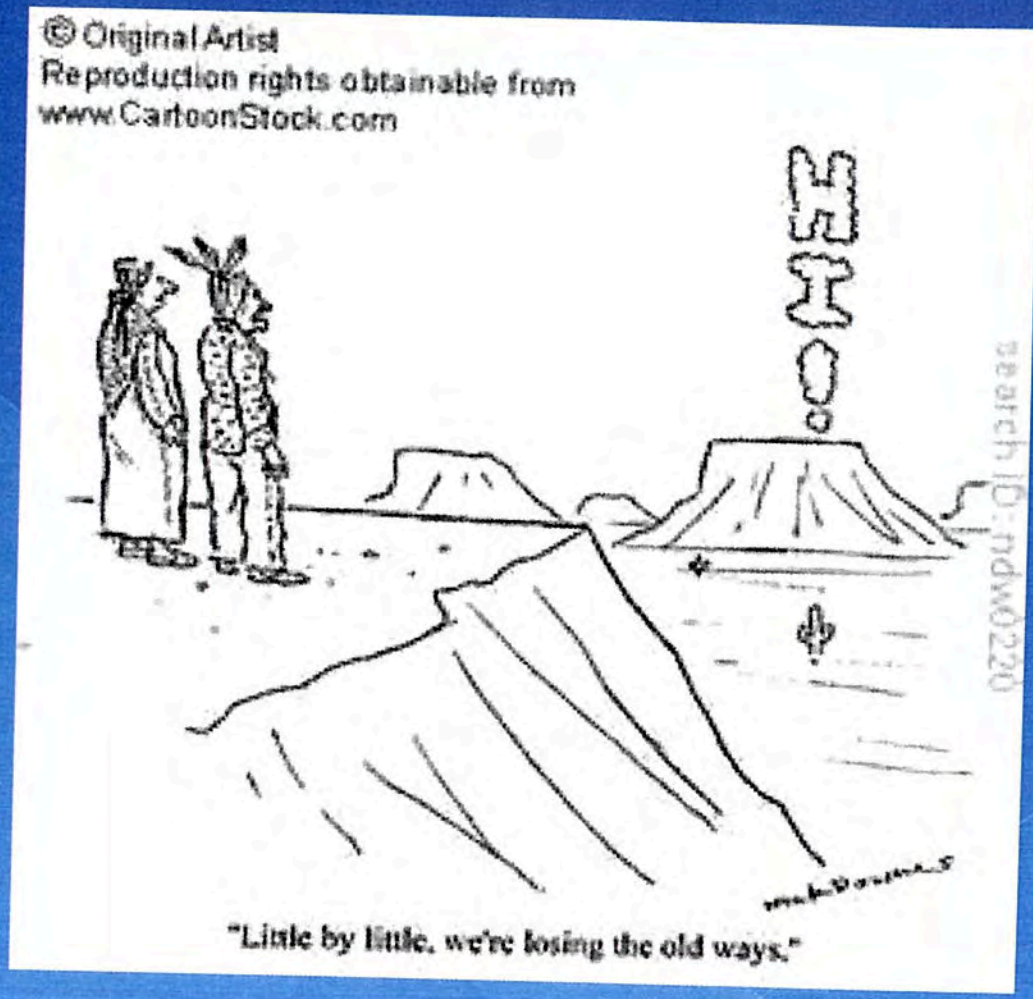
By: Danielle Thomas
Embry Riddle
RET Program 2011

How do you communicate with someone remotely?

Class discussion
*Call them
*Text message
*Instant message

How did people send messages...

Before telephones?
* Smoke signals
* Morse code
* Pony express
* Pigeons
* People who were traveling



How did people send messages...

After telephones?

* Call them
* Snail mail
* Satellite signals
* Two way radio

Class Discussion

How do you think information is transmitted remotely from one place to another using computers?

The Binary Number System

In order to transmit information remotely you need to use a language that is understood by computers.

All information in the digital world is stored and transmitted using the binary code.
It's similar to our decimal system that uses the digits 0 to 9.

The binary system uses only the digits 0 and 1.

Watch On Discovery Education

Example 2: Binary Number Systems -It's Electric

Example 3: Binary Number Systems

Quiz

- 1. What numbers does the base 10 system use?
- 2. What numbers does the binary system use?
- 3. Why do we need the binary system?
- 4. Who uses the binary system?

How has technology has evolved over time?

MODULE ONE
BY: DANIELLE THOMAS
EMBRY RIDDLE
RET PROGRAM 2011

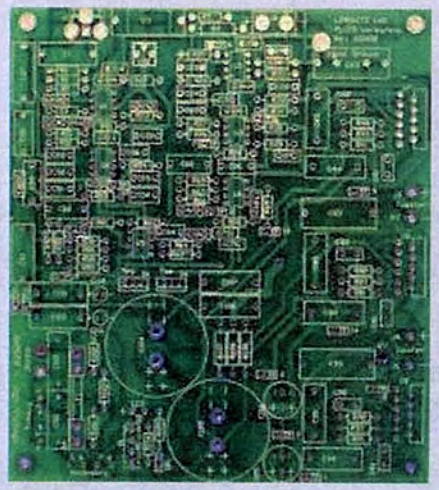
How has technology changed over time?

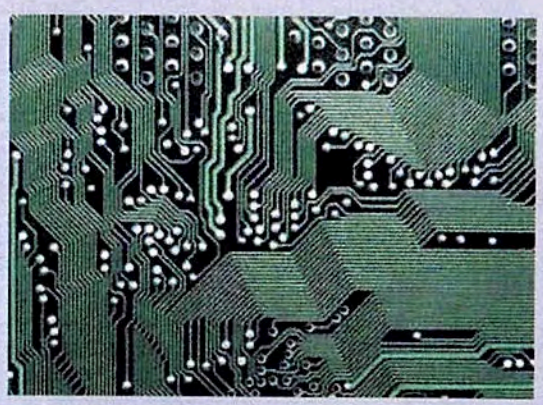
- How has technology changed since you were born?

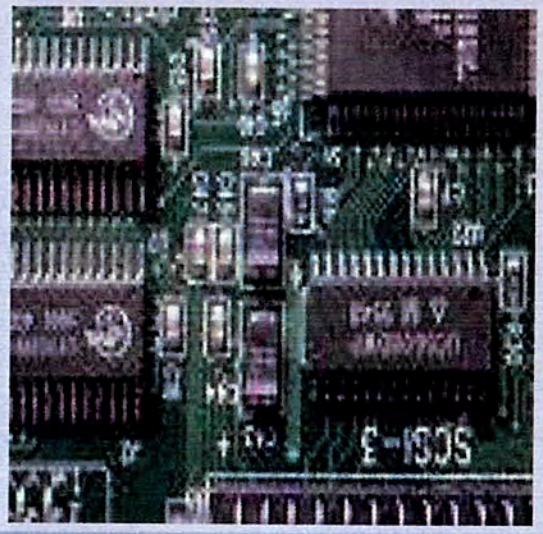
Ohhh how things change…

- DVR is a lot easier to program than a VCR
- Computer used to fill whole rooms and now you can run programs on your cell phone
- Video games had blinking lights and now you can play games with people from around the world
- Boom boxes were very large and now IPODs are small squares that fit in the palm of your hand or you can play music on your phone

Have you ever seen a circuit board?







Where have you seen them?

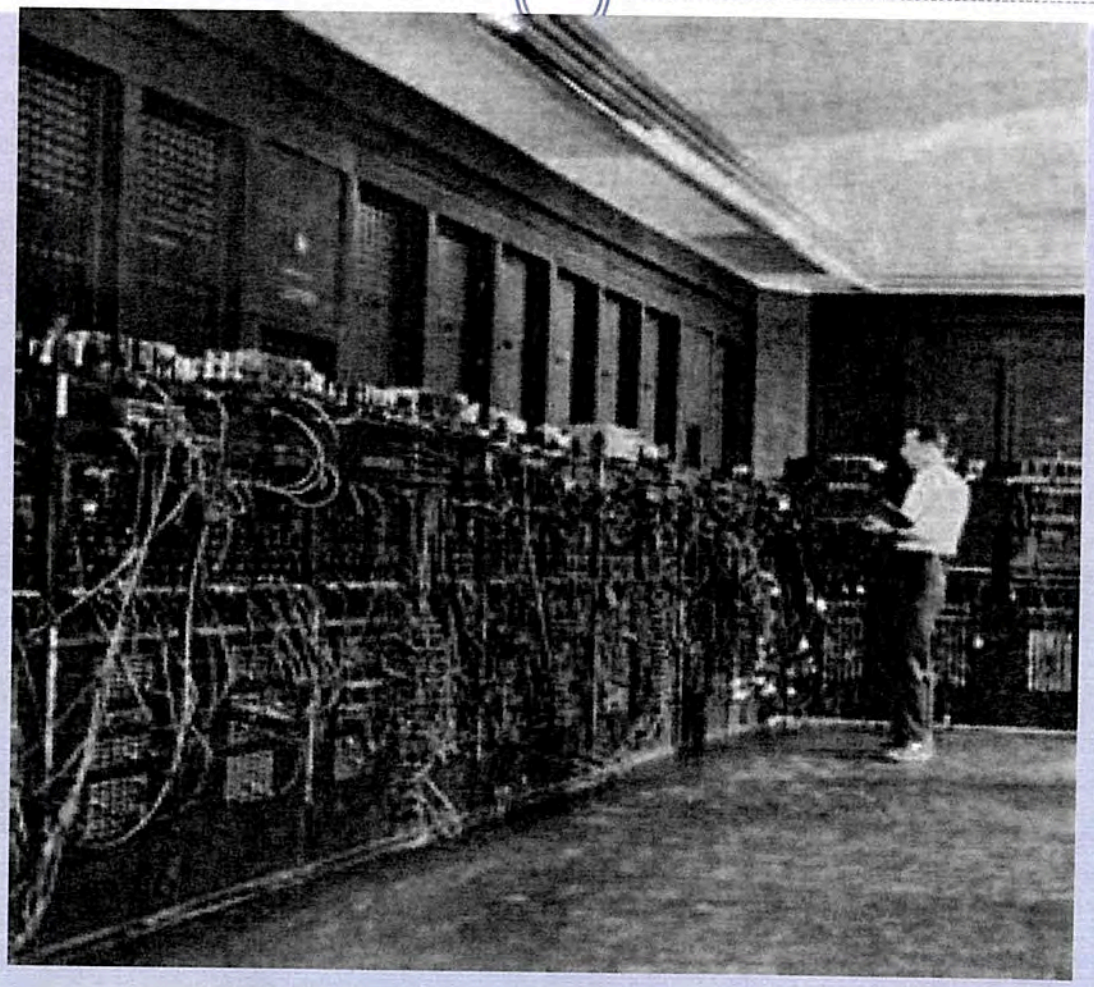
- Examples
- Computers
- Cell phones
- I pods

Computers have become smaller over time

Do you know what ENIAC is?

- Win a prize if you know the answer

ENIAC – The First Computer



ENIAC

- Electronic
- Numerical
- Integrator
- And
- Computer

Bill Nye Communications Video

- http://player.discoveryeducation.com/index.cfm?guidAssetId=57742D4C-420F-4A2E-B324-B6CED8B5A547&blnFromSearch=1&productcode=US

- Take notes during the movie

Moore's Law

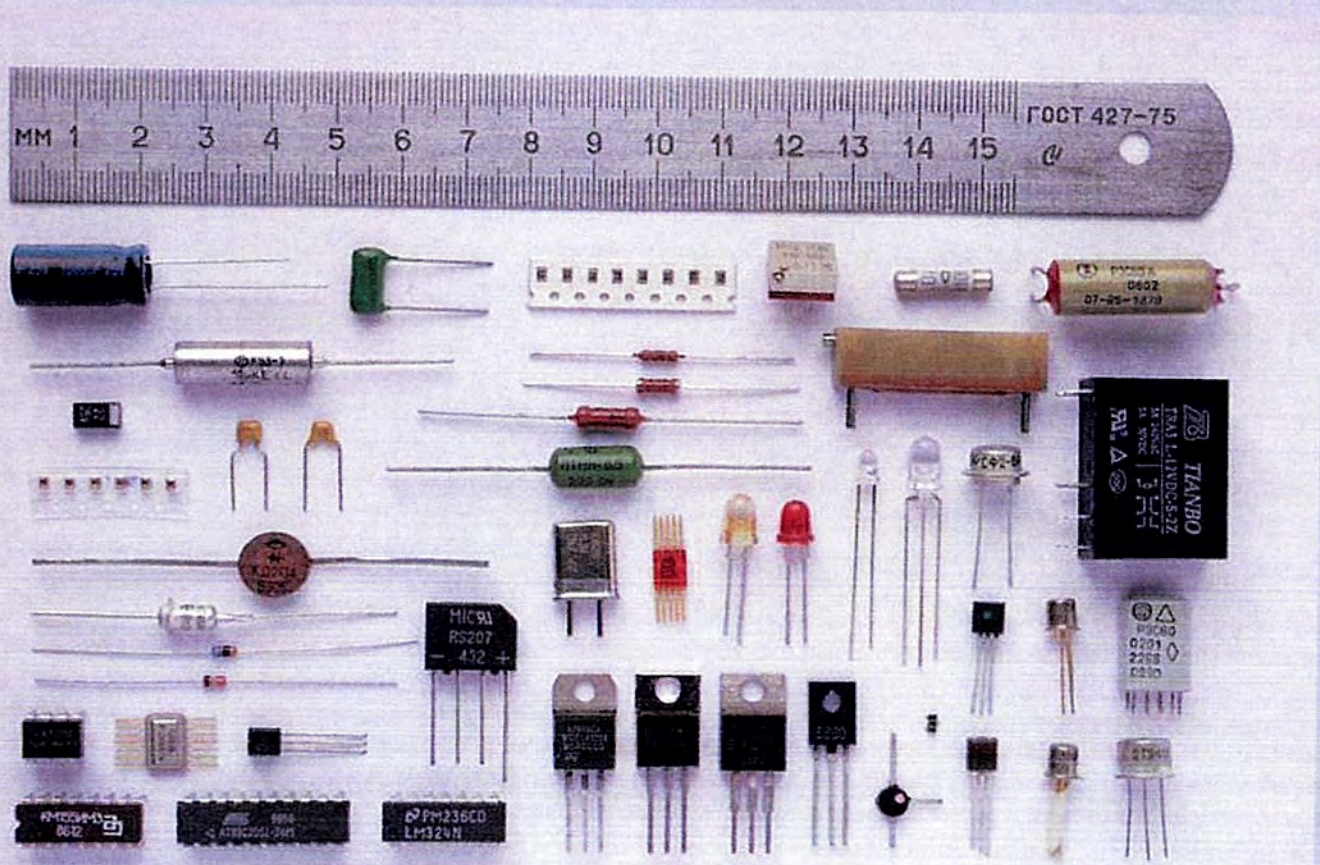
"Moore's law, the observation made by Gordon Moore, co-founder of the Intel Corp., in a 1965 magazine article that the number of transistors per square inch on a microprocessor chip had doubled each year since the integrated circuit had been invented. This led Moore to predict that the number of transistors on a chip would double every 18 months-a time interval he later revised to every two years."

"Technically an axiom rather than a law, the prediction was subsequently dubbed Moore's law by the American physicist Carver Mead. The law became something of a self-fulfilling prophecy as microchip and electronics manufacturers competed to develop faster, smaller, and cheaper electronic devices; by the early 21st cent., the number of transistors on a typical memory chip had gone far beyond 1 billion."

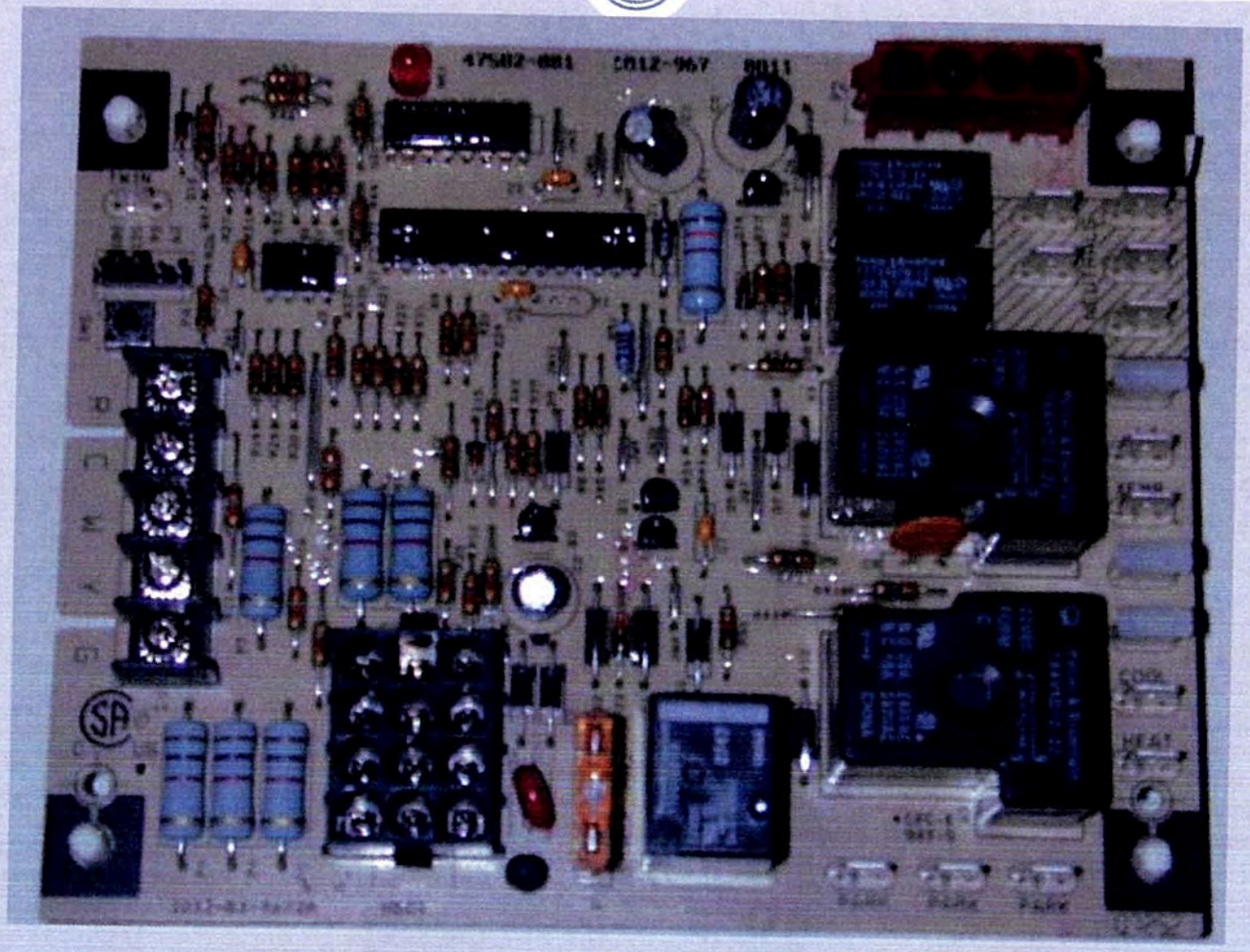
"It is generally accepted that technological improvements in miniaturization and microelectronics will reach a point where circuits are only a few atoms wide, making it physically impossible to make them even smaller. To maintain the pace projected by Moore's law, new technologies such as quantum computers, optical switches, and spintronics will need to be developed."

Read more: http://www.answers.com/topic/moore-s-law#ixzz1Ru6TEX10

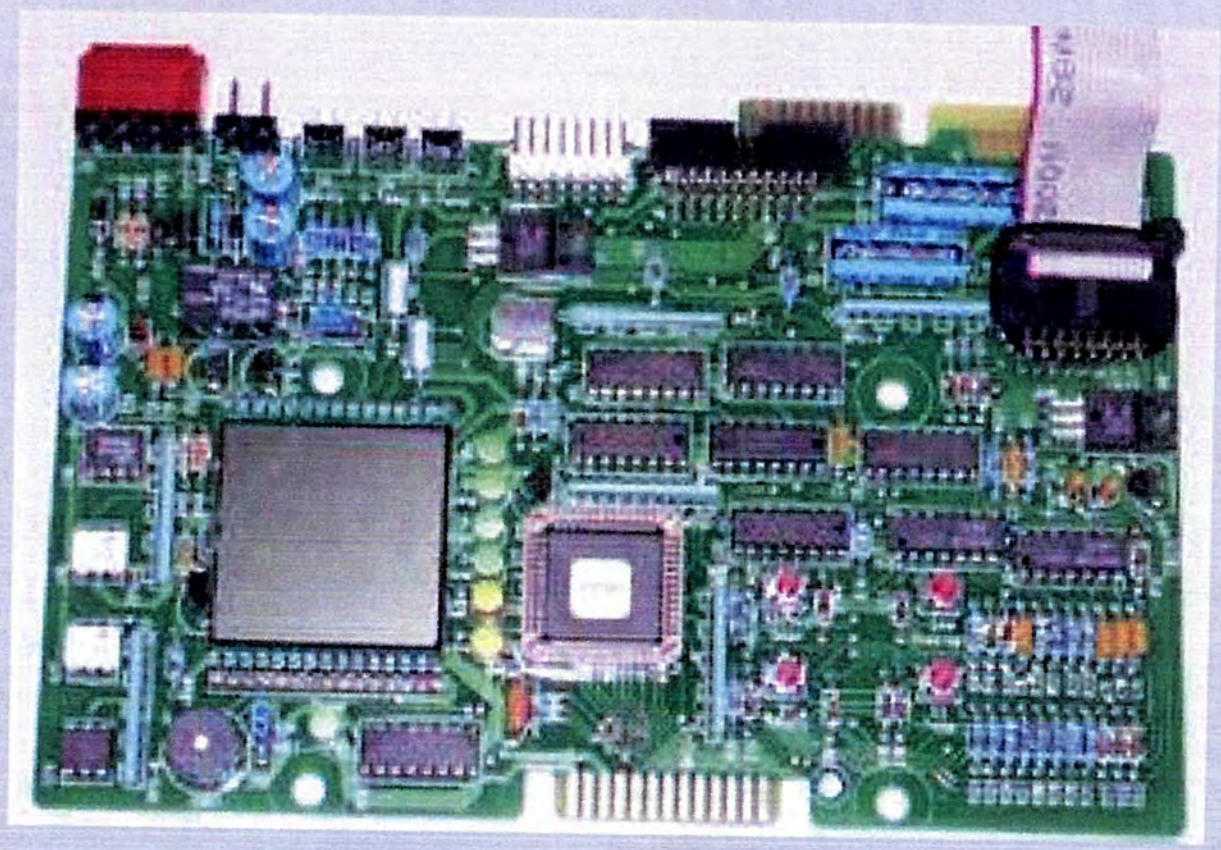
Can you identify the parts of the circuit?



Can you identify the parts of the circuit board ?

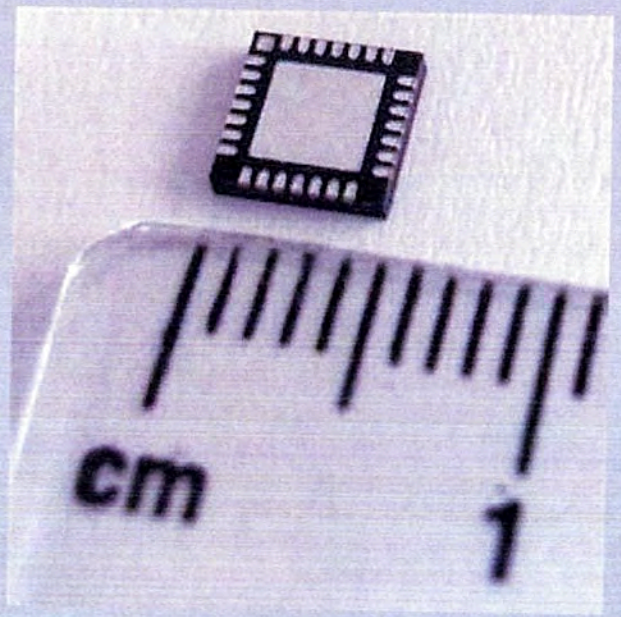


How about now?

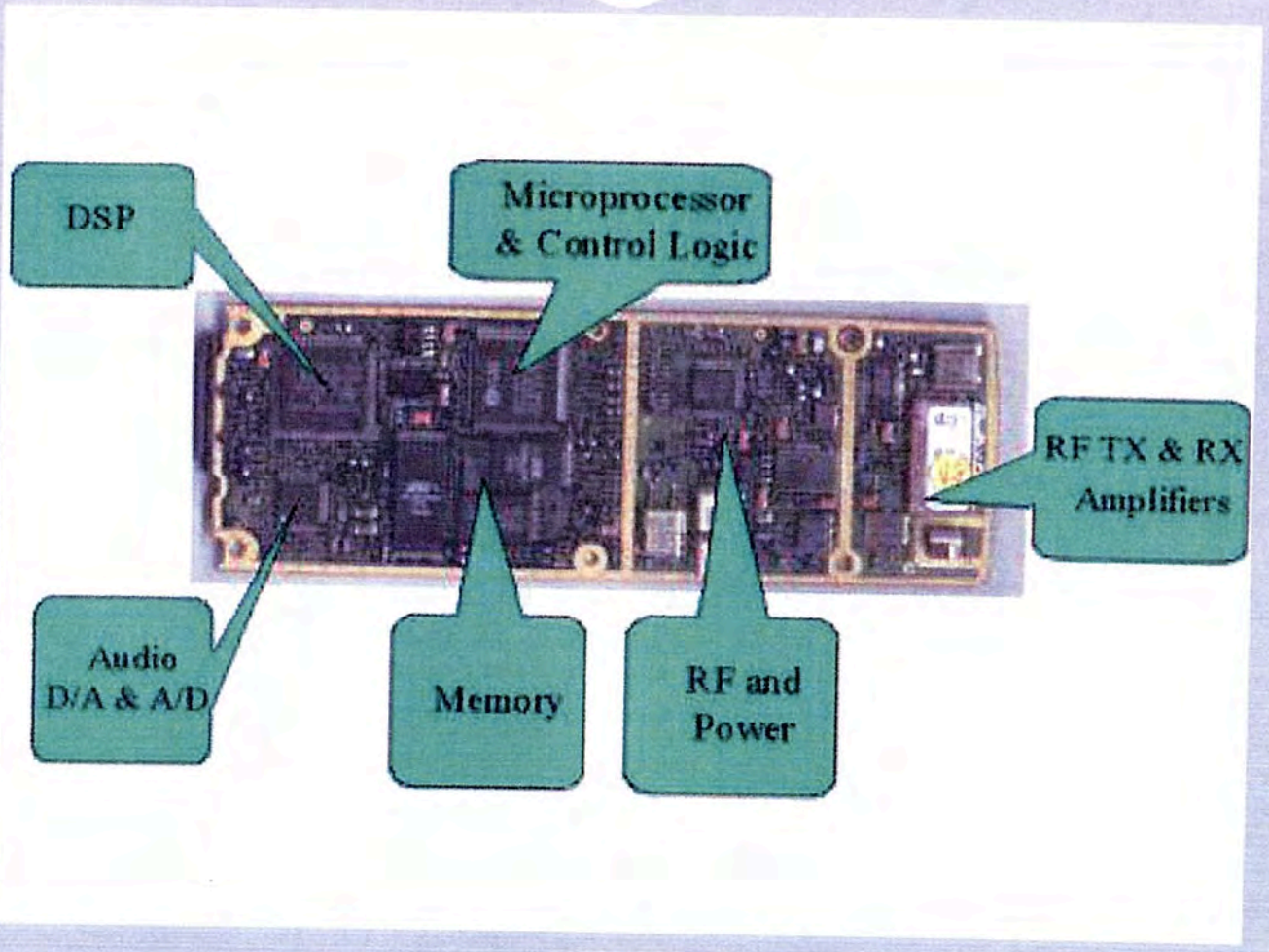


How about now?

- This is an integrated circuit.

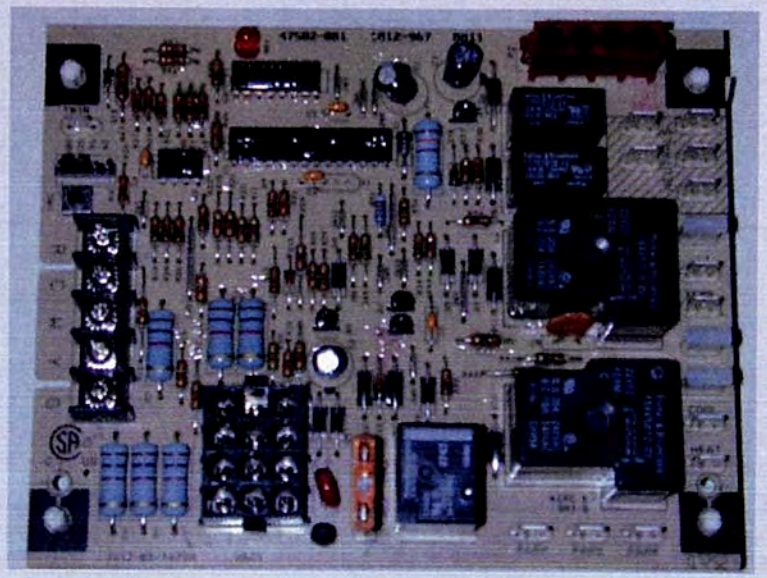


Inside a cell phone

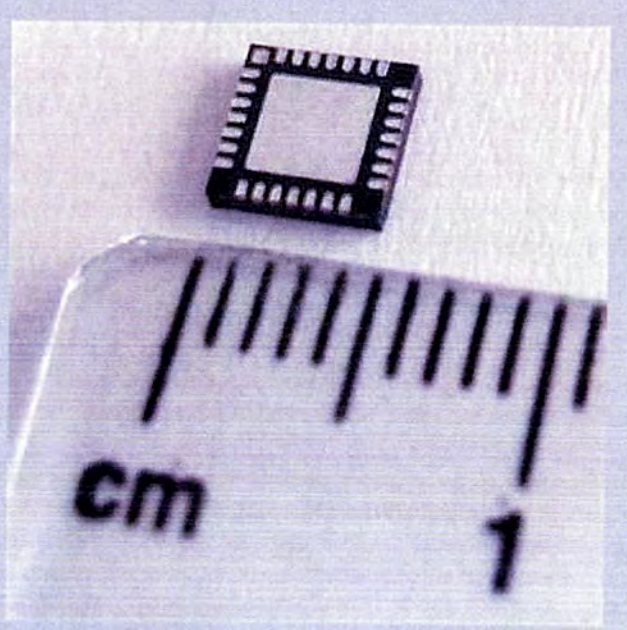


Create a Venn diagram to compare and contrast the two?

Circuit Board Old School



Integrated Circuit



Circuit Board Old School	Similarities	Integrated Circuit