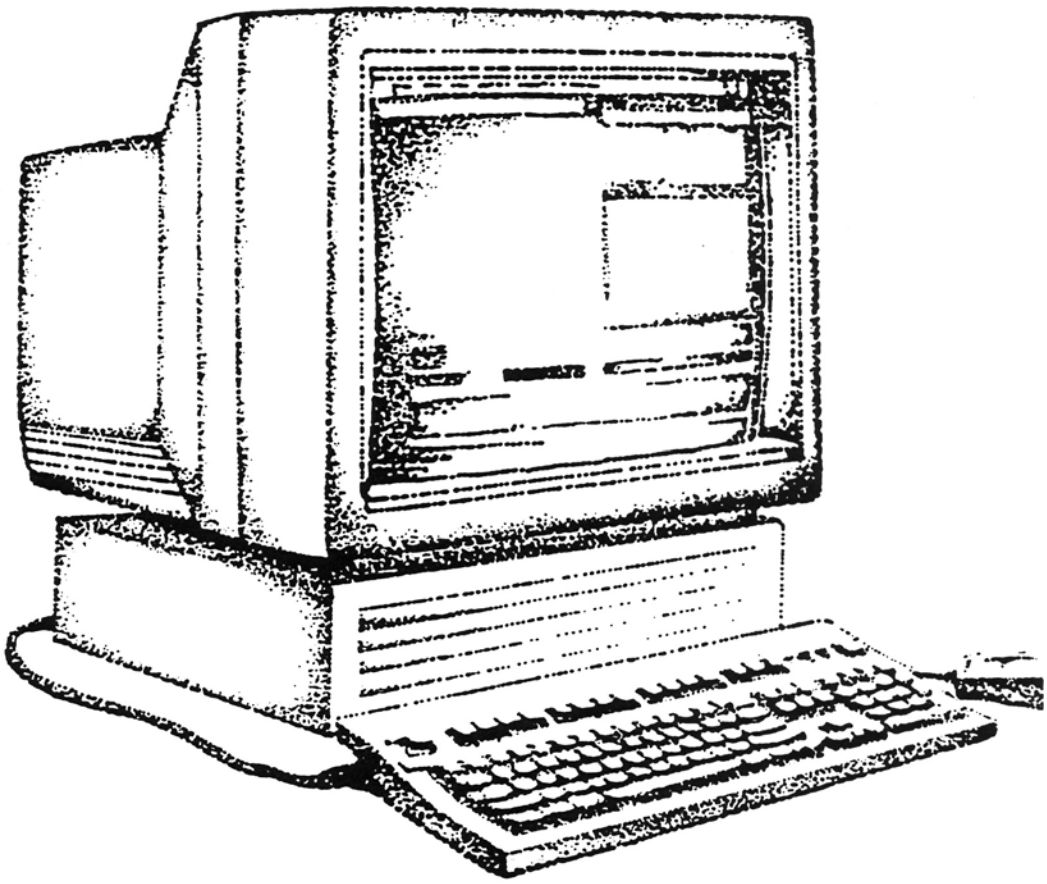
How Does a Computer Work?



Children are starting to use personal computers and other computer-based equipment in their everyday lives. Schools use computers to teach the ABC's, and video games are popular entertainment. Children are curious about how computers work. Relating the operation of a computer to them can be quite a challenge. This project turns the operation of the central processor (brain of the computer) and some of the other components into a simple skit, allowing children to interact and develop basic understanding of how a computer would add two numbers.

Objectives

1. Provide a basic understanding of computer operation.
2. Provide a basic understanding of computer programming.
3. Remove mental barriers of complexity that exist when thinking of computers and programs.
4. Provide a basic understanding of some computer terms.

Grade Level

This activity is targeted for students in grades 5 through 10.

Materials

1. 4' x 4' banner of the central processor and components, (See Figure A).

2. 3" x 8", red instruction cards, (See Figure B).

3. 4" x 12" yellow function name cards, (See Figure C). Students will need to hang these cards from their necks. Tape or tie the string to the cards so that they fit loosely around the neck.

4. 2" x 4" green number cards, (See Figure D)

5. Instruction set handout (See Figure E).

6. Try to obtain a wafer or picture of a wafer and computer chips. On some of the chips if possible, have the plastic removed from the corner of the chip so the children can see inside the package. These should be visible for the children to view.

7. Magnifying lens.

Lesson Outline

1. Introduction-1 minute

A. Discuss how computers are used today, i.e., video games (Nintendo, game boy), personal computers, washers, dryers, and toys. They are used in every facet of our daily lives from toys to airplanes and everywhere in between.
B. Tell students that engineers make computers possible and use them in a variety of ways.
C. Note: Be careful not to use acronyms.

2. Show and Tell-5 minutes

A. If you have a wafer, show it to the class, but do not pass it around for safety reasons.
B. Pass the chips around with a magnifying glass and explain the process of making a wafer and chips. Do not get into specifics of wafer design or chip manufacturing.

Explanation: The process of making a wafer is chemical and not electrical. Explain that engineers make a wafer like a pizza, placing certain chemicals and minerals into certain places on the wafer and then selectively removing others and repeating this cycle-many times-to form the components of the wafer. When the wafer is done, engineers test the wafer to verify that the components in the wafer work properly.

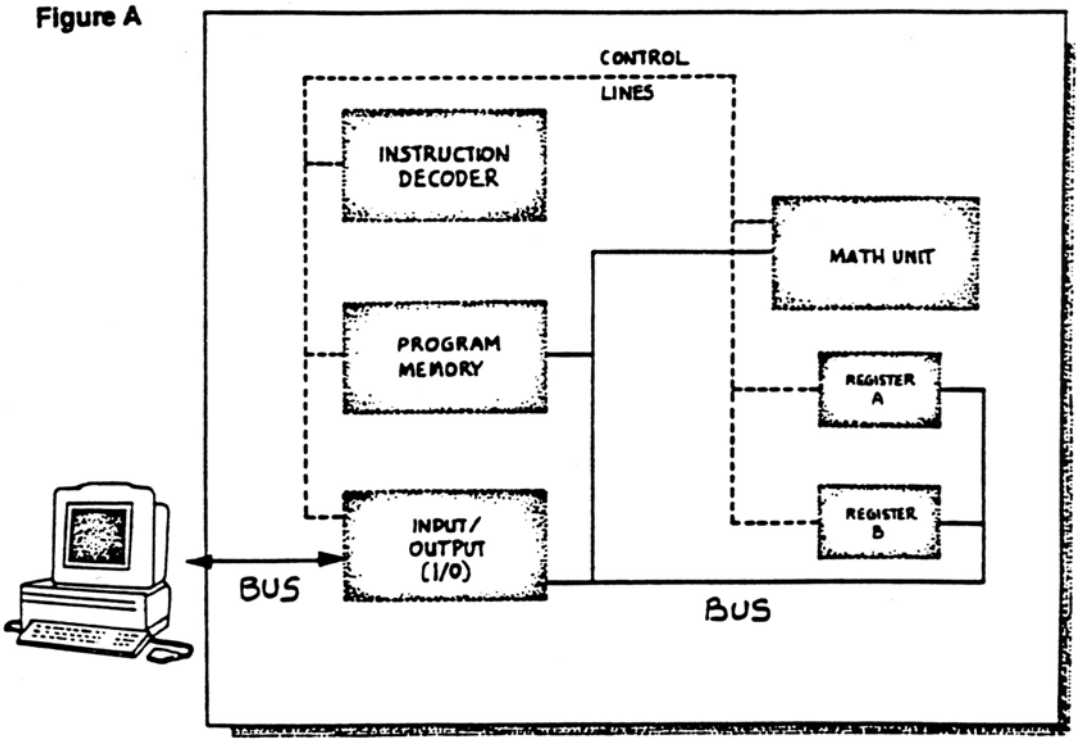
3. Computer Block Diagram-5 minutes

A. Now we are ready to discuss the banner. The banner is a pictorial view of the major processes within the chip. Discuss each of the major components.
B. When using acronyms, explain the meaning of the ones used in this project and try not to use additional ones.
The Instruction Decoder is the brain that controls the internal operations of the chip.
The Input/Output section moves data from either outside the chip to inside or from inside the chip to outside.
The Math Unit (ALU) is the calculator. This unit adds, subtracts multiples, divides and performs other math functions.
The Registers (A and B) are used for local storage while the chip performs calculations and I/0.
The Program Memory is used to store the program or instructions for the computer chip, i.e., Game Boy cartridge
The *CRT* (visual display) is used to visually display the results from the computer, while the keyboard is used to enter data into the computer.
The *BUS* moves data inside the computer chip.

4. Computer Operation-4 minutes

A. Explain that the computer can only do what it is told through the program and the program is a series of instructions. The computer is not smart at all, but can only execute simple instructions.
B. Explain that the computer uses a series of on's and off's-voltage or no voltage-to make decisions. These decisions are based on math results. That is what the math unit does.
C. Be sure throughout your presentation to avoid using acronyms.

Figure A



5. Introduction to Skit-1 minute

A. Explain the object of this lesson. We want this computer to add two numbers received from the CRT (visual display) and return it to the CRT (visual display) via the Input/Output port on the computer.

6. Teach the Computer Instruction Set-10 minutes

A. Now distribute the instruction set handout (see attachment).This paper lists all the valid instructions for our computer. Explain each instruction using the banner block diagram to explain each component and instruction operation. Let's look at the first instruction; *"Add register B to A and put the result in register B "*.The math unit will take the contents of B and add it to A and then put the result back into B. Show the students how each instruction moves data in the banner. Each instruction does a different operation. Go through each, instruction and ensure the children understand.

7. Students Figure Out Which Instructions to the to Add Two Numbers-5 minutes

A. Now have the students take the instruction set handout and order the instructions to be able to enter two numbers at the CRT and receive the result back from the CRT. Divide the children into teams to order the instructions on the handout that will have our computer add two numbers. Make sure you tell the instructions can be used more than once. Tell them to number the sequence of each instruction.

B. Note: *"Get character at Input/Output"* will be executed twice. It will have two numbers.

Answer (There are two answers):

	Move character at **Register B** to **Input/Output**
1, 3	Get character at **CRT** and put in **Input/Output**
2	Move character at **Input/Output** to **Register A**
5	Add **Register A** to **B** and put result in Register A
4	Move character at **Input/Output** to **Register B**
7	Send character at Input/Output out to **CRT**
6	Move character at **A** to **Input/Output**
	Move character at **B** to **Input/Output**

8. Select Volunteers, Ready Members-5 minutes

A. Now ask for volunteers to be part of the skit.
B. Select one person for each component. (See Attachment-Component cards).
C. Spread the students around the room and have them hold or wear the component cards.
D. Give the number cards (2,3) to the CRT.
E. Give the number card 5 to the Math Unit.
F. The instruction decoder should be you and you need the Instruction card **get next instruction.**
G. Now order the function cards in the order of the answer the children derived in 7 above and give the cards to the **program memory**. Tell the students that giving the cards to the program memory is like putting in a Game Boy cartridge or putting in a floppy disk into the computer. It is the set of instructions that the computer reads and follows.
Hints:
A. Tell each child to raise up each instruction when they receive it so others can follow along. The students have a tendency to read each instruction to themselves. Tell them to read out loud and follow the instruction when they get the card.
B. Tell the students that when they are done to give the card back to the **BUS** so it can go back to the instruction decoder.
C. Tell the **math unit** when he or she adds the numbers, he/she needs to go to each register and remove the existing numbers and replace the total into the register indicated on the card.
D. Tell all students that the **BUS** is the only one that can move around except for the **math unit**.

9. Skit Starts--10 minutes

A. Now you are ready to run the program
B. Now as the instruction decoder, call the **BUS** over and tell the **BUS** to get the next instruction from the program memory.
1. Note: Make sure you hold up your card.
C. He or she should walk over and ask the program memory for the first/next instruction and they should bring it back to you.
D. Now read the instruction and tell the **BUS** to take that card to the component indicated on the card.
E. After the component finishes his or her task the **BUS** must bring the card back to you.
F. Go back to B until all the cards are processed.

10. Wow-They Did OK-5 minutes

A. The children should be able to grasp what is happening inside the computer and the central processing chip. Now talk about how long it took to do these 10 instructions. Now explain that a real computer running at 66MHZ or 66 million cycles per second (one instruction per cycle) can do what they did 6.6 trillion times in one second.
B. Now talk about what a program really is.
Explanation: The students developed a little program to add two numbers. Now these series of instructions can be referred to as a function, call it the "add" function. Computer languages have thousands of functions with many instructions and there are many different languages. Programmers use these functions to build programs. Some functions do mathematics, some display numbers and characters on the screen, some write data to the floppy disk while others can make the system go beep. How a computer programmer develops programs is based on what he or she wants the computer to do.

Figure B

Instruction Cards

3”x8”, Red, laminated cards

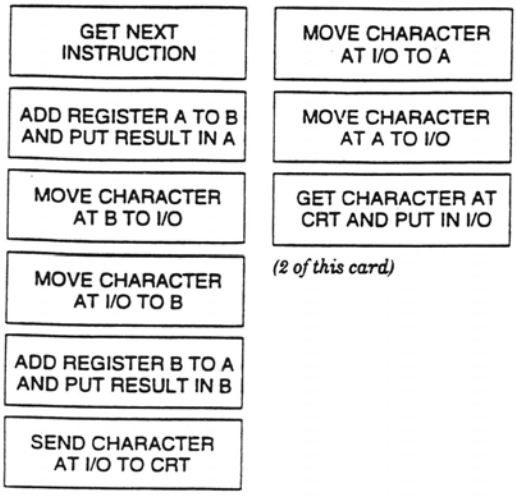


Figure C

Component Cards

4”x12”, Yellow, laminated cards

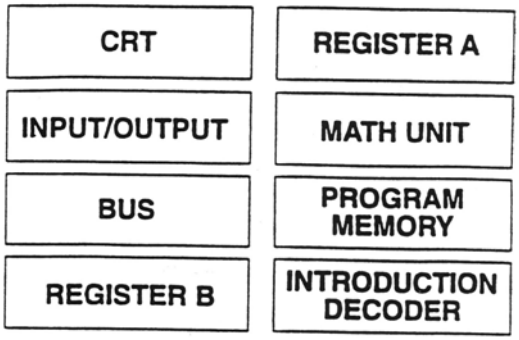


Figure D

2”x4”, Green, laminated cards

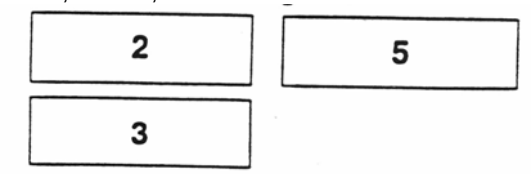


Figure E

Instruction Set Handout

___ Add **Register B** to **A** and put result in **Register B**

___ Get character at **CRT** and put in **Input/Output**

___ Move character at **Input/Output** to **Register A**

___ Add **Register A** to **B** and put result in **Register A**

___ Move character at **Input/Output** to **Register B**

___ Send character at **Input/Output** out to **CRT**

___ Move character at **A** to **Input/Output**

___ Move character at **B** to **Input/Output**