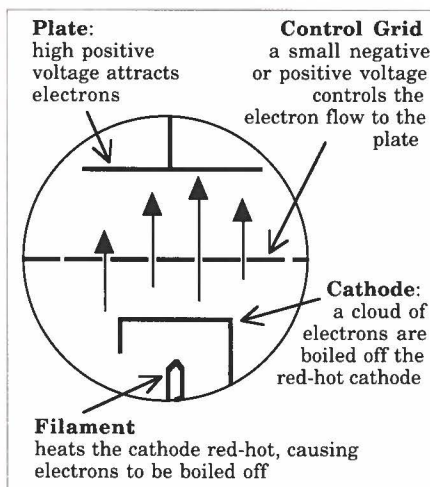# THE JOURNEY INSIDE

The **ISTE** newsletter of classroom ideas and hardware information.   US$3.00

Vacuum Tubes

Thirty or 40 years ago, any engineer who might have suggested designing a device with millions of components per square inch would have been given a new job—that of science-fiction writer. Integrated circuits didn't exist, and engineers considered a device designed to use three or four components per square inch a tremendous achievement.

To provide a way to control the flow of electricity, engineers invented a *vacuum tube*. The vacuum tube or "valve," as the British called it—choosing to name it after its function rather than its shape—is basically an evacuated glass tube. One end contains a piece of metal (cathode) that is heated by a filament until the cathode is red-hot (see diagram).

Plate:
high positive voltage attracts electrons

Control Grid
a small negative or positive voltage controls the electron flow to the plate

Cathode:
a cloud of electrons are boiled off the red-hot cathode

Filament
heats the cathode red-hot, causing electrons to be boiled off

This filament is not unlike the filament inside a light bulb and gives vacuum tubes their soft glow. This filament also produces the heat that causes many tubes to malfunction. When the cathode gets hot enough, electrons begin to "boil off" and form a cloud around the cathode—a "pool" of electrons. The other end of the tube has a positively charged plate to collect these electrons. In between is at least one control grid—a screen of wire that controls the flow of electrons moving through the tube.

The interaction of the components provides a way to control the flow of electricity. When the grid has a positive charge—opposite of the charge of the electron—electrons are attracted to the plate and can move past the control grid. When the grid is negatively charged, electrons are repelled. If the grid is sufficiently negative, the flow of electrons is "shut-off," allowing no electrons to reach the plate. In the following photo, the plates are visible in the complete tube and in the dismantled tube.
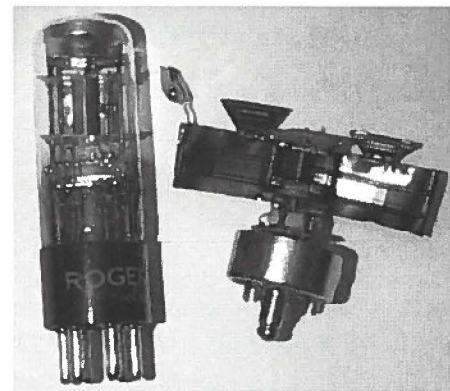
This phenomenon allows the tube to operate as an on/off switch. If the tube is conducting, the switch is on an "up-bit." If the tube is not conducting, the switch is off—a "down-bit." This provides only very basic digital information, but was the best engineers could achieve at the time.

Despite the usefulness of the vacuum tube switches, several factors hinder their use. The main disadvantage of vacuum tubes is the tremendous

Inside This Issue

IMAX Film Schedule

Intel's IMAX film, *The Journey Inside: A Learning Adventure in High Technology*, is currently playing at a number of theaters. For availability in your area, contact your local IMAX theater.

Discovery Place
301 North Tryon Street
Charlotte, NC 28202
704-372-0471
Through May 31, 1996

Space Center
Clyde W. Tombaugh Omnimax Theater
Top of New Mexico Highway 2001
Alamogordo, NM 88310
505-437-2840
Through June 1996

Canadian Museum of Civilization
100 Laurier Street
Hull, PQ J8X 4H2
Canada
819-776-7062
Through January 2000

Workshop Schedule

Intel continues to provide workshops for teachers interested in using the program. These workshops provide ideas and suggestions for using *The Journey Inside: The Computer*. Teaching methods, activities, and reference materials are included in these presentations.

Northwest Council for Computer Education (NCCE)
Oregon Convention Center
Portland, OR
April 24–27, 1996
Contact: Paul Katz
Phone: 541-346-3537

District Staff Development Day
Burns, OR
April 15, 1996
Contact: Lydia Hayes
Phone: 541-573-2058

If you have questions, contact Irene Smith at ISTE, 480 Charnelton Street, Eugene, OR 97401-2626; 541-302-3776.

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waste of energy. Producing the switching effect requires considerable energy, but most of the electricity entering the vacuum tube is lost as heat. Other disadvantages include the size of the tube, the weight of the supportive circuitry, and the time lag for electrons to travel the length of the tube. To offset these problems, vacuum tubes are kept as small as is practical for each specific application. Note the wide range of tube sizes and the comparison to the penny and transistor in the following photo.
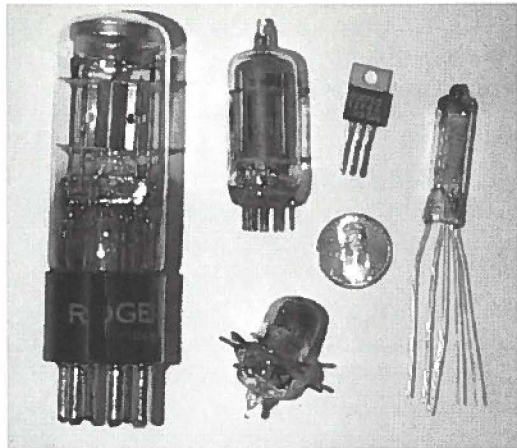
Vacuum tubes have been widely used. Military operations relied on radio transmissions made possible with vacuum-tube-based radios. Vacuum tubes traveled into space in the guidance systems aboard the early guided missiles. However, even though the size of the tubes was reduced considerably for this application, the missile had to carry the batteries needed to supply energy to the tubes. These batteries were large and heavy. Despite the tube's size reduction, the supporting pieces couldn't be miniaturized. In this application, where every ounce is critical, transistors provided a welcome alternative. The move to transistorized circuitry saved space, energy, and weight, and therefore was quickly adopted as the standard for applications in space research.

Most devices requiring the use of a switch now rely on transistor-based controls. However, tubes are still in use in the music industry, where they are preferred in musical amplifiers. They are also used in applications requiring high power, such as radio and television transmitters. In the former USSR, tube-based devices are still more common than devices using transistors. Many of the tubes presently available for use in the United States are imported from former Soviet Bloc countries.

The vacuum tube is a tremendously useful device and represented the "state-of-the-art" in its time. Even with its limitations, the vacuum tube allowed early inventors the opportunity to build basic primitive computers that could perform in minutes the calculations that had previously required many hours of human power. As the limitations of the tubes became too great, new technology arrived. Vacuum tubes were replaced by transistors. Transistors were then packed together into integrated circuits—the present technology. And, who knows. It may be one of your students who invents the replacement for transistor switches. ▫

Dave Uhreen
7837 Hale Way
White City, OR 97503

Chip Kit Replacements

For those of you having difficulty locating replacement pieces for your chip kit, the following provides some suggestions. However, you can undoubtedly locate these items at an electronics shop in your own area. The part numbers will assist you in making the correct selection.

Mouser Electronics
2401 Highway 287N, Mansfield, TX 76063
1-800-633-2246

Item	Order Specs	Stock #
C-cell batteries		573-R14PSW
9V Batteries		573 - 6F22MSW
Slide switches	Miniature solder terminals	10-SM002-1
9V battery snap	Wire size 26AWG, lead length 5 in, contacts 4 prong	12BC095
12V bulbs with wires	.060 amps with 6-in leads	35-LS126-2
Transistors	TO-220 NPN GP Power SGS Non-Jedec	511-TIP48, 333-TIP48
Wire	solid wire hook-up UL1061 wire size 22AWG	515-WPC-2202-02 red, 515-WPC-2201-03 black

West Gard Electronics
8940 Quartz Ave., Northridge, CA 91324

Item	Order Specs	Stock #
14V LEDs	Pre-bond length 6 in	LHSOLRF L 7322-14V

Word to the Motherboard

Creative writing makes for a fun, change-of-pace lesson when learning computer terminology. Steering through Virtual Reality … Navigating the Internet … Simulation Software! These are the exciting, hands-on units that attract many students to computer application courses. Equally important, but not nearly as popular, is the unit on computer hardware. To many students, pausing from engaging, interactive software lessons to discuss computer terminology can be a less-than-exciting change of pace. Through the use of this creative writing assignment, you can improve your students' understanding of computer vocabulary and inject a different kind of enthusiasm into the classroom.

Rapping About Technology

Using a minimum of 12 terms in the following list (or using others from class reading), create one of the following:

1. A Short Story

Example: Sheila and Stew **Byte** live in the big **Apple**. Describe their experiences as they ride the **Databus** from destination to destination. The **Byte** family's experiences should be based on your understanding of **hardware** components.

2. A Rap or Poem

Yo! Write a rap or poem designed to familiarize the reader with the computer terms you have studied in class.

The focus of your work should be on educating the reader about the computer or certain parts of the computer. The best projects will be those that carry a thread of technical truth throughout their work. All computer terms should be entered as bold text to contrast with the other words. If you wish to work with a partner, your final product must include a minimum of 18 terms.

Terms

80 x 86s	Intel
ALU	kilobyte
Apple	Macintosh®
binary number	magnetic tape
bit	megabyte
byte	megahertz
CD-ROM	microprocessor
clock speed	modem
compact disc	motherboard
control unit	mouse

CPU	multimedia
Databus	nibble
floppy disk	Pentium®
gigabyte	primary memory
gigahertz	pulse
GUI	RAM
hard disk	ROM
hardware	secondary memory
IBM	software
icon	window

Student Samples

The student work on the top of the next page will provide you and your students with a model for the end product expected in this assignment.

Guidelines

A good time to introduce this assignment is after a majority of the vocabulary has been covered through assigned reading, class discussion, and demonstration. When explaining the assignment, it is very important to stress the requirement of connecting vocabulary in meaningful ways. The assignment is about more than rhyming neat-sounding words and acronyms. The writing should communicate technical truths. Otherwise, students will create very nice-sounding poems that make very little sense. A pleasant surprise always surfaces when students use computer vocabulary that has not been introduced in class.

Critical to the success of this lesson is providing students with an opportunity to rework their first draft. It's best to collect initial drafts and then write comments questioning terms that are presented in a weak context. Valuable learning takes place as students search for vocabulary that properly relates to other vocabulary. This can also be accomplished through peer-to-peer review.

Once students have settled on a final draft, there will be no problem getting volunteers to step in front of the class to perform their techno-raps. In fact, a number of my students have insisted on bringing in their tape players so that they can perform to the correct beat! In addition to providing a fun way for students to review, this assignment is an opportunity for those students who excel in writing to display their creative talent. If time permits, turn the students loose to desktop publish their masterpieces. The publications make for a great way to dress up the computer lab. ❑

Tom Kendall
Isidore Newman School
New Orleans, LA

Joe's Poem

The Many Parts of the Computer

Listen, dear computer novice and listen well,
To the helpful information I am about to tell.
A **Bit** is a **Binary Digit**, not great in might,
Eight, however, equal exactly one **Byte**.

The **CPU** is the computer's brain made by a
    company **Intel**,
It can do huge programs and graphics, yet
    is very small as well.
The **Databus** is the path information takes
    on its way to the CPU,
Databus, that's an odd name, I think
    it's quite funny, don't you?

RAM is temporary memory, necessary
    for the computer to go,
If, dear novice, you turn the PC off: poof—
    RAM follows the dodo!
ROM, now that's different, volatile it is not,
Turn RAM off and it's gone,
    but turn ROM off and ROM you've still got! ▫

Joe Galiastro
St. Peter's Prep

Rapping With Patrick

The Computer Rap!

What's this I see before my eyes,
It's a **Keyboard,** and **Monitor**,
    but there's more inside!
There's a **CPU** small but large
    because it's in charge,
But that's not all there is on the **Mother** barge!
We have **ROM** and **RAM** so now we can really jam,
having these in a box can make you the man.
We gotta have a way to get around I trust,
that's when I like to hop on the **Databus**
I have **Disks**, big, small, **Floppy** and **Hard**,
I can hear things now with my new **Sound Card**.
I'll lay it to you straight there's **IBM** and **Apple**,
for many years they've been in a grapple.
A **Gigahertz** is a mighty fast **Clock Speed**
with this, your **Databus** traffic will not impede,
so that's it. I have explained a lot,
so make your way to the electronics shops.
Remember to get the things I explained to you,
If you want a computer that can get a clue! ▫
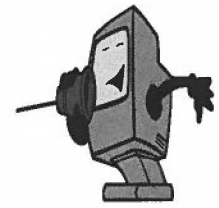
Patrick Beahm
Isidore Newman School

Stories From Behind the Scenes

Have you ever really thought about how the computer you use actually came into existence? Are you aware that regardless of the amazing things one can accomplish using a computer, the human mind is even more amazing? If you, like many other people, wonder how the technology evolved to its present state and what kind of people it took to not only consider such machines possible, but also to find a way to make them work and produce the development of today's computer technology, wonder no more. Stop. Take the time to do a bit of reading.

There are many writers who have taken the time to research and record the human interest stories that abound in the computer industry. The personal stories of the people who spent hours creating and using the crude computers first produced are interesting and will help you develop a new understanding of the computer you presently use. The ethics of the computer hackers may seem strange in view of our present world, but you will learn to appreciate the hacker culture.

If you are a typical computer user, you tend to view the computer world as a machine-based existence and overlook the fact that computers only exist because of people. Your perspective will change if you take the time to peruse at least one of the items mentioned in this article. The first two are considered classic references and the last two are new selections. These books will provide you with an entertaining read while teaching you the colorful background of the computer industry.

The Soul of a New Machine (1981)

Tracy Kidder
New York
*Avon Books*
Reissued in 1990

Tracy Kidder was awarded the 1982 Pulitzer Prize for this phenomenal book. Kidder's book is easy and fun to read—a story you can enjoy regardless of your computer background. In addition, the book provides some insights into how a computer works and the technology required to actually create one. The group of people discussed in this story were challenged to produce a machine more complex than had ever existed and to do it in an extremely short time. Even without these pressures, the task they undertook was

enormous. The book provides a glimpse into the lives of these people. You will gain not only some appreciation of the job of the computer engineer, but also some understanding of the people who devote countless hours to making the perfect machine and the ultimate system.

Hackers—Heroes of the Computer Revolution (1984)
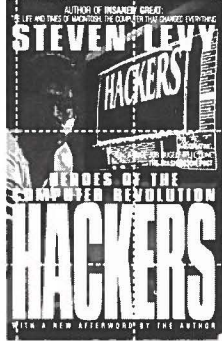
Steven Levy
New York: Dell Publishing
Afterword 1994

Levy has provided an in-depth look into the psyche and lives of the people who have pushed computer technology from the huge monoliths behind locked doors to the development of the desktop computers of the early 1980s. Levy shares the insights from three distinct eras. Part One is titled *The True Hackers—The Fifties and Sixties*. This section provides stories from behind the scenes in university settings, such as the Massachusetts Institute of Technology (MIT) labs in Cambridge. Part Two, *Hardware Hackers of Northern California*, relates stories that focus on the desperate efforts people were making to put together a computer system that could accomplish more and more. With computer parts scarce or nonexistent, the stories of these people report on innovative and creative hardware hacking. Part Three is titled *Game Hackers—The Sierras of the Eighties*. Today's games may have a totally new look and feel, but they definitely have their origins in the original programming and designs being done during the eighties.

Twentieth Anniversary Special Issue

*BYTE*
September 1995
Phone: 603-924-2550

This special issue gathers, in abbreviated form, many of the stories that are classics to people familiar with the computer industry. The editors have created many lists, including the 20 most important people, notorious bugs, 20 spectacular failures, noted and notorious hacker feats, and the most important companies. Other lists include a look at the top 20 small systems, the top 20 software products, the most important chips, the most important networking products, and the best things online. For any reader at the beginning level of the journey into the computer world, these lists are a great place to begin researching the color and interest behind the development of the computer industry. The lists are relatively short, but the items have been well chosen and will provide you with a great starting place.

You can visit the BYTE home page on the Web at http://www.byte.com.

The Microprocessor—A Biography (1995)
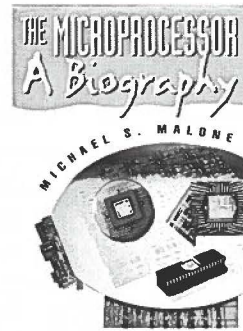
Michael Malone
Santa Clara, CA
Springer-Verlag Publishers

Today's integrated circuitry is incredible considering the short time since the concept was introduced. As recent as 1970, Intel Corporation was testing the *4000 Family* of chips. Changes in speed and in power continue to occur at an unbelievable and dramatic speed.

Malone has chosen to start his story with the earliest microprocessors when companies risked their very existence to produce an unproven technology. He shares many names and stories of companies that are continuing to make their mark in the computer industry. Finally, Malone makes an attempt to look into the future to see where new research and development may be taking the computer industry.

The book is written in an effort to share the impact and marvels of the microprocessor to anyone that might be interested. The author clearly understands that most readers will not deal well with text consisting of highly technical description. Malone provides an interesting account, not only of the development of the microprocessor, but also of the business world that has grown along with the technology. There is a tremendous amount of information between the covers of this well-written and entertaining book. ❏

Irene E. Smith

Think BIG

Some people view the idea of learning about computer hardware as a **BIG** challenge. However, the staff of The Computer Museum in Boston, MA, thinks of **BIG** in a different context. To help the first group with its challenge, The Computer Museum is displaying a **BIG** multimedia computer system. In this instance, the term **BIG** applies to the amount of *fun,* the amount of *learning*, and the hardware *size* available to you and your students if you visit this exhibit.

The Computer Museum's exhibit, The Walk-Through Computer® 2000, is a huge working model of a computer. It's the size of a two-story house and comes complete with all the latest technology found on the machines available in your local computer store. The computer is complete with a high-speed Pentium® processor, multimedia boards, CD-ROM drive, and network connections—all at 50 times scale.

The Walk-Through Computer 2000 provides visitors the opportunity to try some of the same tasks they can do on their computers at home. For instance, you might want to stop at the 8-foot CD-ROM player and write a message onto coaster-sized pits in the 6-foot disc. The message can be read by the laser. Or, since the computer is able to display your picture on the screen, you might want to stop and manipulate the image. You can soon discover how easily a computer allows you to distort a digital picture. Sound? Sure, just use the ceiling-high audio card to enhance or distort the sound of your voice to help you understand how computers store and manipulate sounds. However, the car-sized mouse and the 20-foot long keyboard are hardly comparable to the input devices normally available to computer users.

Photo Credit: Fayfoto / John Rich

Unlike the desktop computers at home, The Walk-Through Computer 2000 provides visitors with a way to walk inside the computer itself. By stepping through the entrance to the computer's giant chassis, visitors find themselves surrounded by circuit boards loaded with suitcase-sized chips. The buslines on the motherboard floor lead the visitor toward the huge microprocessor that functions as the heart of the system. Viewing the microprocessor from this perspective reinforces the idea that a chip looks like a very huge city viewed from an airplane.

Photo Credit: Intel Corporation

The Walk-Through Computer 2000 is an upgrade to the previous walk-through machine and took 18 months to complete. This exhibit involved the creative and technical expertise and support of more than 60 people from 14 different corporations around the world. The two principal sponsors of this project are Cirrus Logic, Inc. and Intel Corporation.

For further information on The Walk-Through Computer 2000, feel free to contact The Computer Museum at 617-426-2800. In addition, you might enjoy a visit to The Computer Museum's World Wide Web site—http://www.tcm.org. □

Additional Travel Guides From ISTE

As your tour guide, I hear a lot of questions about travel. What else can I share with students? We've had fun with all the lessons, but how do we learn more about computer history? The travel agents working to ensure you enjoy *The Journey Inside* are pleased to announce some special excursions at reasonable prices. Read about several trips waiting for your enjoyment.

The History of Computers by Les Freed

The ENIAC became 50 years old in 1996. Use this fun history presentation done with graphics and text to give you and your students a glimpse into the past. Understand and enjoy the incredible world of technology that was born along with the ENIAC.

Computers Illustrated by Nat Gertler

You and your students will enjoy a slow page-by-page journey through an incredible book that helps you to see inside your computer equipment. Using this book alongside the real thing makes the terminology easier to remember and the concepts easier to understand. A great trip to take with a group or by yourself.

20th Century Computers and How They Worked by Jennifer Flynn

This quick trip into the future is a Star Trek adventure that provides a unique perspective on the primitive technology of the 1990s. A must for the seasoned traveler. This tour provides an in-depth understanding of our present technology and is a lot of fun. Enjoy. ▫

Irene E. Smith, PhD
Workshop Tour Guide

Travel agents are standing by ISTE's phones to complete your reservation. Dial 1-800-336-5191 and reserve the excursion of your choice. For other travel options, ask for ISTE's free Resource Guide.

International Society for Technology in Education
Administrative Office
1787 Agate Street, Eugene, OR 97403-1923 USA