Summer 1996
Volume 2 • Issue 3

THE JOURNEY INSIDE

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

World's Biggest Traveling Museum

In celebration of its 150th anniversary in 1996, the Smithsonian Institution has created "America's Smithsonian," a traveling exhibition that will bring more than 300 of its most noted treasures to 12 cities throughout the country.

Artifacts in the exhibition include an Apollo space capsule, Judy Garland's ruby slippers from the *Wizard of Oz*, Lewis and Clark's compass, a Wright brothers' plane, Mohammed Ali's boxing gloves, an early Edison light bulb, various fossils, and a meteorite from Mars. An estimated 10 million people will visit "America's Smithsonian," which at 50,000 square feet is the largest traveling museum exhibition ever assembled.

As one of a handful of corporate sponsors, Intel—which is also celebrating the 25th anniversary of the microprocessor—will have its own 3,000-square-foot exhibit on the tour. The Intel exhibit resembles a larger-than-life computer (shown below), including a giant keyboard and 12-foot-tall monitor next to a coffee cup the size of a hot tub.

Visitors can learn how the invention of the microprocessor made PCs accessible to millions. They can also see demonstrations of how PCs are changing the world with video conferencing, interactive entertainment, virtual reality, and other technology. Visitors can also visit the World Wide Web, experience the interactive PC of tomorrow, and explore new educational software.

Intel's Web site (described on the next page) also includes some special information celebrating the history of the microprocessor.

In addition to financial support, Intel provided Pentium® processor-based systems to design the touring exhibition and Pentium Pro processor-based systems to create the tour's promotional poster and the World Wide Web site for the 150th anniversary celebration.

"America's Smithsonian" began its tour in Los Angeles, California, in February. Other stops include Kansas City, Missouri; New York, New York; Providence, Rhode Island; Houston and Dallas, Texas; Portland, Oregon; San Jose, California; and Chicago, Illinois. Additional cities will be announced at a later date. For ticket information, call 800-913-TOUR. For more information on the Smithsonian and its anniversary, visit **http://www.si.edu**. ▫

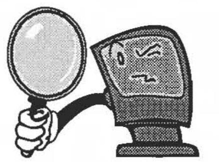
Adapted from Intel Leads Quarterly Q1 '96

Inside This Issue

A joint publication of Intel Corporation and the International Society for Technology in Education (ISTE).

An Invitation

Visit Intel in cyberspace at **http:// www.intel.com** as one stop on the web. The Intel Web site has a cool new look with a special place reserved for educators. Find *The Teacher's Corner* by pointing your Web browser to **http:// pentium.intel.com/procs/homepc/index.htm**. At the moment, you will find information relating to *The Journey Inside: The Computer*. However, we are in the process of changing and updating the entire site. Our additions will include extension activities for *The Journey Inside: The Computer*, newsgroup discussions, information on high-tech careers, and other special projects. Drop in once in a while to check out the progress. You are welcome anytime.



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

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Please note: As of November 1, 1995, ISTE's area code changed from 503 to 541.

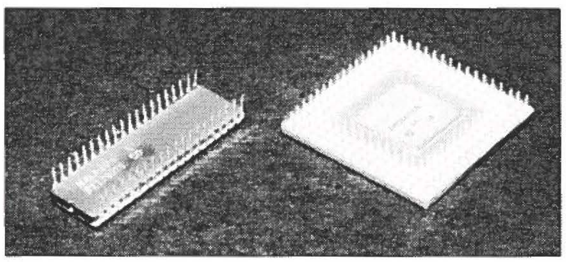
Questions and Answers

Q: Is there a special term used to refer to the sample microprocessor package—the black ceramic component—found in our chip kits?

A: This particular arrangement is referred to as *Pin Grid Array* (PGA) packaging. Since it is possible to place many pins into this arrangement, the packaging is ideal for the powerful microprocessors used today.

In your computer, other chips may be packaged differently. Less sophisticated packaging uses the *Dual In-Line Package* (DIP) format. Usually rectangular, this type of package provides a very limited pin count.

In the following photo, the item on the left is the DIP, which contains an 8088 Intel chip (an early version of a microprocessor). The other item is the PGA package, which contains an Intel 386™ chip.



Q: What does the term *scribed die* mean?

A: The term *die* is used interchangeably with the term *computer chip*. Many chips are created at once on the surface of the wafer. Each chip has to be cut from the wafer before packaging. The chip, after it has been removed from the wafer, can be referred to as a *scribed die*.

Q: Why are the wafers limited to an 8-inch diameter? Couldn't one create more chips on a larger wafer?

A: At the moment, the existing fabrication rooms are built with the equipment to produce a wafer that has a maximum diameter of 8 inches. However, manufacturers are predicting that by the year 2000, a wafer almost 12 inches in diameter will be available—almost 2.18 times the surface area of the present 8-inch wafer.

A recent item in the *Wall Street Journal* indicates that the consortium Sematech comprised of U.S. semiconductor and equipment manufacturers is working to perfect a wafer that will be 300 millimeters across (about 11.81 inches). However, this new design would need new machinery, new materials, and new ways to create the chips. The changeover would cost somewhere between $10 billion and $16 billion over the next few years.

Q: Do the transistors in the chips ever wear out or break, and **if they do**, how long does this take to happen?

A: The answer to your question is rather complex and involves lots of statistics. So, to keep it simple, transistors, by their very nature, have an extremely low failure rate and a very long life. Transistors have no moving parts. Other parts in the computer with mechanical subsystems, like floppy drives, hard-disk drives, and CD-ROMs, have much higher failure rates (several orders of magnitude greater) as compared to the circuits and transistors found in the chips. Transistors can stop working, but it is usually due to factors such as moisture, excessive voltage/current applied, and static electricity.

Malone's *The Microprocessor—A Biography* (see *The Journey Inside*, Volume 2, Issue 2) provides the following information:

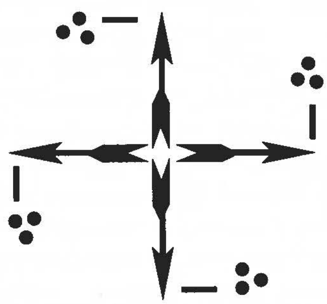
> The microprocessor, with its semiconductor brethren, is the most reliable manufactured product in human history. With no moving parts, its form as pure and strong as a crystal, and packaged in a nearly-unbreakable case, the microprocessor is built to last. It is possible that at least a few of the microprocessors built today will still be around a thousand years from now—and, except for a few defects caused by cosmic rays and other stray radiation, they will still work. (p. 83)

Q: I was told that the size of the Intel Pentium™ microprocessor made today is much smaller in size than the first version of the Pentium. How is this possible if the number of transistors on the Pentium chip is still 3.1 million?

A: The number of transistors on the Pentium chip has not changed from 3.1 million and, yes, the surface area of the chip is about one quarter of the original chip's surface area. This has been achieved by reducing the width of the connections between the transistors. The chip's first version used a circuit trace width of 0.8 microns. Today's Pentium chip is manufactured with a trace width of 0.35 microns. In the future, circuit traces may become even smaller. ❑

Number Systems

The use of numbers to count items has evolved over the years from a system of indicating "one or many" to today's base 10 or decimal system with many variations in between. For example, the following illustration shows how Pueblo Indians used their arrows, rocks, and sticks to represent numerical value.[1]



Each arrow has a value of 1.
Each stick has a value of 1.
Each rock has a value of 1.

The placement of the four arrows is considered powerful magic and adds a value of 1.

Total value is 21.

Many numerical representations evolved until numerical values were no longer given only in physical form, such as a pile of stones, a number of fingers, or other items. Instead, they were also represented in written form. Roman numerals—I, II, III, IV, V, ...—represent one of the earliest yet long-lasting written formats. Roman numerals conveniently represent a counted value but do not lend themselves to doing calculations such as adding and multiplying. However, they are still frequently used to designate order in text material.

The decimal or Arabic system used today took many years to develop. Today, this system seems very natural and logical. It is easily written and works well for calculations. But this standard is arbitrary, to say the least. Ancient Mesopotamians developed a sophisticated system using a base of 60. Having to use 59 numerals to write their numbers was challenging, but the calculations done in their system produced easily used answers. The Sumerians' number system also used base 60 but was written with only two symbols.[2]

In Central America, the Mayans used a place-value system of base 20 with only two symbols—a dot for the value 1 and a short horizontal line for the value 5. Numbers were written in columns read from the bottom to the top.[3]

Regardless of the base selected or the choice of symbols, for a number system to be useful it needs special qualities. The symbols need to be easy to remember and produce. They also need to be clear and easy to read. Since using the symbols in calculations is equally important to representing values, the system should provide flexible options in producing answers.

While counting on our fingers works for simple tasks, people continue to create devices to help them with more complex jobs. The Chinese abacus (developed about 5,000 years ago), Napier's bones (17th century), Pascal's Pascaline calculator (1642), Leibniz's wheel (1673), Babbage's Difference Engine (1832), and the ENIAC (1946)[4] have all been useful devices. However, their value pales when compared to today's computers. Using a number system of only two symbols—binary—to represent and manipulate digital data, the computer has almost no limitations in manipulating and processing numerical data. ❑

1 Bergamini, D. *Mathematics.* Life Science Library.

2 Ronan, C. (Ed.) *Science Explained.* Holt Publishing.

3 Ibid., 4 Ibid.

Project Lesson Plans

The following lesson plans are adapted from materials in Joan Montgomery's book *Math Excursions.* You may want to consult this resource for complete details before you attempt this project. This set of lessons helps students investigate the base 10 number system, work with a number system in a different base, and create a booklet illustrating this new system.

Grade Level

Grades 6–8

Time Required

Minimum of eight teaching periods

Objectives

- Students will extend their knowledge of the base 10 number system by creating a symbol system for some other base.
- Students will create a booklet containing their symbols, an illustration of counting, a place-value chart, samples of small and large numbers, an addition table, a multiplication table, and sample problems.

- Students will become more familiar with terms such as base systems, place-value, numerals, powers, and exponents.

Activities and Procedures

Day 1—Symbols and Counting Chart

1. Discuss symbols in a number system, the connection between symbols and base used, and the need to keep symbols simple.
2. Students select a base system and create their own symbols.
3. Students create the name of their system.
4. Students create a chart illustrating the symbols.
5. Students create a counting chart. Have students work from expanded form so that 245 is thought of as 2(100) + 4(10) + 5(1) and similarly in their own system.

Day 2—Place-Value Charts

1. Discuss place-value in base 10 system.
2. Discuss place-value in base 4 system.
3. You may want students to use calculators.
4. Have students make their place-value charts to 10 places.

Days 3 & 4—Writing Numbers

1. Illustrate from base 10 number system and review expanded notation.
2. Students write a one-digit number, a two-digit number, ..., a 10-digit number in their own system, showing expanded and short forms.
3. Students convert base 10 numbers into their own system and vice-versa. (Be patient—this takes considerable time and effort.)

Day 5—Addition and Multiplication Charts

1. Students make an addition table and a multiplication table in their system after the teacher demonstrates the steps.

Days 6 & 7—Sample Addition, Subtraction, and Multiplication

1. Illustrate each step before having students attempt it.
2. Students create four to six addition problems that include carrying of values.
3. Students create four to six subtraction problems that involve borrowing.
4. Students create several multiplication problems.

Day 8—Assembling the Project

1. Students create a booklet cover.
2. Students make a table of contents.
3. Students assemble all the pages.

Follow-Up Activities

From *The Journey Inside: The Computer*

1. Show video segments 2 & 3.
2. Unit 3: Introductory Level lessons and activities.
3. Unit 3: Intermediate Level lessons and activities. ❑

Project—Student Samples

The students in Monica Bergman's class in Everett, Washington, report that they have had a great time learning about number systems. Each student produced their own number system using the previous lesson plans.

Monica Bergman's class.

The following comments and sample project items were selected from the projects submitted by four students in Monica Bergman's class. The pieces together create a model project resulting from these lessons.

Gracielle's Introduction

The whole purpose of this project was to build a better understanding of how number systems work. In this project I created my own number system. I had to make up my own numbers, come up with a base, and I had to switch my thinking from the usual number system to mine. It was a challenging project, but it helped me understand how number systems work. It's a different way for me to be taught math, but it was still really interesting.

Gracielle Loree

Matthew's Introduction

Hi, my name is Matthew Ogurkow. This project is about making my own number system. Just like the number system based on 10, mine is based on 5 using my own symbols. For every place you move over there is greater value. Since mine is based on 5, every place you move over is 5 times greater value from the original place, just like ours is 10 times the greater value from the original place. After you have read this project you will know how to count, add, subtract, multiply, and write numbers in my system. There is even an addition chart, multiplication chart, and place-value chart to help you. I am doing this project in Mrs. Bergman's advanced sixth-grade math class because we have been studying number systems all over the globe. I hope you find this project interesting and enjoyable.

Matthew Ogurkow

The DP System Project

Day 8—Table of Contents

David Peterson

Matelonian System—Base 5

Day 1—Symbols Chart

0	1	2	3	4
◆	■	✱	✔	▲

Day 1—Counting Chart

0	◆	10	✱◆	20	▲◆
1	■	11	✱■	21	▲■
2	✱	12	✱✱	22	▲✱
3	✔	13	✱✔	23	▲✔
4	▲	14	✱▲	24	▲▲
5	■◆	15	✔◆	25	■◆◆
6	■■	16	✔■	26	■◆■
7	■✱	17	✔✱	27	■◆✱
8	■✔	18	✔✔	28	■◆✔
9	■▲	19	✔▲	29	■◆▲

Matthew Ogurkow

DP System—Base 7

Day 1—Symbols Chart

0	1	2	3	4	5	6

Day 2—Place-Value Chart

7^0 = 1's 7^1 = 7's 7^2 = 49's
7^3 = 343's 7^4 = 2401's 7^5 = 16807's
7^6 = 117649's 7^7 = 823543's …

Days 3 & 4—DP Number Examples

96 = 1(49) + 6(7) + 6(1) = 

146 = 2(49) + 6(7) + 6(1) = 

540 = 1(343) + 4(49) + 0(7) + 1(1) = 

David Peterson

Lorian System—Base 5

Day 1—Symbols Chart

0	1	2	3	4
☹	🌢	♈	⌖	❖

Day 5—Addition Chart

+	☹	🌢	♈	⌖	❖
☹	☹	🌢	♈	⌖	❖
🌢	🌢	♈	⌖	❖	☹🌢
♈	♈	⌖	❖	☹🌢	🌢🌢
⌖	⌖	❖	☹🌢	🌢🌢	🌢♈
❖	❖	☹🌢	🌢🌢	🌢♈	🌢⌖

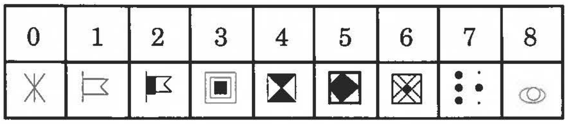
Day 5—Multiplication Chart

x	☹	🌢	♈	⌖	❖
☹	☹	☹	☹	☹	☹
🌢	☹	🌢	♈	⌖	❖
♈	☹	♈	❖	🌢🌢	🌢⌖
⌖	☹	⌖	🌢🌢	🌢❖	♈♈
❖	☹	❖	🌢♈	♈♈	⌖🌢

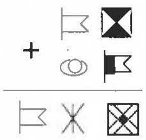
Gracielle Loree

EyeWay System—Base 9

Day 1—Symbols Chart

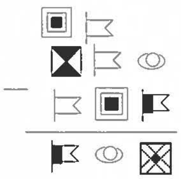


Days 6 & 7—Addition Example



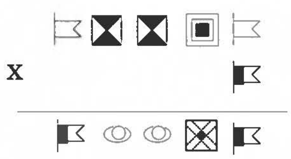
$$\begin{array}{r} 14 \\ +\ 82 \\ \hline 106 \end{array}$$

Days 6 & 7—Subtraction Example



$$\begin{array}{r} {}^{3}{}^{1}\!\not{4}18 \\ -\ 132 \\ \hline 286 \end{array}$$

Days 6 & 7—Multiplication Example



$$\begin{array}{r} 14431 \\ \times\ 2 \\ \hline 28862 \end{array}$$

Kelleigh Kappel

The student contributors show their projects.

Summary

In Mrs. Bergman's sixth-grade advanced math class, the students spent the first quarter of the 1995–96 school year learning about a variety of cultural and historical numerical systems.

One of the numerical systems they studied was the binary system. When they realized how interesting the binary system and its relationship to computers was, they stopped to investigate further. As part of their investigation, they watched three short videos, studied charts, learned about graphing, and investigated the way computers process numbers and letters using the binary system.

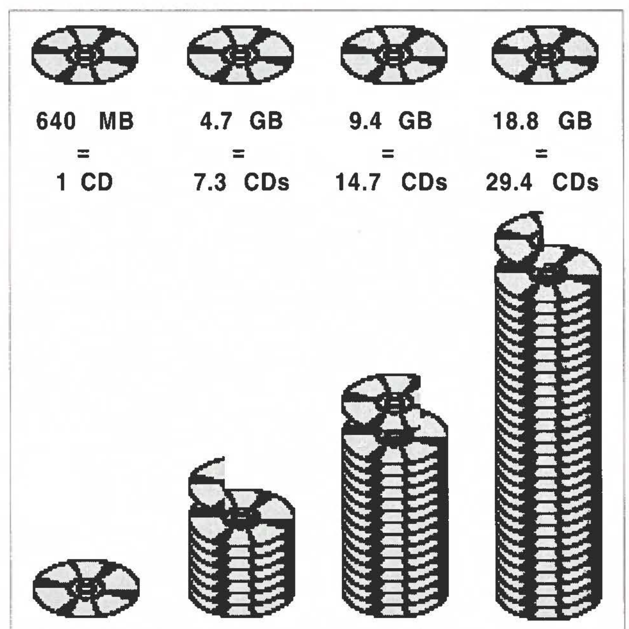
After studying these exciting numerical systems, the students decided to create their own numerical systems. They had a lot of fun, and enjoyed the challenges of the exercise involved in creating and proving their systems. When this class looks back, they will remember that learning can be fun. ❑

Kelleigh Kappel

Unit 3—Storage Capacity

In Unit 3, the activities include a look at storage capacity devices. In *The Journey Inside* (Volume 1, Issue 4), a graphic was included to show your students common storage capacities.

Recently, an agreement was reached for high-capacity, low-cost digital media standards called DVD (digital videodisc). This new standard provides huge changes in storage capacity. The present CD-ROM standard holds about 640 MB of data. In the first version of DVD, the storage capacity jumps to 4.7 GB (Yes, really!) using the same single-sided, single-layered disc already being used. The standard provides for double-layered discs holding 9.4 GB and a double-sided, double-layered disc holding 18.8 GB—almost 30 times the capacity of today's CD-ROMs.



DVD drives will be available in late 1996 and will still handle today's CD-ROMs and audio CDs—at 6x speed. As your students research storage capacity concepts in Unit 3 Advanced Level, give them a glimpse into an astounding "just-around-the-corner" storage solution. ❑

Irene E. Smith

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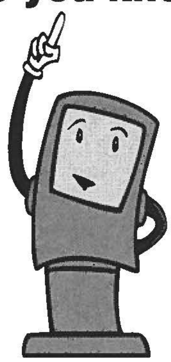
Expand your travels by purchasing the ultimate tour!

Do you know

How much the ENIAC weighed?

How to build an abacus?

The name of the first known computer game?



The major difference between RAM and ROM?

What the insert key does?

What film the lovable robot R2D2 starred in?

The Ultimate Collection of Computer Facts and Fun
by Cindra Tison and Mary Jo Woodside

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