The Journey Inside

A Newsletter of Classroom Ideas and Hardware Information

Inside This Issue

●intel.

Printers: Inkjets and Lasers

Our desktop computers have increased our ability to create documents that communicate our messages effectively to others. As our communication skills increase, both in terms of design of the document and in terms of making better use of the technology we have, each of us gains control over the quality of what we publish. Paper output is still a valuable commodity; a quote from the future by Captain Jean-Luc Picard of the U.S.S. Enterprise reminds us that, "There is still something romantically compelling about the crispness, the creamy texture of paper, that simply cannot be found in the cold touch of a personal access display device." When the final document is to be shared in print format, knowing something about how a printer actually works may help us to avoid problems.

Many educators have access to either an inkjet printer or a laser printer. These two types of printers are very different in their approach to producing a final image. Each kind of printer has its own strengths and weaknesses to offer to the overall printing process.
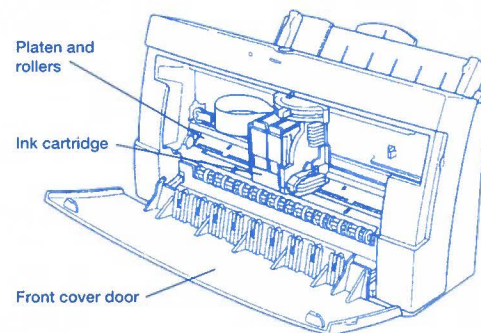
Color Inkjet Printers

A color inkjet printer has an ink-filled print cartridge attached to the print head. The print head moves sideways across the width of the paper being fed through the printer. Some printers use two cartridges to produce the colors; others have the four colors—cyan (blue), magenta (red), yellow, black—in one cartridge.

The print head itself contains four separate cartridges made up of small ink-filled chambers. Each chamber is attached to an extremely small nozzle. An electrical pulse moves through the thin resistors placed at the bottom of these chambers. The chambers receiving the electrical pulse are determined by the character being sent to the printer. This electrical pulse is sufficient to momentarily heat a thin layer of ink at the bottom of the chamber to 900° F. The ink boils and forms a bubble of vaporized ink that expands and pushes ink through the nozzle to produce an extremely small droplet of ink at the nozzle's tip.

When the droplet falls onto the paper, part of the character is formed. The volume of the ejected ink is about 1 millionth that of a drop of water from a typical eyedropper. Many such droplets are used to form each character being printed. The ink in the chamber stays warm for a very short time. When the resistor cools, the bubble

Platen and rollers
Ink cartridge
Front cover door

collapses and a slight suction results. This suction helps the printer pull fresh ink from the attached reservoir to be used in the next printing.

Since inkjet printers rely on very small openings, keeping the cartridges clean will help maintain trouble-free printing. In addition, if an inkjet printer is used infrequently, removing the cartridge and storing it in an airtight container helps. Because the print-head moves sideways, make sure that the cable attached to the

Questions & Answers

Q Why are the chips created on a round wafer rather than a square wafer? Wouldn't there be less waste if the wafer was square?

A Indeed a square wafer would have advantages. The surface area would be well-suited to producing chips that are rectangular in shape. However, the answer to your question is found by considering the process used to produce the wafer. The wafer is a very thin slice of material cut from a silicon ingot. This silicon ingot is created by forcing a silicon *crystal* to form. A seed crystal is used to begin the growth that is continued with hot, molten silicon. The shape of such silicon crystals are not rectangular. Having all the chips fabricated across a single crystal structure decreases the possibility of chips being ruined because of a flaw in the base silicon structure. So, while the round shape does have disadvantages, the advantage of using a slice of silicon crystal outweighs the disadvantage of the crystal's shape.

Q I installed a new program on my Macintosh Performa* and I keep getting a message telling me there is *not enough memory to run the application*. I have 24 MB of RAM and don't get the message from my other applications. Do I need to install more memory on my computer?

A This common problem *looks* like it can be solved by adding memory. However, by adjusting the way the hardware is configured to handle the software, your problem should disappear. The message is actually telling you that the application does not have enough memory space to work in— not that your computer doesn't have enough memory. You need to increase the amount of space that the application is allowed to use.

Make sure you have the *Finder* menu showing on your screen. Open the folder where you have the application stored so the application icon is visible. Do not launch or open the application. Instead, click once on the application icon to highlight it. Use *Command-I* or select *Get Info* under the *File* menu found in the *Finder* menu.

On my computer, these steps produced the following window from the *ClarisWorks 4.0** application icon.
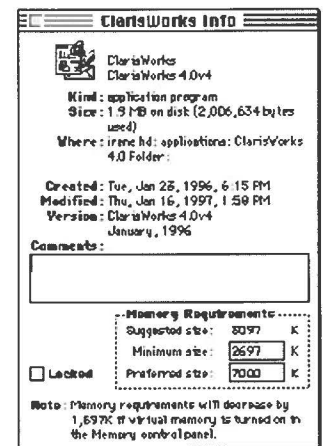
At the lower-right corner of this window, you see three numbers giving suggested size, minimum size, and preferred size. The numbers appearing in the last two boxes can be changed. Increase the amount given to the preferred size and your application should operate just fine.

If you are using a computer using Windows* as your operating system, the memory allocation for applications is handled differently. Programs can access different areas of memory and often start with a Base Memory area that is only 640K. Software written specifically for the Windows system will automatically use high memory and make memory adjustments for you. If you move from the Windows system to a DOS-based program, you may find you have a problem. Programs written for the DOS operating system do not automatically have the ability to switch memory allocation. Check your manuals for details in changing your configuration.

head is not tangled or accidentally blocked. Your inkjet printer may have different settings for printing on regular paper or thick paper such as envelopes. Be sure to select the correct setting so the ink cartridge can be placed in the correct position relative to the paper. If you use one color much more than others, finding a printer that uses separate cartridges for each color is a tremendous advantage.

Laser Printers

A laser printer produces a crisp image by having the print engine—the mechanism that transfers a black powder to the page—respond to its own on-board microprocessor instructions. A laser printer requires that the microprocessor turn on and off a beam of light from a laser to provide the needed instructions as to where the characters will be placed on the page. To produce images on the page, a laser printer works from one end of the page to the other, printing across the width of the page, moving about 1/300th of an inch or less, and again printing across the page. This means that until the cylinder has been rotated enough times for the laser to complete the charac-

ters in the line, a mishap could leave you with partial characters across an entire line of text.

A spinning mirror deflects the light beam onto the surface of a moving cylinder called a *drum*. As the paper is fed into the printer, the paper is pulled past an electrically charged wire that places a static electrical charge on the surface of the paper. When the beam from the laser strikes the drum, the surface of the drum is electrically charged at the point where the laser beam strikes the surface. In this manner, the pattern that makes up the characters being printed is placed on the drum as an electrical charge that matches the charge on the paper. As the drum passes the bin containing the toner or black powder, this electrical charge attracts toner to the charged areas to form the same pattern on the drum with toner dots. When the paper comes into contact with the drum where the toner is placed, the charge on the paper is strong enough to pull the toner pattern from the drum and onto the paper itself. A roller contacts the drum and removes the static charge so that the drum can continue to receive pattern information from the computer for the next line of characters.

If the print process stopped there, you would have a great deal of trouble keeping your characters on the page. The toner must be fused to the surface of the page to gain any permanence. The fusing system combines pressure and heat to bind the toner permanently to the paper by melting the wax part of the toner.

A laser printer is very reliable and can print many pages without error. Most of the problems you encounter when printing with a laser printer will originate in the file itself or from software difficulties rather than printer failure. Technicians recommend that you keep a laser printer on a regular cleaning schedule to ensure that its service is uninterrupted. Near the drum you will locate the corona wire—the wire that is used to remove the electrical charge holding the character patterns. If you see a page with unprinted portions, this wire may be coated with some dry toner that needs to be removed. Clean the wire with a small amount of isopropyl alcohol. When installing a new toner cartridge, you may want to replace the fuser wand located on top of the fuser rollers. If your page shows unwanted lines or stains at the top, a clean fuser wand may solve the problem. When a toner cartridge first seems empty, gently shaking the cartridge from side to side will move the residue powder into a position where it can be used. As you change cartridges, be careful to not let any toner spill into the innards of the printer. The black toner powder is quite abrasive and can cause unwanted wear on the printer gears or scratch the surface of the drum. ✪

—Dr. Irene E. Smith
ISTE

Mirror
Laser
Toner
Printer
Circuit Board
Paper
Drum
Fuser
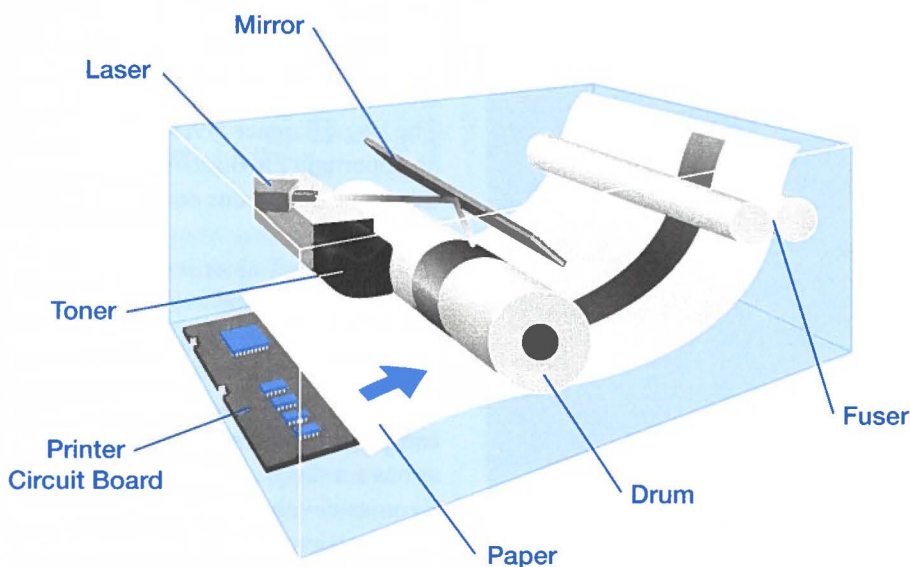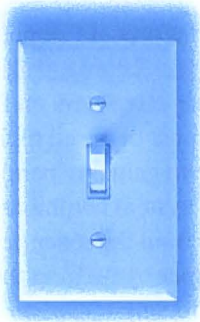
Using Switches to Make Decisions

Unit 4 of *The Journey Inside: The Computer* includes an introduction to the concepts of electricity. However, the activities are limited to a very basic level. Many teachers have been adding to the unit by creating some interesting activities.

The following article was contributed by Len Wieczorek in Salem, Oregon. His students indicate they really enjoy the exercises built into Len's Logic Trainer as a way to further their understanding of how a computer is able to use electrical circuits to process information. Thanks for sharing Len.

The classroom materials distributed with *The Journey Inside* make two principles of computing machines completely clear:

- computers cannot think; they can only execute the instructions given to their central processing unit by the software, and
- microprocessors are made up of vast collections of transistors— very fast electronic switches.

After presenting these materials, the students usually still want to know how switches turning *on* and *off* can do anything that even remotely resembles the actions of a computer. Students have difficulty connecting the use of switches to the many applications of microprocessor-control discussed in unit 1. My attempts at presenting the materials in a traditional lecture mode have met with varying degrees of success.

In an attempt to improve student understanding, I have assembled the Logic Trainer shown in the photograph. The Logic Trainer uses the slide switches provided with *The Journey Inside* kit assembled to simulate an AND (switches in series) and an OR (switches in parallel) gate. (Note: The face of the trainer is covered with clear contact paper allowing the use of erasable overhead pens for multiple use.) The Logic Trainer includes two truth tables set up with spaces for students to insert a 0 or a 1 to represent the switch being off or on. I cover the truth tables with a clear plastic sheet so that I can easily remove the work done by one student to ready the Logic Trainer for the next person to use.

The arrangement allows me to demonstrate the central functioning of a computer to students who are not intimate with or trained in computer architecture and to tie together the two ideas presented in the first paragraph. The Logic Trainer allows the students to discover for themselves that simple collections of switches can indeed *act* intelligently. This outcome requires that we be clever in how we set up the switches (transistors, hardware) and that we control our input (software) to these switches. The Logic Trainer gives the students an opportunity to discover and observe this using conditions controlled by the teacher.

The Logic Trainer is flexible enough to allow the teacher to choose creative accompanying scenarios that are consistent with the personality and skill level of the class. The scenarios can range from simple "what if" situations for the younger students to rigorous development of digital logic and Boolean algebra for the better prepared, secondary student.

As an example of using the Logic Trainer with younger students, I made
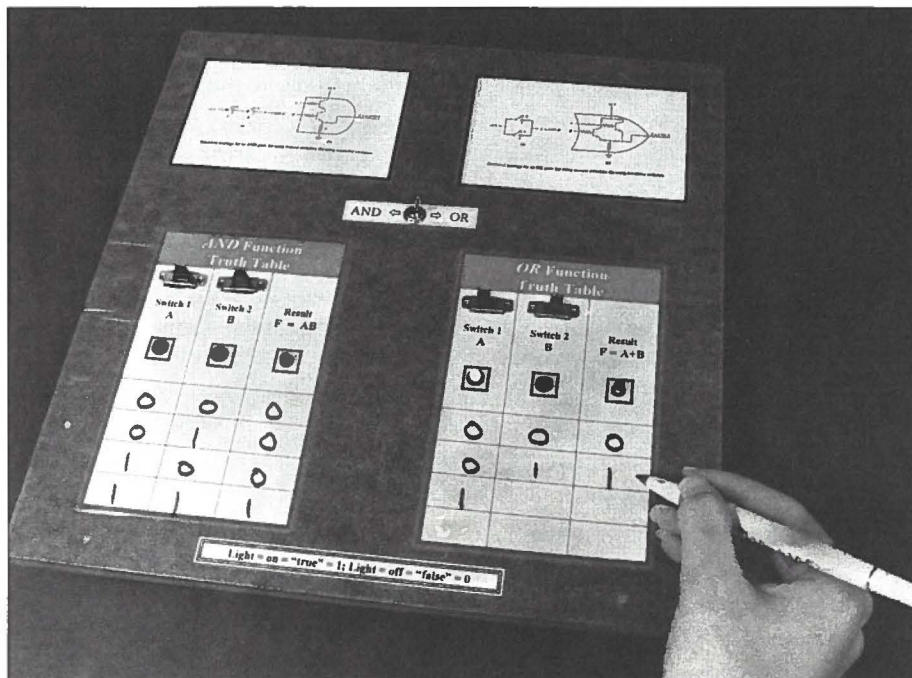
One of Len's students is busy calculating the truth on the Logic Trainer.

Logic Trainer

Circuit schematic and materials list. This can be used as a photocopy page.
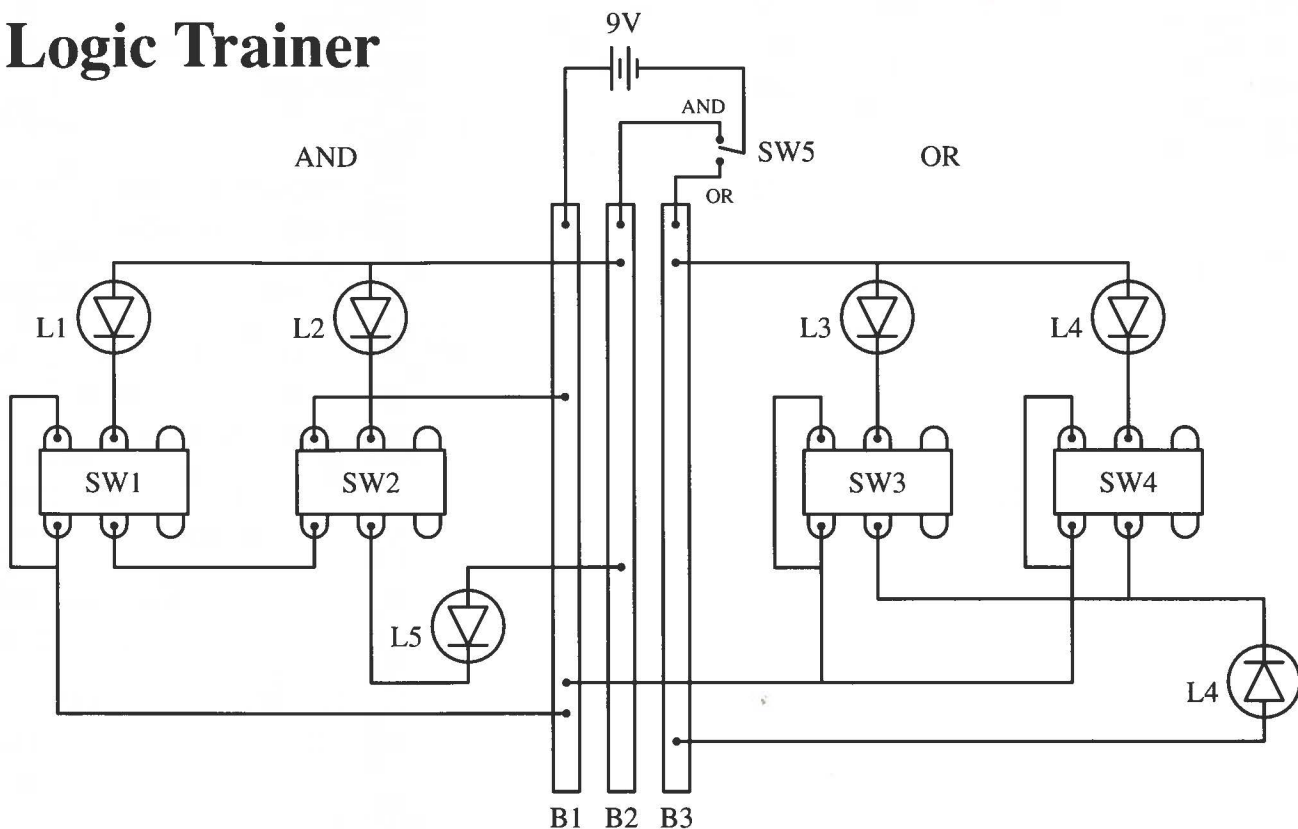
List of Materials

a. Circuit
   L1, L2, L3, L4: red LEDs
   L5, L6: blinking red LEDs
   SW1, SW2, SW3, SW4: slide switches
   SW5: toggle switch (or slide)
   9V battery clip
      B1, B2, B3: heavy gauge copper
      wire bus (optional)

b. Module
   Templates
   2 pieces masonite: about 30 cm by 30 cm
   clear contact paper to cover masonite
   wood to build frame
   4 sheet metal or wood screws
   wood glue

a presentation to a seventh grade class whose teacher had recently completed *The Journey Inside* material and activities. Both the AND and the OR switching circuits were presented by posing questions in an IF–THEN format. The classroom teacher presented the introductory materials and video segment to her class prior to a discussion of the many ways and places that microprocessors play major roles in the lives of everyone in a technological society. As the session approached its natural lifetime, I began asking questions about how simple switches could help us in making decisions and obtaining answers to questions. The teacher used this as the entry point to demonstrate, with the Logic Trainer, that by choosing our questions (*input*) with care we can get properly constructed arrangements of switches to respond in a predictable and intelligent manner.

The scenarios that were used try to tap into the experiential level of the students. I used situations that were familiar to all of the students. This helped them identify more strongly with the decision that was made based on the input. For example,

IF (*mom "crabby"*) **OR** (*dad "crabby"*) THEN (*stay out of sight*)

IF (*I walk the dog*) **AND** (*I take out the garbage*) THEN (*I get my allowance*)

Each of the conditions/inputs, such as *I walk the dog*, was written above the appropriate switch and the students informed that the condition was being input into the *computer* when the corresponding LED lit up—condition "true." Every attempt was made to solidify the connection between input and software in a computing machine. The students were encouraged to test all possible combinations of conditions. For example, took the garbage out, but didn't walk the dog. As they tested the combinations, they were to mark the corresponding blanks on the truth table. They were also directed to note whether or not the computer

thinks that they should be awarded their allowance and whether or not they agreed with this decision. When both inputs were correct to satisfy the question *Do I get my allowance?*, the computer notified the user by causing the output LED to light. The students easily grasped that a decision had been made, and that a machine had made that decision. No mention was made of Boolean algebra, functions, truth tables or gates.

In my grades 10–12 digital logic class, the input conditions deal with a simple home security system for the OR function. It is readily agreed by all involved that leaving either a front or back *door unlocked* renders a building *unsecured*. The OR input switches representing the input conditions are therefore labeled *SW1: front door unlocked* and *SW2: rear door unlocked;* the output LED (F = A + B) is labeled *building unsecured*. Setting either of the input switches to high (true) as indicated by the LED associated with that switch causes the output LED to light up indicating that the building is in an unsecured condition.

A traffic-control device for preventing backup of off-ramp traffic onto a freeway serves to illustrate the AND function. The two input conditions used here are: *SW1: auto waiting to enter traffic at head of off-ramp* and *SW2: auto sitting on pad at bottom of off-ramp*. With a little reflection, it can be seen that if these two conditions are true (both inputs high), then an accident is in the making if the traffic light at the head of the off-ramp does not turn green and allow the off-ramp to empty. In this case, the output from the function is used to actuate the traffic signal. Note that the more advanced grade level allows for the introduction of the circuit as a *function*. Also, at this grade level, I use the parts of the trainer dealing with logic gates, transistor equivalents, and Boolean algebra.

Regardless of which grade levels are involved, homework is assigned. The homework requires the younger students to identify a situation that could be tested using the switching arrangements shown on the trainer and to complete the truth table there for that situation. No problems have been encountered in getting the lower grade students to understand truth tables as representing all of the possible situations that can exist for their set of input conditions. A typical grade school level submission would be:

IF (*plant watered*) **AND** (*sun shining*) THEN (*plant happy*)

AND Truth Table		
Switch 1 A ☐	Switch 2 B ☐	Result F=AB ☐

OR Truth Table		
Switch 1 A ☐	Switch 2 B ☐	Result F=A+B ☐

Light = on = true = 1
No light = off = false = 0

The high school students are given a more difficult assignment involving the group design of a primitive traffic-control signal (essentially a four-way stop sign) using only switches. This assignment is chosen because their design is modified as the course progresses. The design and implementation of an intelligent traffic-control system using timing circuits, sequencers and counters, etc., is the final project in the course. A lab class is provided at the appropriate part of the course to give students the time to complete these more complex circuits. This traffic-control system has timed lights, allows protected turns, and adjusts to current traffic volumes. Usually, design teams consist of four students and competing teams serve to test the functioning of the designs done by each of the other groups.

The electrical components provided with *The Journey Inside: The Computer* kit are sufficient for building the trainer circuits. I feel, however, that student response is enhanced using extra materials, for example, a blinking LED or buzzer to indicate that the function conditions have been satisfied. (Our most recent modification to the trainer makes use of a wailing siren as a "crabby parent" alarm.) A materials list, colored template, and circuit schematic will be sent to anyone providing a large self-addressed stamped envelope to:
Len Wieczorek
McKay High School
2440 Lancaster Drive NE
Salem, OR 97305
(E-mail: lwieczor@open.org) ✪

—Len Wieczorek
McKay High School

Supercomputer That's Faster Than a Speeding Bullet

One trillion operations-per-second. At least, that was the number that appeared at the top of the news release that made the headlines throughout the world in late December 1996.
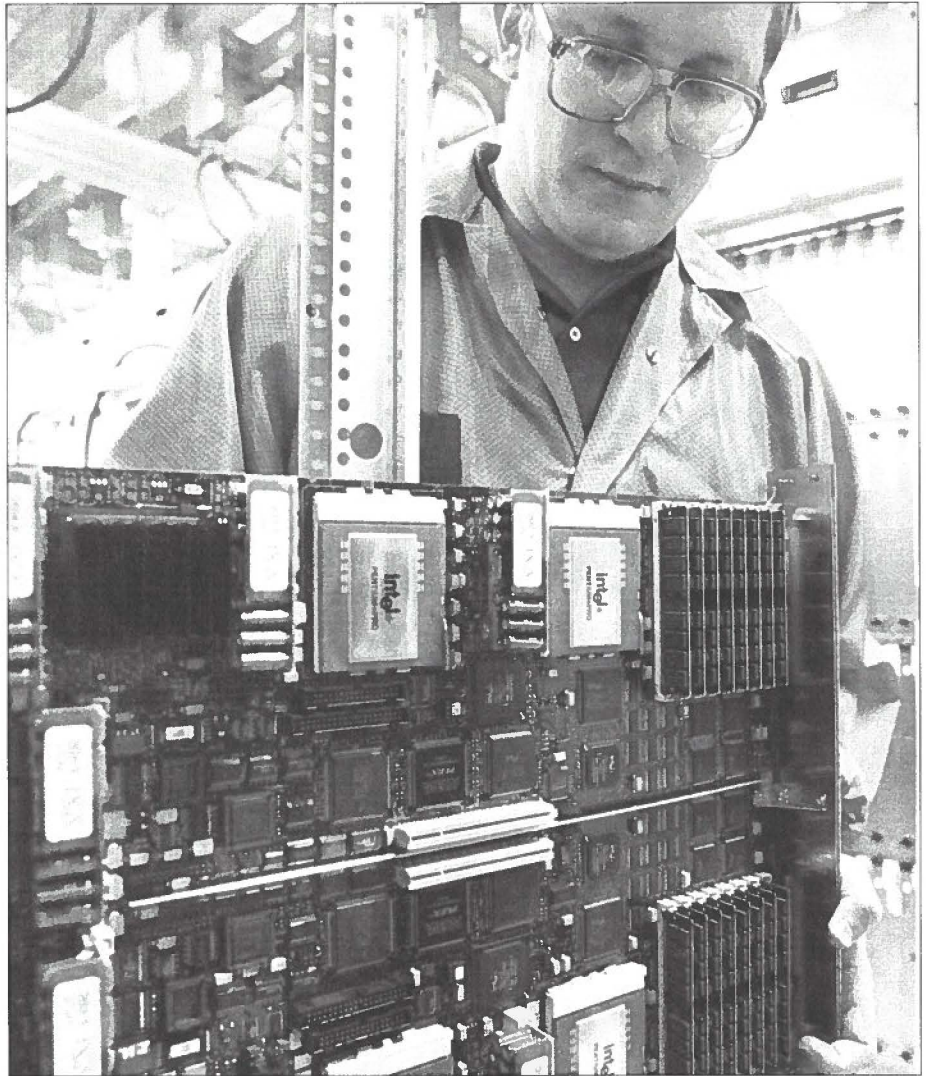
"United States Department of Energy's Sandia National Laboratory and Intel Corporation, the world's largest computer chip company, have built a parallel supercomputer that has reached the one trillion operations-per-second performance mark using the industry standard Linpack measurement method. The achievement of 1.06 teraflops— or trillions of floating point operations-per-second—shatters the previous performance record of 368.2 gigaflops (billions of operations-per-second) by over 250 percent."

There is no plan to stop with this achievement. If this standard is possible in 1996, can you imagine where the standard might be by 2000?

As you contemplate a computer of this magnitude, think about the following interesting facts.

How Fast Is the Intel ASCI Teraflops Computer?

- The Intel Accelerated Strategic Computing Initiative (ASCI) computer that broke the teraflops barrier is still under construction, and the record-shattering run used just three-fourths of what will become the full system. When it's finished, the computer will provide peak performance of 1.8 teraflops.
- This computer is faster than a speeding bullet. By the time a bullet travels one foot, the computer will have completed 667 million calculations.
- This computer is faster than the blink of an eye. In the 1/50th of a second or so it takes you to blink, the computer will complete 40 billion calculations.
- This computer is well over 10,000 times more powerful than the Pentium® processor-based system that might be sitting on your desktop.

How Big Is It?

- With 86 cabinets, it's as big as a good-sized starter home (1,728 square feet, counting the space between the aisles and leaving a 4-foot space to walk around the machine).
- It has 9,260 200-MHz Pentium® Pro processors, 573 gigabytes of system memory and 2.25 terabytes of disk storage.
- Its peak power consumption is 850 kilowatts (a typical desktop system consumes 200 watts).
- It takes roughly two miles of cabling to interconnect the system nodes and cabinets.
- It weighs about 44 tons and requires 300 tons of air conditioning to cool it.
- The configuration that ran the 1.06 teraflops MP Linpack rating consisted of 57 cabinets, 7,264 Pentium Pro processors, and 454 gigabytes of system memory.

Note: Additional information is available online at **www.intel. com/pressroom**

—News Release
Intel Corporation
December 1996

Paul Work, a computational scientist at Intel, inspects Pentium® Pro processors used to shatter the world's computing speed record.

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For the latest information on attending or exhibiting, check us out on the Web or call us toll-free today!

NECC '97 is hosted by Western Washington University (WWU) and is sponsored by the National Educational Computing Association (NECA).

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