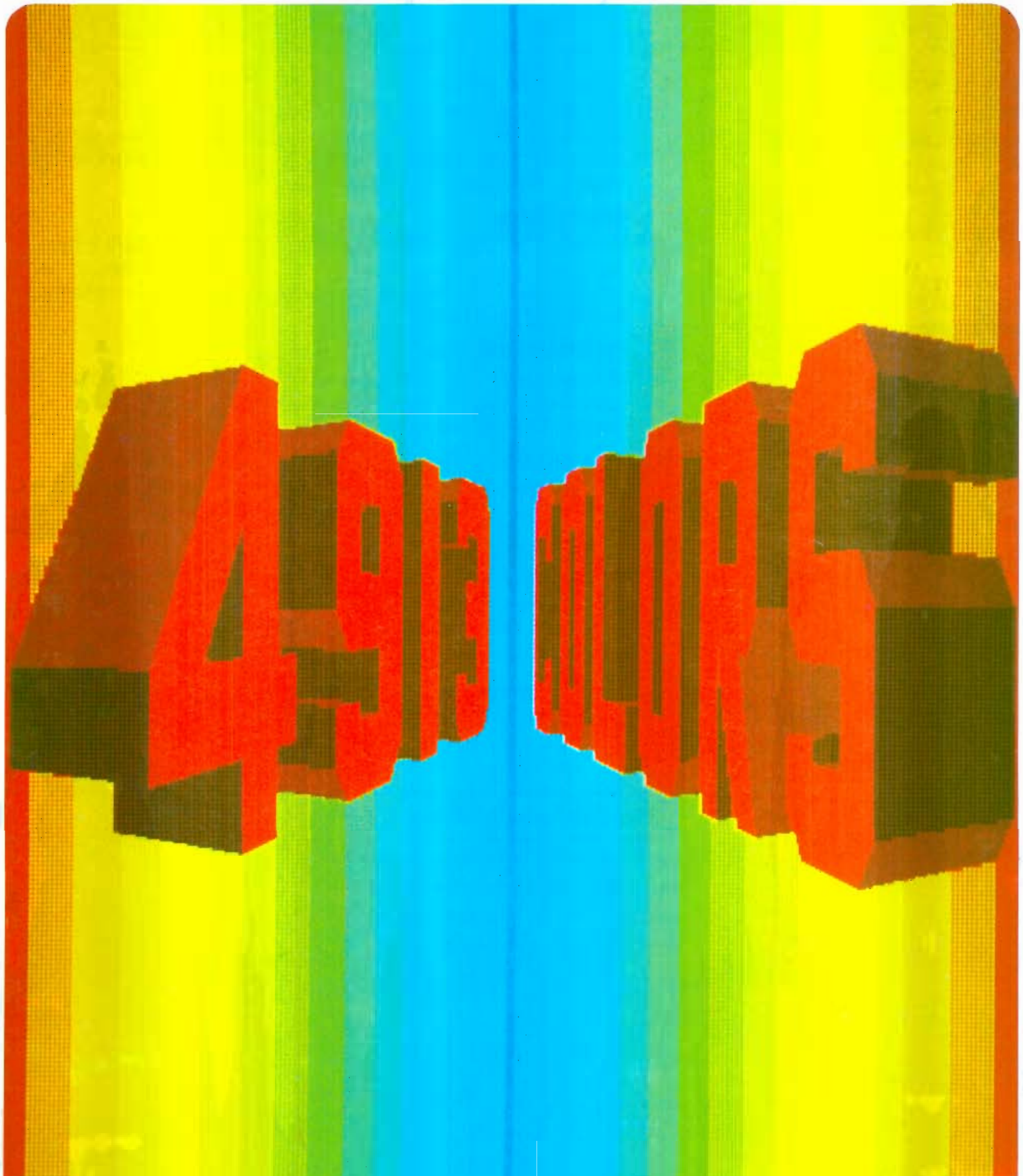
Keyboard

Jul-Aug/80 A Publication of Hewlett-Packard Desktop Computer Division



Keyboard

July-August 1980

Cover

The color capabilities of the 45C Desktop Computer are portrayed on the cover of this issue. The artwork was developed for *Keyboard* by Steve Hug of HP's Desktop Computer Division.

The Gasinstituut article, which begins on page 5, opens with an abstract in Dutch, for local readers.

Photo and artwork credits

Cover — System 45C screen image developed by Steve Hug

pages 1, 2, 3, 4, 10 (right), 11 and 12 — Hal Andersen

pages 5, 6, 7 and 8 — Wim de Wilde, Gasinstituut photographer

page 10 (left) — Colorado Viscomm

Many small parts

The 13th Annual Model Bridge Building Contest was held recently in Denver, Colorado, U.S.A. The event was sponsored by the Department of the Interior's Water and Power Resources Service (WPRS, formerly the Bureau of Reclamation) and the Professional Engineers of Colorado (PEC).

Occuring on February 23, the contest was sandwiched between the U.S. hockey team's Olympic victory over the Russians the previous night, and their win over the Finnish team on Sunday, which earned them a gold medal. We present this information not to compare the Olympics to the contest, but to demonstrate that, in the words of the American poet Walt Whitman, "Nothing endures but personal qualities." The following narrative is set at the WPRS laboratory at the Denver Federal Center where the Contest was held, and where two HP 9825 desktop computers served as umpires.

by John Monahan
Hewlett-Packard Company
Desktop Computer Division

At the end of the contest, while they were tabulating the final scores, Service employees placed a solid cylinder of concrete beneath the "fist" of a testing machine of four million pounds compression capacity (17.792 kilonewtons). They would break the cylinder as a demonstration.

First they gave it 500 000 pounds compression pressure (2 224 Kn), and it took it. They increased the pressure steadily until it reached one million pounds (4 448 Kn) but nothing happened, although the people were ready and the kids poised like vultures were ready to collect the pieces; nothing happened at a million and a half, (6 672 Kn) either, except that the people became restless and the kids had to go to the bathroom, but they were resisting as hard as the concrete cylinder everyone was hoping would break.

They did it: they saw it shatter at about 1.8 million pounds (8 007 Kn): the boom startled them. Adults talked, while their children collected the pieces, gray dust settling on their shoes.

The people

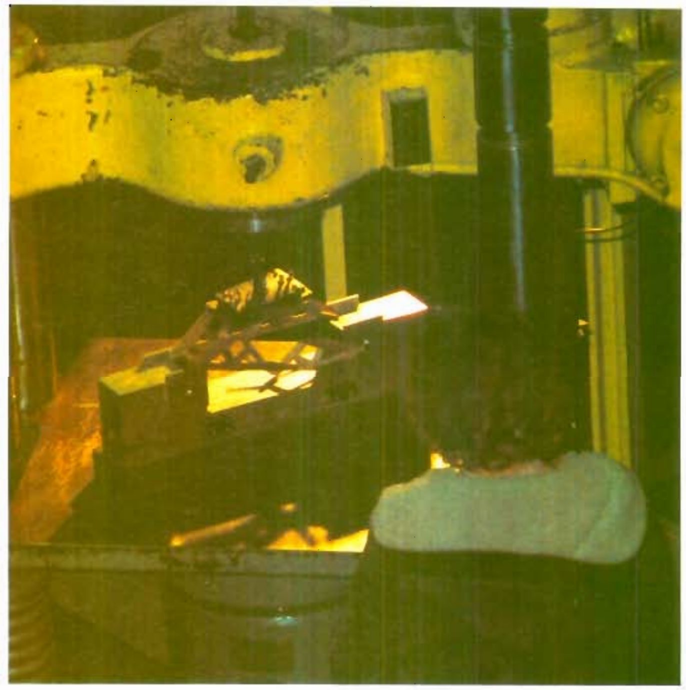
But nobody had wanted the bridges to break when the contest started five hours before.

Not even the rival teachers. Oh, they weren't sorry when an opponent's bridge was crushed straightaway by the 120 000 pound (534 Kn) capacity compression testing machine used in measuring the efficiency of the bridges. But they weren't necessarily glad; they pulled more for their own students than against the other teachers' protégés.

And there were 108 smart-looking protégés. They came from 42 Colorado high schools and, except in the case of students from smaller schools, were the top three finishers in intramural competitions held earlier.

The parents came. Mothers and fathers by and large more knowledgeable about the forces of inflation than the forces that crumple a model bridge. They came, though, and craned their necks and crossed their fingers for luck and clicked their lips when the inevitable failure came. They maintained hope to the end; they were mothers and fathers.

Even the Olympics needed volunteers and the contest was no different. Men and women from the WPRS operated the weighing scales, test machine, and desktop computers used in determining the winning bridges. The PEC judged the entries for aesthetics and adherence to specifications. The organization also provided trophies for the top eight individual finishers and top nine schools. There was no politics and no quibbling over national anthems. Because the best bridges spoke for themselves.



The bridge is loaded . . . the pressure begins. When a bridge gave way, there was not a bang, as with the cylinder, but a whimper.

The bridges

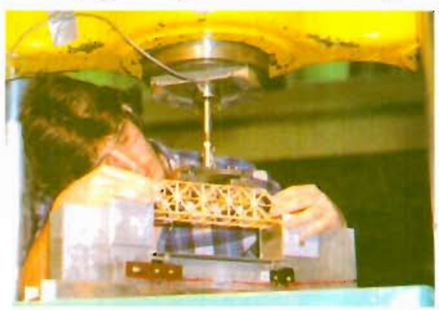
When a bridge spoke its last, there was not an explosion as with the concrete. No, there was a ripping sound, the sound of balsa wood breaking or glue tearing from joints or beams. Not a bang, but a whimper.

It was like a neighborhood dog show. There was the roughhewn mut-of-a-bridge, odd-looking or plain, but owned by a girl keen with pride.

And then the purebred bridges: polished and precise, with struts, and a design straight out of the latest magazine.

Some bridges were made for brute strength — they were the bulldogs — while others were thin and lean — greyhounds.

Whatever its breed, each bridge was 12 inches (30.48 cm) long and weighed no more than two ounces (56.7 grams). A 1.18 x 1.18 inch (30 x 30 mm) longitudal opening through which a rod could pass was required, along with two areas at the top where the load was placed.



Nervous fingers loaded their creation.

Winners without losers

Nervous fingers put the bridge they had made so meticulously onto the 120 000 pound (534 Kn) compression capacity testing machine. The bridge was moved, removed, adjusted and readjusted until its maker deemed it in the perfect position.

Then they started the pressure. Just a little, followed by a delay of five seconds. We're okay so far.

Then it came in earnest. You could watch on a television screen as a plotter drew a curve of the bridge's efficiency, or the amount of load it carried versus its weight.

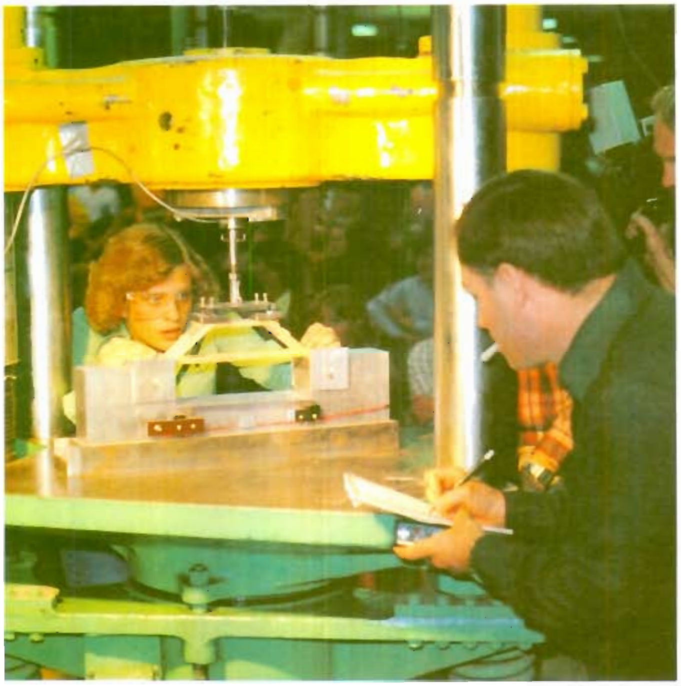
Most builders were too involved to look at the television monitors; how could you not watch the bridge that had been the object of your engineering affection for so long? And as the kids watched their bridges, the parents watched the kids and the bridges. The TV screens were for bystanders and the press.

We're okay so far; it's been holding out great; just a little more and . . .

Lauri McLaughlin was a senior at Denver's John F. Kennedy High School. A petite blond, she built a bridge more of the mongrel variety than purebred. But pal, did it have heart.

The leaders in the contest saw their bridges rated with an efficiency ratio of over 8 000, when Lauri put her bridge on the machine.

As the pressure on the bridge grew, the plotter showing the bridge's efficiency continued upward on the graph paper. Past 6 000, past 8 000, past 10 000 . . . as they would later with the concrete cylinder, the crowd waited for the break . . . past 12 000, past 14 000



Lauri McLaughlin prepares the bridge that won top honors. Later, she explained her success to other contestants: many small parts.

. . . by now the plotter's pen was nearing the top of the scale . . . past 15 000 when the failure came: 15 844.6 to be exact, the most any bridge had ever held under the present contest rules. Everyone clapped.

Lauri's bridge of 0.71 ounces (20.15 grams) held 15 000 times its own weight. The cylinder held 1 5000 times its weight.

How was Lauri's bridge different from the others?

It wasn't because Lauri was more experienced than the other bridge makers. It was her first time in the contest. And it wasn't her unique bent for engineering — she says she's planning on a career in law when she enters college in the fall.

Probably it was what her physics instructor, Ron Baldwin, said it was: meticulousness.

Because balsa wood is not easily saturated by glue, Lauri built her bridge out of many small parts, enabling her to get more glue on the stress areas of the bridge. She then laminated the entire structure. Many small parts.

The bridge which won the contest was the third of a series she'd built, each of which was more efficient than its predecessor. The first model had an efficiency rating of 9 000, the second 13 000, leading up to her 15 000 effort.

"I learned precision and patience," Lauri said after the contest. "With a winning design you can't cut corners." Many small parts.

Following Lauri were Kent Steinke of Gateway High School and Brian Mitchem of Rangely High. All three advanced to a national contest in Chicago, Illinois, U.S.A. last May.

There, under somewhat different rules from those used in the Colorado contest, Lauri's bridge finished second, while Kent's was first. For his efforts, Kent was awarded an HP 41C handheld calculator by the sponsors of the contest, the Illinois State Physics Project. Twenty students from 10 regions competed.

The Award of Merit, given for the bridge with the most pleasing appearance and load transmission potential, went to Dave Ressel of Mitchell High School. His bridge had the eleventh highest efficiency rating.

The umpire

It was not a contest where the fans booed the umpire or the participants were sent to the showers for arguing. Everyone presumed the umpire infallible until proved otherwise.

The umpire was the Hewlett-Packard 9825A Desktop Computer; it was programmed to make 30 to 50 decisions each second, and there was no instant replay.

The program was written by Brent Mefford of the WPRS. The configuration of the hardware was selected by the Service's Lynn Carpenter, an eight-year contest veteran. John Petty, also of the Service, was in charge of the electronics involved in configuring the system.

Here is how the bridges were judged.

Each student gave his name, school and weight of his bridge to

The contest provides Service employees a chance to write programs and learn from the experience.

Service employees ran the equipment: test machine, scales and the "umpires" (two HP 9825s).

WPRS volunteers stationed at a table. This pretest information was entered in an HP 9825, and stored on a tape cartridge, which was then handed to the student. The program automatically verified the weight of the bridge and the identity of the student and school.

Next, the student gave the tape to a WPRS volunteer operating a second HP 9825 and placed his bridge on the test machine, a Baldwin Universal Testing System. Meanwhile, the student's name, school, and bridge weight were sent by the 9825 to an HP 9872A Four-Color Plotter, where they were plotted on preprinted graph paper. A load of ten pounds (4.5 kg) was placed on the bridge by the Baldwin machine for five seconds. An HP 98035A Real Time Clock sent an interrupt to the desktop computer when the five seconds were up.

Then, with the preciseness of a practiced team, the equipment went through its paces:

The 9825 directed an HP 3325A Oscillator, through HP-IB, to output zero to 10 volts over 90 seconds to a servo controller. The controller looked at the oscillator's output and compared it to the voltage feedback reported by a load cell on the Baldwin; the difference, called the control signal, was relayed to the Baldwin's electro-hydraulic load control valve, so that each bridge encountered the same load versus time excursion.

The computer, taking load readings 30 to 50 times a second through an HP-IB interfaced voltmeter, determined when a decrease of 90% of the maximum voltage sent from the load cell had been received.

This told it that the bridge had reached its maximum efficiency and was crushed. The computer then left the readings-taking loop.

While the 9825 was taking load cell readings, it simultaneously graphed the bridge's efficiency curve with the HP 9872 plotter. Final test results — the student's name, school, bridge weight, maximum load, and efficiency — were stored in a second tape cartridge as a backup copy. This information was also kept in the computer's memory and used at the contest's conclusion to sort overall results, which were printed by an HP 2631A Dot Matrix Printer.

The student's cassette tape then was taken back to the first 9825 and used again. In all, ten tapes were continually recycled.

For the Service, as Mefford points out, the contest provides employees a chance to write programs and learn from the experience. Mefford already has used his contest experience in writing a program for an hydraulics research project.

So what?

This is probably the longest account of the 13th Annual Bridge Contest ever written. Yet it cannot rival the reams of copy written about the Olympics. And so what?

Talking to the students involved, one heard stories about participants from five years ago who came back to their alma maters to help this year's participants.

"I'd like to come back next year and coach the kids who'll be in the contest," said Rod Cross, a senior at Abraham Lincoln High School. His bridge earned a fourth-place trophy.

And then there was the inter-school competition, as intense as that generated by athletics, but viewed from the perspective that winning isn't everything (or the only thing).

As one student said, holding a bridge crushed into sticks, "I did the best I could." Many small parts.

Gasinstituut

Het VEG Gasinstituut, een onderzoek instelling in Nederland, gebruikt een analyse opstelling die bestuurd wordt door een Systeem 45 tafelcomputer. De apparatuur controleert de samenstelling van het aardgas dat in het land wordt verkocht.

by Jaap Vegter and Bill Sharp
Hewlett-Packard Company

A valve system specially designed and built at the Gasinstituut for the gas mixing station, controls the movement of different gases from the station into the laboratories for testing and analysis.

Travel posters depicting windmills and canals may contribute to the impression of Nederland, or the Netherlands, as a largely agricultural nation. But it is in fact one of the most densely populated countries on earth.

Data from 1979 indicates that an average of 1066 Nederlanders inhabit each square mile of their country (the state of New York has an average of 358 persons per square mile). Nederland's population density has great impact, because the industrial European nation has high energy consumption.

Nederland depends upon natural gas to meet more than half of its energy requirements. These natural gas needs amounted to some 7.14×10^{10} cubic meters in 1976.

Changing resources

Nederland has long used combustable gases for fuel. About 20 years ago, coal gasification was, on a relatively small scale, a primary gas source. Local coal-gas plants produced the low-energy fuel, which was piped into houses and factories for cooking, heating and manufacturing.

More recently, Nederlanders tapped underground natural gas deposits at Slochteren, in the north of the country. This deposit contains high-quality fuel.

Coal gasification plants were quickly abandoned. Gas-consuming appliances throughout the country were converted to fittings designed for optimum performance with Slochteren fuel.

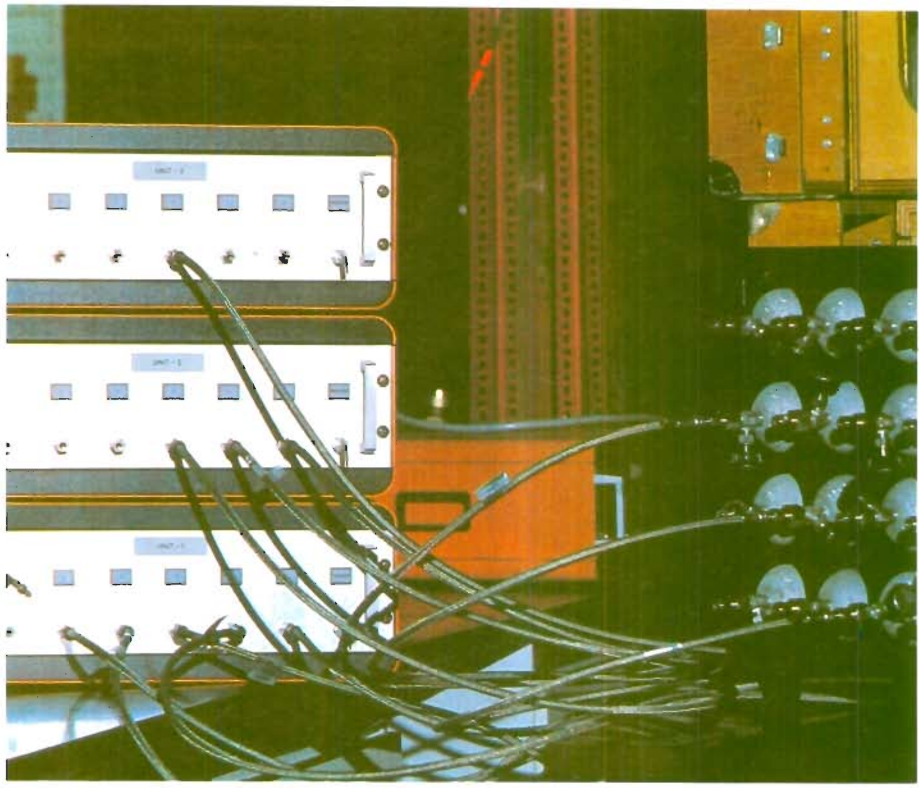
People have become aware in the past few years that supplies of natural gas from Slochteren are not inexhaustible. In efforts to extend the life of the valuable field, gases from other fields in Nederland are now mixed with North Sea gases to duplicate Slochteren-quality gas. About 150 local gas distribution companies sell the gas to businesses and homeowners.

Quality assurance

Veg Gasinstituut, a gas research organization in Apeldoorn, is funded by the gas distribution companies. The Gasinstituut monitors natural gas composition and calorific value as an aid to price determination. It also conducts research for the industry and tests natural gas-consuming appliances to make certain they will operate safely.

The Gasinstituut monitors the quality of this natural gas mix to make certain that it is both safe to use and consistent in calorific value.

These determinations are made using a trio of gas chromatographs. A few months ago, control of, and data collection from, these chromatographs became the duty of a Hewlett-Packard System 45 Desktop Computer.



On command from the System 45, solenoid valves at left control the relay of sample gases from the compressed air bottles at right to the GCs located nearby on the laboratory bench.

Calorific value

"Perhaps our most important function is the determination of the calorific value of the gas which is distributed to customers in Nederland," says Royce R.D. Hakkers, automatic analysis project leader at the Gasinstituut. Hakkers heads a project group which includes engineers Martin Hagen and Will In't Veld, who wrote the software for the analysis system; and electrical engineers Harry Slats and Joop van Aerde, who developed the necessary electronic and I/O connections.

"This calorific value is the relative amount of heat that a unit of the gas will generate," says Hakkers.

"The market price of the fuel depends on this value. The Wobbe Index, which is a function of the calorific value, also can affect the safety of its use," he says.

For these reasons, Nederland, like many other countries, requires determination of the calorific value of natural gas. Frequently, these determinations are made by a calorimeter. This instrument burns the fuel and measures the heat generated during combustion. The test is not exact enough, with several sources of possible error.

Gas chromatography

The Gasinstituut uses gas chromatography for determining the calorific value of the gas. The analytical instruments can separate the components in the natural gas. After separation, the component peaks will be evaluated along with data from analysis of calibration gases. This makes it possible to determine the concentration of each component in the natural gas mixture. Once the composition of the gas is known precisely, the calorific value can be computed using known calorific values of the individual gaseous compounds in the mixture.

Hardware in the system

The natural gas is separated by three Perkin-Elmer gas chromatographs. Each of the chromatographs contains a separation column and a reference column.

Chromatograph 1, a molecular sieve column, separates the components oxygen, nitrogen and methane. Chromatograph 2, a "Porapak R" column, separates carbon dioxide and C_2H_6 to C_5H_{12}. Chromatograph 3, a silicone oil column, separates C_5H_{12} to C_8H_{18}.

Chromatographs 1 and 2 use thermal conductivity detectors, while chromatograph 3 uses a flame ionization detector. Signals of all three chromatographs are integrated by Spectra Physics Autolab 1 Integrators.

Signals of all three chromatographs are transported to the System 45 by RS-232C interfaces. The 45 receives the data, carries out data reduction and compares the reduced data to that from the calibration gas.

The determined concentration of each component in the gas sample is used in computations by the System 45, along with physical property factors of the component such as calorific value, specific gravity, and the compressability factor of the natural gas at specific temperature and pressure.

Periodically, the gas companies take samples of the fuel delivered to them, and relay the sample to the Gasinstituut for analysis. This analysis for calorific value determines the

A worker is dwarfed by the storage tanks which hold the mixed test gases used by the Gasinstituut. The test gases are used for studying performance of gas burners and as GC calibration samples.

price that each company has to pay. This makes Nederland the first country in world where the price of the gas is fixed by a determination of the calorific value, or energy level, of the fuel by gas chromatography. Veg Gasinstituut has played an important role in this.

Wobbe index

The Wobbe Index is the most important safety consideration for natural gas use. Once a burner is designed to work efficiently and safely for a certain fuel composition, a change by even 2% can seriously effect performance and safety of appliances.

Until a few months ago, all these gas chromatographic (GC) analyses were performed manually by staff members at the Gasinstituut. When they realized that increasing demand for the analyses was about to necessitate an increase in the number of GCs and staff members to perform the analyses, they turned to a computer-controlled system to increase their efficiency.

Mixing of gases now means that many more samples are submitted to the Gasinstituut. Engineer Wil In't Veld says that, without the System 45, they would have had to acquire a much larger staff, or work nights, to keep up with the demand for analyses. "We would have had to purchase three more gas chromatographs (each equal to the price of a System 45), hire two more workers to run them, and add on integraters and converters."

What they have instead is three Perkin-Elmer F17 GCs, three Spectra-Physics Integrators, and one System 45 Desktop Computer.

The desktop computer controls the operation of the GCs via 16-bit parallel interfaces, and collects data from the GC/Integrator units through RS-232 C interfaces. In working with the electrical engineering and I/O for the system, Slats found that he had to reverse the logic of the control interfaces for safety reasons. The parallel interfaces came with logic that would have left gas valve status undetermined when no power was applied. For safety reasons, Slats modified the interfaces with a diode and jumper to make certain that the valves would always be closed when no power is applied.

The 45 also controls the solenoid and valve system which transports sample gases to the GCs, and periodically runs calibration samples through the chromatographs. Because all these functions are automated with the computer in control, workers in the laboratory can set up several sets of samples, and then are free to perform other functions.

This means that the GCs can be set up to run all night, unattended. And this is fortunate, as companies have begun asking for even more frequent tests of the gas they are receiving.

Test gases

The Gasinstituut's "gas station" mixes some 16 different test gas formulations. These gases are used in testing appliances to determine combustion behavior of different fuel compositions in burners.

Samples of these gases are periodically taken to the computer-controlled GCs for more precise analysis. Hakkers automates these tests.

The team at Veg Gasinstituut n.v. has become an essential part of coping with changing energy conditions in Nederland.

Royce R.D. Hakkers is automated analysis project leader at the Gasinstituut.

Each of the test gases goes through a specially designed solenoid valve configuration to a line stretching the 300 meters from the gas mixing station to the laboratory building. The design guarantees a homogeneous mixture of the gas and allows control by the System 45.

Sampling

Samples from the field curently are collected in two different ways. Where the sample is being taken from a pressurized gas line, an evacuated metal cylinder sample bottle is used. In cases where non-pressurized samples must be taken, as with domestic connections, a glass sample bottle is used.

Pressurized metal sample bottles make it simple for the laboratory to link the bottle to a line leading to the GCs, through a valve control board run by the System 45. When the computer is ready for the sample to be taken into one of the GCs, it opens a valve to the cylinder, and the pressurized gas flows into the GC sample stream.

The method above cannot be used when samples must be collected in non-pressurized glass bottles. The gas must be under some pressure to flow into the GCs. To get this pressure, the sample must be forced from the bottle by pumping acidic water into one end of the bottle, and allowing the fuel to escape from the other end.

Once the sample is introduced, all control, data handling and data reduction are done by the 45.

Programming

The System 45 determines when the valves in the gas transport system to the GCs will open and close. It takes a sample and directs one of the GCs to analyze it. It then selects a calibration sample and analyzes that as well.

The programming is based on real-time interrupts, using the System 45's Real Time Clock. The program as a whole is divided into subprograms.

The program displays the time on the CRT when the computer is not actively controlling the test. It can be used for other purposes during the actual running of the analyses, which takes half an hour to an hour, then interrupts to perform its functions when the analysis is complete.

A data cartridge which holds the program is inserted into the 45, and the computer is turned on in AUTOSTART. The System 45 can then set up the GCs, take the time from the clock, and start samples into the GCs.

The team at Veg Gasinstituut n.v. has become an essential part of coping with changing energy conditions in Nederland. At the same time, the Gasinstituut does research on coal gasification to ensure a continuous gas supply in Nederland.

By using the best technology available, and looking a ways into the future, they expect to remain several steps ahead of the needs of their countrymen. ■

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Programming Tips

SFKs for running and waiting programs (System 35/45)

When users need to interact with a program, the special function keys (SFKs) can be declared with the ON KEY#... statement described in the "Operating and Programming" manual.

However, SFKs only operate as interrupts on running programs when they are declared in this way. The ON KEY#... statements do not apply when the program is waiting due to a PAUSE, INPUT, LINPUT or EDIT statement. During a wait the SFKs default to their definitions as typing aids.

Suppose a user wants to branch to a certain line whether or not the program is running. This can be done with a technique illustrated in the following example:

```
10   ON KEY #1 GOTO Add_data
20   ON KEY #2 GOTO Delete_data
30   ON KEY #3 GOTO Change_data
40   LOAD KEY "KEYS"
50 Ready:          !
     .
     .
     .
1000 Add_data:!
     .
     .
     .
     GOTO Ready
2000 Delete_data:!
     .
     .
     .
     GOTO Ready
3000 Change_data:!
     .
     .
     .
     GOTO Ready
     .
     .
     .
     END
```

Lines 10-30 define the SFKs when the program is running (priorities could be assigned to these interrupt declarations). Line 40 loads the predefined key file "KEYS" so that when the program is not running and k1, k2 or k3 is pressed, the program starts running at Add_data, Delete_data or Change_data, respectively. "KEYS" uses the CONT command and is defined as follows:

KEY – 1
- Clear line
- CONT Add_data
- Execute

KEY – 2
- Clear line
- CONT Delete_data
- Execute

KEY – 3
- Clear line
- CONT Delete_data
- Execute

Ready is where the program returns after k1, k2 or k3 is pressed.

Using this technique, selected lines in the running or waiting program can be accessed by the user.

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Logical and/logical or statements (9820A)

We recently acquired a HP 9820A from another branch of this headquarters. While experimenting with the new language, we discovered a technique not listed in the programming manual. We have no way of knowing whether it is common practice or something new, so we are sending it to you for evaluation.

The notation — If (V1 = C1) + (V2 = C2) = 1 — is read as a 'logical or' statement. By changing to — If (V1 = C1) (V2 = C2) = 1 — it becomes a 'logical and' statement and — if (V1 = C1) + (V2 = C2) = 0 — is a 'nor' statement. Other transformations are possible: — If (V1 = C1) + (V2 = C2) + (V3 = C3) = 2 — Requires 2 out or 3 conditions to match.

[This Tip gives expanded examples of a concept noted at the bottom of page 5-5 of the 9820 manual— Editor.]

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HQ MAC/XPMEM
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Flashing CRT attracts attention (System 35/45)

This program is designed to make the screen of the System 45 flash on and off. It prints the screen white, then flashes it rapidly from black to white.

```
5     PRINTER IS 16,WIDTH(160)
10    PRINT PAGE
20    FOR I=1 TO 20
30    PRINT RPT$(CHR$(129)&" ",79)
40    NEXT I
50    WAIT 300
60    PRINT
70    FOR J=1 TO 40
80    PRINT CHR$(27)&"U"
90    WAIT 70
100   PRINT CHR$(27)&"V"
110   NEXT J
120   END
```

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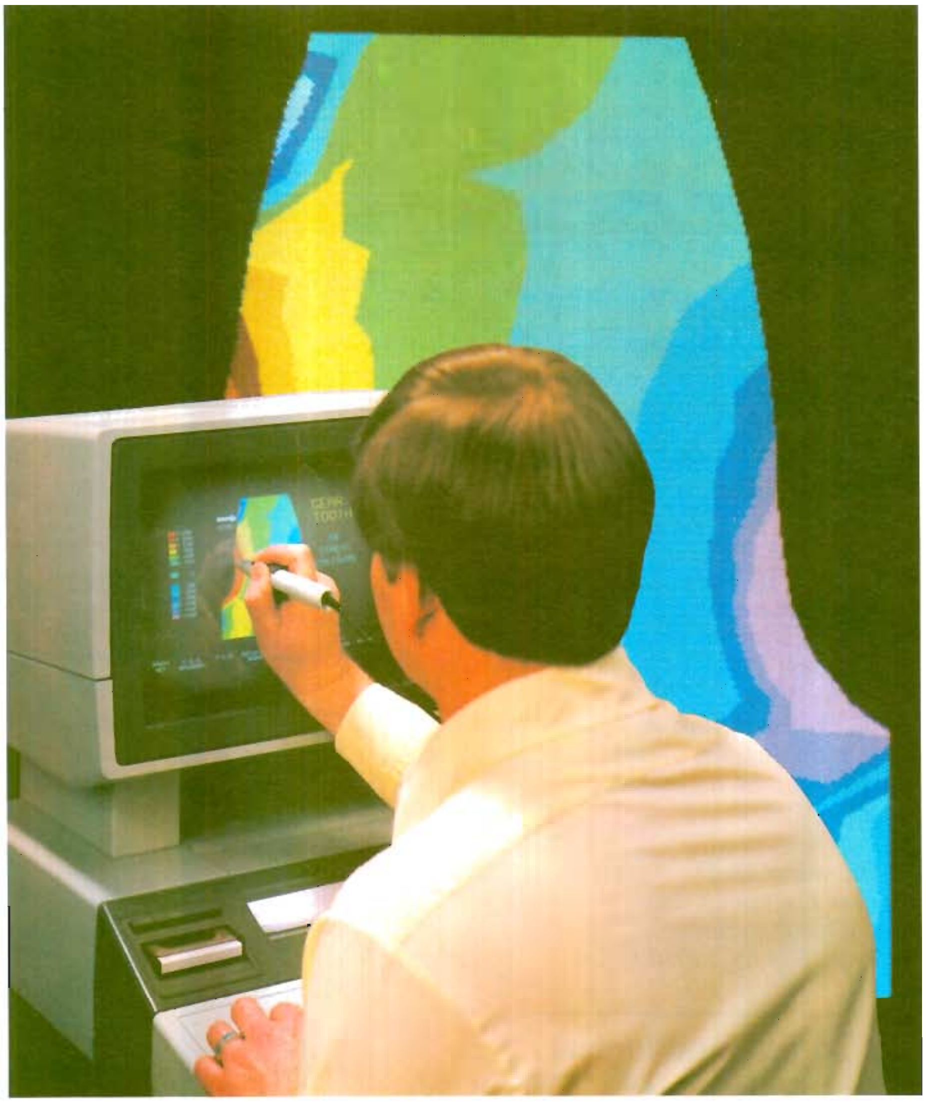
System 45C: a new dimension



Keyboard staff article

We've added a new dimension to the power of the System 45.

Color — a spectrum of 4913 colors.

What this means to you is the ability to transcend the considerable capabilities of the System 45B. You can communicate using an added dimension; the dimension of almost limitless color.

Color communicates

An image of the space shuttle on the CRT screen can show the structure of the aft shuttle interior, viewed in perspective and partial cutaway, leaving the forward exterior intact. All this can be done without color.

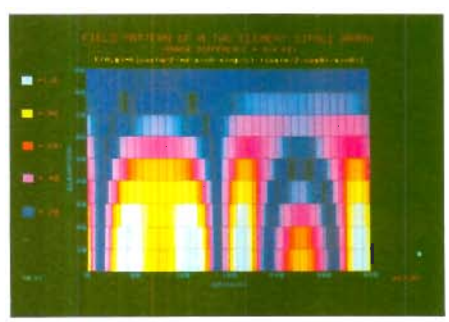
With color, it is possible to show, in a manner that promotes easy and rapid understanding, the different sections of the shuttle interior, with each section color coded. And, what is more exciting, the various temperatures of the shuttle skin during reentry can easily be shown on the forward shuttle exterior using a color range. The rapid assimilation of data this makes possible cannot be duplicated without color, and can be done nowhere else as simply.

Two more enhancements that come with the 45C are the light pen, which gives you control over your own creations on the CRT, right down to a single dot on the screen; and the graphics language, now expanded to 70 specific commands from the 40 available with the System 45B.

Applications

Scientific applications in addition to the one outlined above might include natural resource exploration, environmental studies of problems such as acid rain, and nuclear physics mapping of subatomic particle interactions.

An engineer could use the 45C to help in the interactive design of radio antennas. Colors can be used



Electromagnetic energy values are represented by a color scale on the System 45C.

to represent electromagnetic energy values, simplifying the study of radio wave signal patterns around antennas.

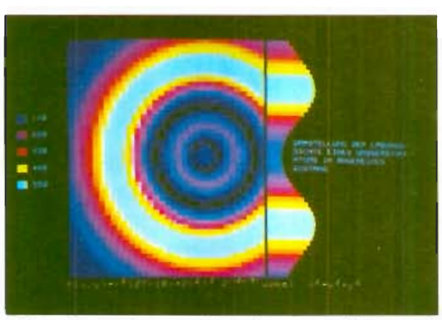
Other engineering and design applications could include integrated circuit modeling and design, schematic generation, construction and land use planning, acoustic design, dynamic and kinematic design and analysis, fluid modeling and finite element analysis, to name a few.

Data acquisition and control could be enhanced by using the 45C's color to simplify quick monitoring of conditions in any system under observation. Real-time display of color-coded graphics can provide instant recognition of system difficulties.

More than color

But there is more to the System 45C than color. The computer is built to be a complete work station for people in a multitude of different fields trying to tackle complex problems.

The light pen, a standard part of the 45C, makes it easy to pick, move and construct objects on the CRT. Using the tracking cursor on the CRT, you have control down to individual dots through a predictive firmware algorithm that moves the cursor in the direction and at the speed of the light pen's motion.



This charge density plot of an excited state of the hydrogen atom is labeled in German.

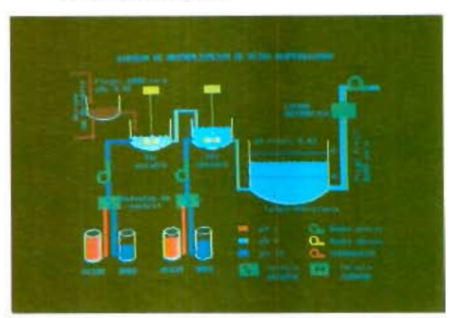
Graphics language in the 45C nearly doubles the previously available number of graphics commands to 70, providing greater graphics power and ease of interaction with devices such as the light pen and the 9874A Digitizer. Considerable software accompanies the 45C, including programs on numeric analysis and vector manipulation, along with financial, statistical and other programs. Beginning and advanced graphics packs, along with a set of training tapes, help the new user become rapidly comfortable with the computer and its power. A variety of other software packs is available, including two-dimensional graphics and the first color three-dimensional graphics utilities designed for a desktop computer.

Configurations

The 45C includes 4913 colors, built-in light pen, keyboard, mass memory, enhanced BASIC language, operating system and thermal line printer, all in one desktop unit.

Standard configuration for the computer includes 187K bytes of user read/write (R/W) memory. Read-only memories (ROMs) contain 152K bytes of independent firmware memory, including graphics, adding significantly to the desktop's power, while leaving the R/W memory entirely available to you.

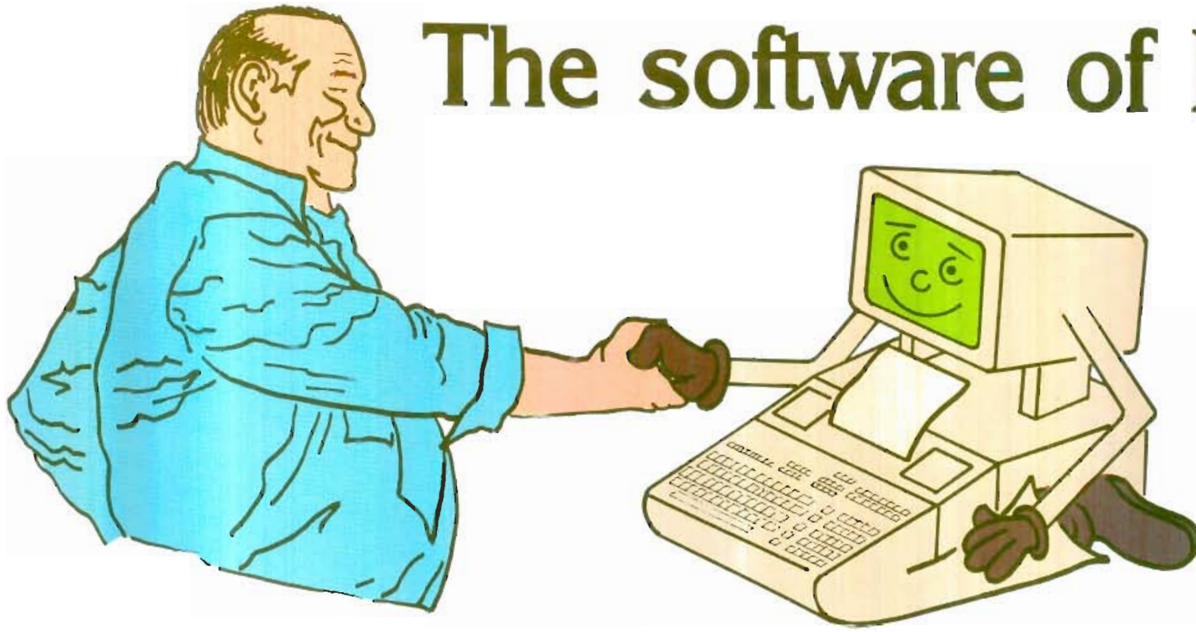
Optional user R/W memory configurations from 56K bytes to 449K bytes are available. Customers can select additional options to tailor systems to their specific needs. Other ROMs available to enhance the System 45C's power include



The 45C here controls operation of an acid waste neutralization system (labels in Spanish).

Interfacing (I/O), Mass Storage, Advanced Programming, Assembly, Data Communications and IMAGE/45 Data-Base Management. K

The software of I/O



by Steve Leibson
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One of the most critical parts of a computer system is the human operator. During the development of a system, the programmer will communicate with the machine through a programming language.

This language could be at the machine level, though that practice is growing less common. More likely, it will be at a high level, through a sophisticated programming language provided by the machine manufacturer.

After the system software is developed, people will use it for accomplishing tasks. The computer must be able to interface with these people in a concise manner. They are not concerned with the software running the system, but with the results produced. This article will address high-level software of I/O.

Representing information

There are many different kinds of information in the world, such as prices, quantities, voltages, written documents, drawings and innumerable other forms.

Information is one of humankind's most powerful tools. One of the reasons that computers have become such a major factor in current human endeavor is their information processing power.

Yet for all this capability, computers can only store information in two forms: numbers and non-numbers. There are no prices, inventory quantities or voltages in a computer memory. There are only the two forms with which a program associates these values.

There are no pages in my text editor program, but only character data that is processed by the software to print pages. The software of I/O is a tool that instructs the computer how to accept data from the outside world and how to provide internally stored data to the world.

Storing information

We must first study how information is stored in the computer in order to use the software I/O. Numbers are usually stored in something called internal format.

The author of the programming language for the computer decided the best way or ways to represent numbers inside the machine. The ones and zeroes that make up the number are probably not easily recognized as a number. For example the number 21 in 16-bit binary is 0000000000010101.

In addition, though we have many ways of writing numbers such as $2.69, 6.02*10^23 and 3.14159, the computer will have only a limited number of numeric types.

The most common numeric types are integer and floating point. But in whatever type a number is stored, we want the computer to print the number out in the format that makes the most sense to humans.

Bank tellers will laugh if our payroll program prints checks that read 6.02E2 dollars. We won't find it funny, however, when that number is interpreted as six dollars and two cents instead of six hundred two dollars.

Formatting

Most high-level languages make it possible for the computer to input or output numeric values in the form desired. This is called formatting.

The capability may come as a format statement or as a format field within a statement that causes the computer to output information. In either case the format specification describes exactly how the number is to be output or input.

We may use the above check writing example to demonstrate formatted I/O. Suppose our program has the following statement in it:

```
210 PRINT Pay
```

That is a very simple program statement. The computer, being the simple machine that it is, will print the value of the variable Pay, in whatever format the computer is currently using.

If the machine is in fixed 2 format and Pay = 502, we get "602.00" printed, just what we want. If the machine is in fixed 0 format, we get "602", which is close. However, if the machine is in FLOAT 9 format, we get "6.020000000E+02". This last

The best way to learn how to perform formatted I/O in a given language is to read the manual — several times.

printout is not even close to being acceptable.

Finding a solution

What can we do about this PRINT statement to prevent unacceptable output from the program? A first attempt might be to change the default format of the machine just before the print statement:

```
200 FIXED 2
210 PRINT Pay
```

This approach is taken by programmers who don't know about or don't want to learn about formatting their output. The disadvantage of this approach is that when the state of the machine is altered, all subsequent printing will be done in the fixed 2 format unless another FIXED or FLOAT statement is executed. We are also missing the dollar sign that precedes the number on the printout.

The program could be changed to:

```
200 FIXED 2
210 PRINT "$",Pay
```

Now we get "$ 602.00" on the printout. Clearly the machine is just not understanding what it is we want.

The means for telling it exactly how the number is to be printed is the format field in the PRINT USING statement.

Now we can change the program to:

```
210 PRINT USING "A,000.00";"$",Pay
```

The printout reads "$602.00" which is exactly what was desired.

Just as different computer languages have different statements for performing similar functions, format techniques vary widely from language to language. Even differing dialects of one language, such as BASIC, may vary as to how formatted I/O is performed

The best way to learn how to perform formatted I/O in a given language is to read the manual — several times.

Stringing things together

As mentioned earlier, not all data can be represented in numeric form. Text, such as magazine articles, is best represented as a linear array of characters. Such arrays are usually called strings. This data type is useful for storing letters, instructions and even command sequences for some instruments.

The previous article in this series discussed character codes. They are used to represent text data in a form that may be transferred from machine to machine. Each character is represented by five to eight bits. The most popular code is ASCII, which is a seven-bit code.

Eight bits is a very convenient size for data storage in most modern digital computers. Therefore, strings are usually composed of eight-bit parcels of data. Since ASCII is only seven bits, one bit of each string character is usually wasted.

Input and output of strings is much simpler than for numerics. The internal representation for strings is what the printout might look like — almost. The exception to this statement is the terminator.

Input of a string must stop at some point so that the data can be processed. The terminating character tells the computer when it has reached the end of the message.

A common default terminator is the line-feed character. It is so common that most input statements default to terminating upon receipt of a line feed. Most output statements automatically add a line feed at the end of a string output.

Just as with numeric I/O, everything runs fine until you don't want the defaults any more. At some time, you will have to read data in from a device that outputs carriage return as a message terminator.

Or perhaps you will have a printer that needs an ENQ character as a terminator instead of a line feed. Eventually, a situation will arise where the defaults won't work.

What can we do? It's time to use a format statement again.Suppose we have a device that requires only a carriage return as a message terminator. The program might contain the following statement:

```
200 PRINT A$
```

This program will output the string A$ and follow it with the carriage return and line feed characters. Since the device we are outputting to will terminate one message on the carriage return, it will interpret the line feed as the start of a new message.

This may be suppressed by changing the program to:

```
200 PRINT USING "#";A$,CHR$(13)
```

The "#" specifier tells the computer to refrain from adding any embellishments to the string being output. The CHR$(13) is a carriage return, which is the proper terminating character. Again, the formatting capabilities of the language have allowed us to specify exactly what we want the I/O to do.

The software of I/O is an extremely important topic in interfacing. It is the interface between the computer user and the computer.

By understanding how to communicate system I/O needs through explicit software statements, a user can make a "dumb" computer work as the flexible problem solver it was intended to be. K

Update

62K bytes of R/W memory for 9825

The HP 9825 Desktop Computer is now available with up to 62K bytes of read/write memory. The improvement does not reduce the speed on which the 9825 built its reputation. And, this new, larger memory can be added easily to any existing 9825 in the field.

Two models

Two new models, the 9825B and the 9825T, were made possible by reducing the physical size of the memory inside the 9825, and by devising a hardware block-switching scheme. The two new 9825s are completely compatible with programs written for the 9825A or S.

Easy upgrade

Any 9825A or S can be converted to a 9825T with an upgrade kit. Local HP sales personnel can upgrade your 9825 in their office or yours.

The kit provides 62K bytes of read/write memory and built-in option ROMs. The upgraded 9825T will operate without any loss of speed.

Many functions previously available only as plug-in options have been integrated into internal ROMs (read-only memories) of the 9825B. These internal ROMs are: Strings, Advanced Programming, Plotter, General I/O and Extended I/O.

The 9825T includes 62K bytes of read/write memory, all the built-in ROMs contained in the 9825B, plus a built-in Systems Programming ROM.

The Systems Programming ROM is still available as a plug-in option for the 9825B. The Matrix ROM and the 9885 Flexible Disc ROM are available as options for both the B and T models.

The 9825B and T also include the improved typewriter keyboard that was introduced on the 9825A/S a few months ago (see Update in *Keyboard*, March/April 1980). The new keyboard provides higher reliability and a familiar, typewriter-like feel that makes entry faster and more comfortable.

HP's premier desktop controller

For data acquisition, instrument control and computation, the 9825 is HP's fastest desktop computer. It can perform direct memory access at up to 800K bytes per second, fast read/write at up to 70K bytes per second, and formatted read/write at up to 16K bytes per second.

All 9825 models have three I/O slots, expandable to 14.

The 9825's usefulness grows every year as the number of available HP-IB instruments increases. There are now more than 100 available from HP. K

Keyboard

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