Keyboard

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Cover

Senior HP art designer Hal Platt's depiction of the Space Shuttle safely returning from a mission is featured. One reason the Shuttle can return to base is that a desktop computer has determined that there is no lightning threatening the craft's re-entry path. For details, see page one. Platt is a sculptor and painter whose work has been displayed in various galleries.

1 Find the lightning, save the mission
Engineers at the Kennedy Space Center, Florida, are planning an airborne lightning locater system to circumvent the risk that the Space Shuttle will be struck by a thunderbolt as it leaves or returns to base.

4 A place in the sun
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Photo and artwork credits

page 1,2,3 — courtesy of NASA, Kennedy Space Center, Florida.

pages 4,6,7 — Stiebel Eltron Company, Holzminden, West Germany.

page 5 — diagram, Paula Dennee.

page 10, 11,12 — U.S. Naval Torpedo Station, Keyport, Washington.

Find the lightning, save the mission

by John Monahan
Assistant Editor

The numerator of the John F. Kennedy Space Center is manifest by the seven silent rockets standing sentinel at the Visitors' Information Center; the denominator is found along the Indian River nearby, where pelicans keep their guileful eyes alert for fish.

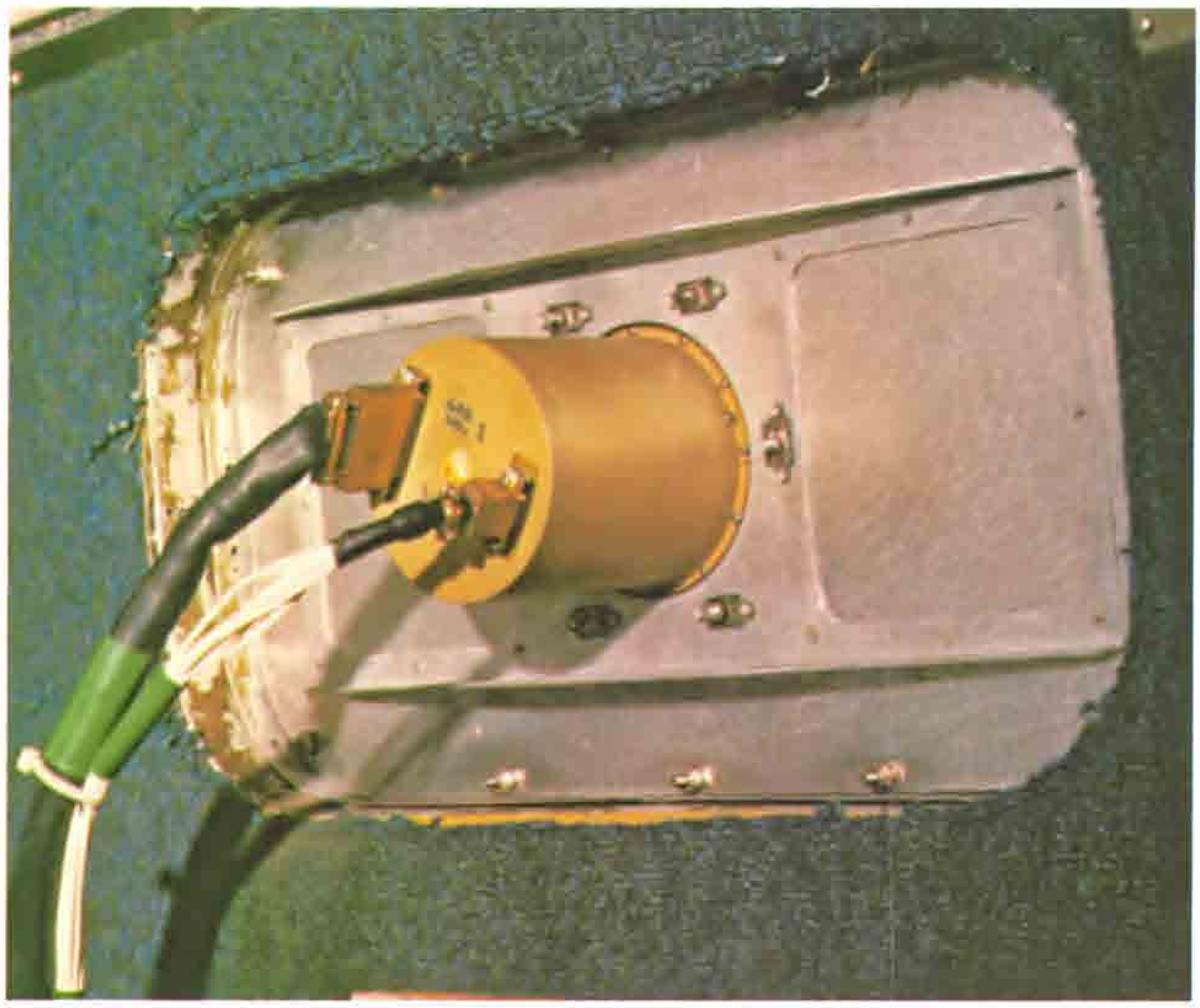
It is a salient juxtaposition that the very place where the evolution from earth-orbiting satellite to lunar lander took place should stand within the Merritt Island National Wildlife Refuge, dedicated as it is to preserving the engine of natural evolution. Man's most earnest technological strivings to overcome nature, are counterbalanced by the daily workings of nature. And so the rocket/and so the pelican.

The bird that most watchers are looking at today, however, is the Space Shuttle. Under the direction of the National Aeronautics and Space Administration (NASA), the vehicle is designed to transport heavy cargoes into earth orbit. But unlike the rockets at the Visitors' Center, the manned Shuttle may be reused as many as 100 times. It's a rocket when it leaves earth, and an airplane when it returns.

Through the years, NASA has earned a reputation for covering all contingencies associated with the complex task of launching men into space. The hardware itself presents a challenge to engineering acumen, but to a degree it is controllable; the realm of the pelican is not. This is where Charles Tucker of NASA's Telemetry Section of Design Engineering enters the story.

The friendly Southerner, who has been with NASA for ten years, works under the title of airborne field mill system engineer. His assignment is not to control nature, but rather to help predict one of her most capricious forces: lightning. In 1969 the manned Apollo 12 launch vehicle, on its way to the moon's Sea of Storms, was struck by lightning several thousand feet above the earth. While the mission was successfully completed, the consternation the incident caused later spurred NASA to start thinking about better ways to determine when atmospheric conditions are conducive to lightning.

For the last year Tucker and his associates have been devising an airborne field mill, a kind of lightning forecaster in the sky. Central to this data collecting and



One of four airborne field mills affixed to fuselage of prop aircraft used in initial tests.

analysis system is the Hewlett-Packard System 35B Desktop Computer, made in Fort Collins, Colorado, USA.

Hunting thunderbolts

The "mill" in airborne field mill describes the operation of the unit, because it "chops" or mills the atmospheric static electric field. (Four of the mills are currently mounted in prop aircraft for testing purposes.) When the Shuttle begins regular service, the mills will be mounted in a jet. The airplane will climb to an altitude as high as 50 000 feet (the limits of storm clouds) and descend in a spiral along the path the Shuttle will take on launch or reentry. The mills will take five electric field samples per second, and feed their readings to the System 35B.

The desktop computer will analyze these readings, and activate a digital display in front of the pilot, who then radios to launch officials the computer's findings concerning where in the atmosphere lightning is probable. On a normal Florida day, Tucker says, one can expect 200 volts of "potential electricity" per meter of air. Lightning is indicated when the potential climbs between 10 to 30 kilovolts per meter. Using these parameters, launch officials will have immediate and reliable data to use when deciding if the Shuttle should be launched or where it can safely land.

NASA has not been oblivious to the lightning problem; indeed, Tucker says the agency boasts the most sophisticated prediction system in the world. Still, the ground field mills used by NASA since 1974 have limitations. Tucker observes that these mills often have difficulty making accurate readings immediately after a storm. They may correctly give a low-altitude ground-to-air static field result, but cannot precisely indicate conditions higher in the atmosphere. He views the airborne field mill as a needed complement to the earth-based ones.

Mission accomplished

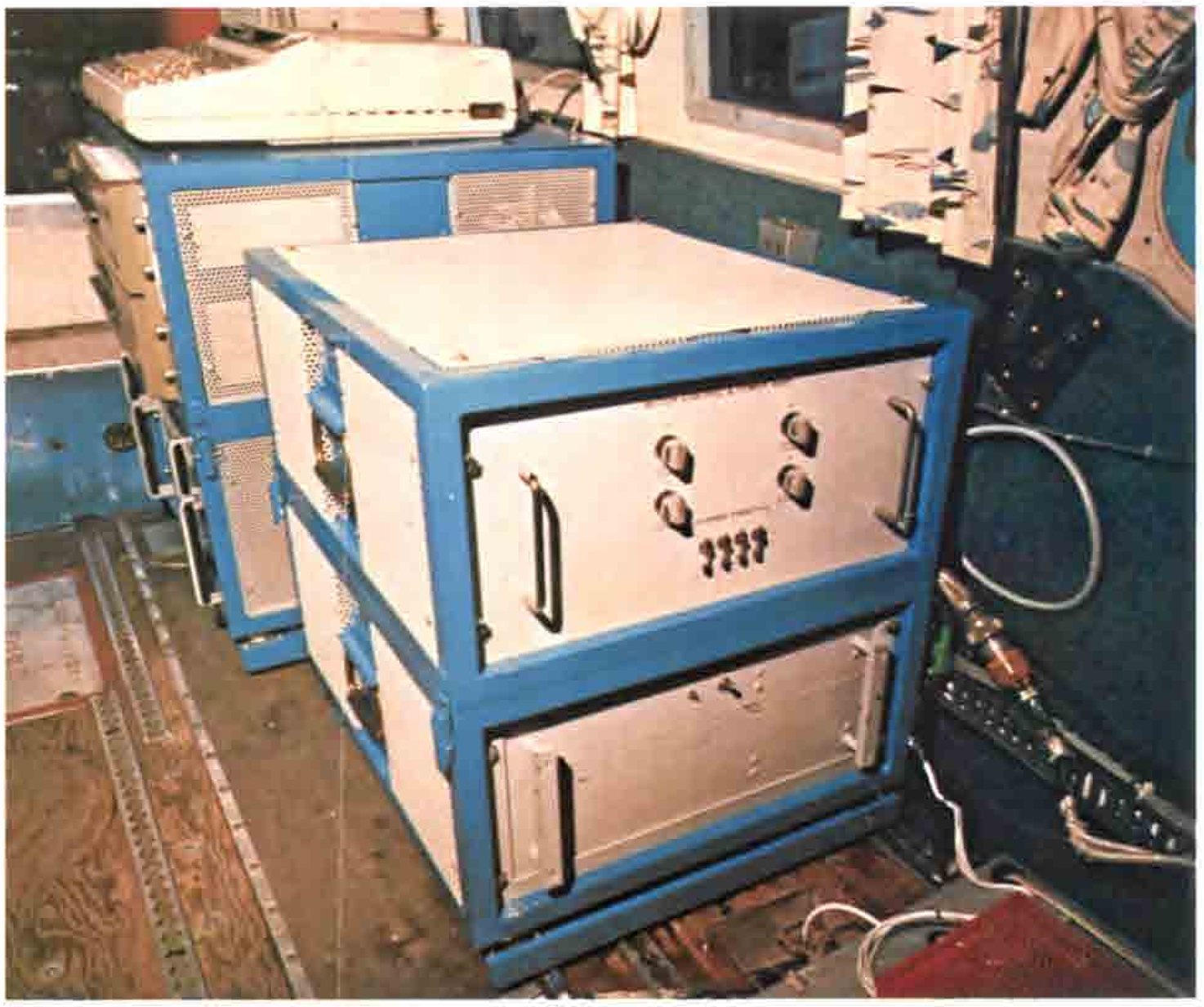
Plans, if approved, call for the airborne field mill to be in service when the Space Shuttle begins its regular space visits next year. The Shuttle is a big target, and helping it avoid lightning that could damage the craft is a prime concern. However, as Tucker points out, the field mill system could lead to a considerable savings in taxpayers' dollars.

Like a commercial airliner, the Shuttle will be expected to fly rain or shine. If Tucker's mill can determine that the Shuttle's launch trajectory will take it along a path where lightning is unlikely, the mill will save the high costs of scrubbing the launch and rescheduling the mission.

Similarly, upon the Shuttle's return, the mill might determine that although it's raining at either of the two regular landing sites — the Kennedy Space Center in Florida or Vandenberg Air Force Base in California — the entry path is clear of lightning and the Shuttle may proceed. If the atmospheric conditions were not as precisely measured as afforded by the mill, the Shuttle would be diverted to an alternative landing site in the western United States, and then transported back home atop a Boeing 747 jet aircraft. The costs of moving a vehicle 37 meters (122 feet) long, with a wingspan of 24 meters (78 feet), and weighing 68 000 kilograms (150,000 pounds) loom as large as the craft itself.

Tucker and his associates, including James Stahmann, Stan

Thomson, and Michael Brooks of Planning Research Corporation, were required to complete work on their airborne field mill system in nine months. The reason for the tight schedule was that the test aircraft was slated for other uses. Out of this urgency Tucker opted for a desktop computer.



The System 35B fits easily inside the test airplane along with hardware it controls.

'Canned success'

"We looked at micro-computers," he says, "but we would have had to build them up from the board level. We needed something we could buy, take out of the box, and start to work with. I call it canned success."

The field mills consist of four plates, above which a rotor spins at 3000 rpm to cause the chopping effect. On the jet they will be situated in the tail, right and left in the fuselage, and in the belly.

Three mills measure electric fields in three dimensions from the aircraft: magnitude, azimuth, and elevation. It is therefore possible, using the computer, to determine not only the magnitude of the electric field in a storm cloud, but the direction of the field, and hence charge location. The fourth mill monitors charge build-up on the airplane. This factor is corrected by the System 35B automatically to insure that only the atomospheric electric field is gauged.

Data from the field mills streams to the desktop computer via an HP 6940B Multiprogrammer. Two HP 9885 disc drives act as data storage media; each 0.5M byte disc fills up with data in 45 minutes, so during the average hour-long flight the pilot has 30 minutes to spare. The entire system was connected using the HP-IB interface. "For this application it was much easier to program with HP-IB than with 16-bit (parallel)," Tucker says.

The pilot need not worry about the mills' functioning, because the System 35B performs an out-of-tolerance test to ascertain that all systems are go. Moreover, the computer monitors the speed of the mills' rotors, to assure they are turning at the proper rate. When the plane returns, the data from the discs is printed by an HP 9876A Thermal Graphics Printer for further analysis.

Software for the System 35B was written by Chuck Simmons of Planning Research Corporation, a Kennedy Space Center-based contractor to NASA. For Simmons, who is a senior software analyst, it was his first time working in Enhanced BASIC, the System 35B's built-in programming language.

"I was used to working in FORTRAN," he says, "but there was a lot of similarity between the two (languages), and it didn't take a long time to learn." Simmons adds that when the switch is made from the prop aircraft to the jet, he will convert BASIC into ASSEMBLY language because the latter provides a faster execution speed.

One giant leap

Several years ago a poll was taken among the world's historians that asked them who were the 100 greatest movers of history. Among the select people named was President John F. Kennedy. He will be remembered, the chroniclers opined, not for any political achievements, but because he was responsible for launching mankind's greatest exploration: to send someone from this dim planet to the moon.

As you walk among the seven rockets at the Kennedy Space Center, you perhaps realize that all mankind has to remember past glories are the symbols we erect. It is like visiting statues of heros from distant wars. Yet there is one difference. These are not monuments to a feast of vultures, but to another kind of human struggle: to go where no pelican will ever fly. K

A place in the sun

Der Markt von Geräpen zur Gewinnung von Sonnenenergie wächst weltweit sehr schnell. Da die meisten von uns relativ wenig über Solarenergiesysteme wissen, wurde das Bereitstellen von zuverlässigen Informationen über Solarenergie genauso wichtig wie das Bauen und verkaufen von Geräten. Die Firma Stiebel Eltron in Holzminden, West Deutschland hat mit Hilfe eines Tischcomputers eine universelle Methode entwickelt um diese Informationen der Öffentlichkeit bereitzustellen.

by Christoph Sobotta and Bill Sharp

Assuring an energy supply through conservation, innovation and development has acquired the same importance as assuring a supply of food, water and air. Energy is something we must have; there is no alternative. But at times procuring enough of it seems an unattainable goal.

And yet, as individual human beings, there is a lot that we can do. The owner of a house or commercial building does not need the perfect solution to the energy shortage. All he needs is a solution for one structure — and something that is available now.

Research scientists spend a great amount of time seeking the ultimate answer to dwindling energy supplies. While they ponder these great questions, a large part of the answer to near-term energy needs is streaming down onto the roofs over their heads.

Sol, our sun, cannot satisfy all our earthbound energy requirements with existing solar technology, but it can be used by any of us to help meet our needs.

Solar energy can bring to mind vast arrays of mirrors concentrating photons from a large area onto a single target boiler that is fried by intense heat and supplies steam-generated power to hundreds of homes. Solar energy can also be a single collector on the rooftop of one home.

Companies now offering systems that use solar energy must face the challenge of convincing the public that these products work well and save money and resources. Desktop computers are aiding this educational process.

Smaller scale

All over the world people have become conscious of the energy problem. This prompted Steibel Eltron to enter this field at the beginning of the 1970s, and we now manufacture heat pumps and solar energy systems along with our electrical products. As a result, our company is one of the foremost and best-known manufacturers of solar energy systems in Europe.

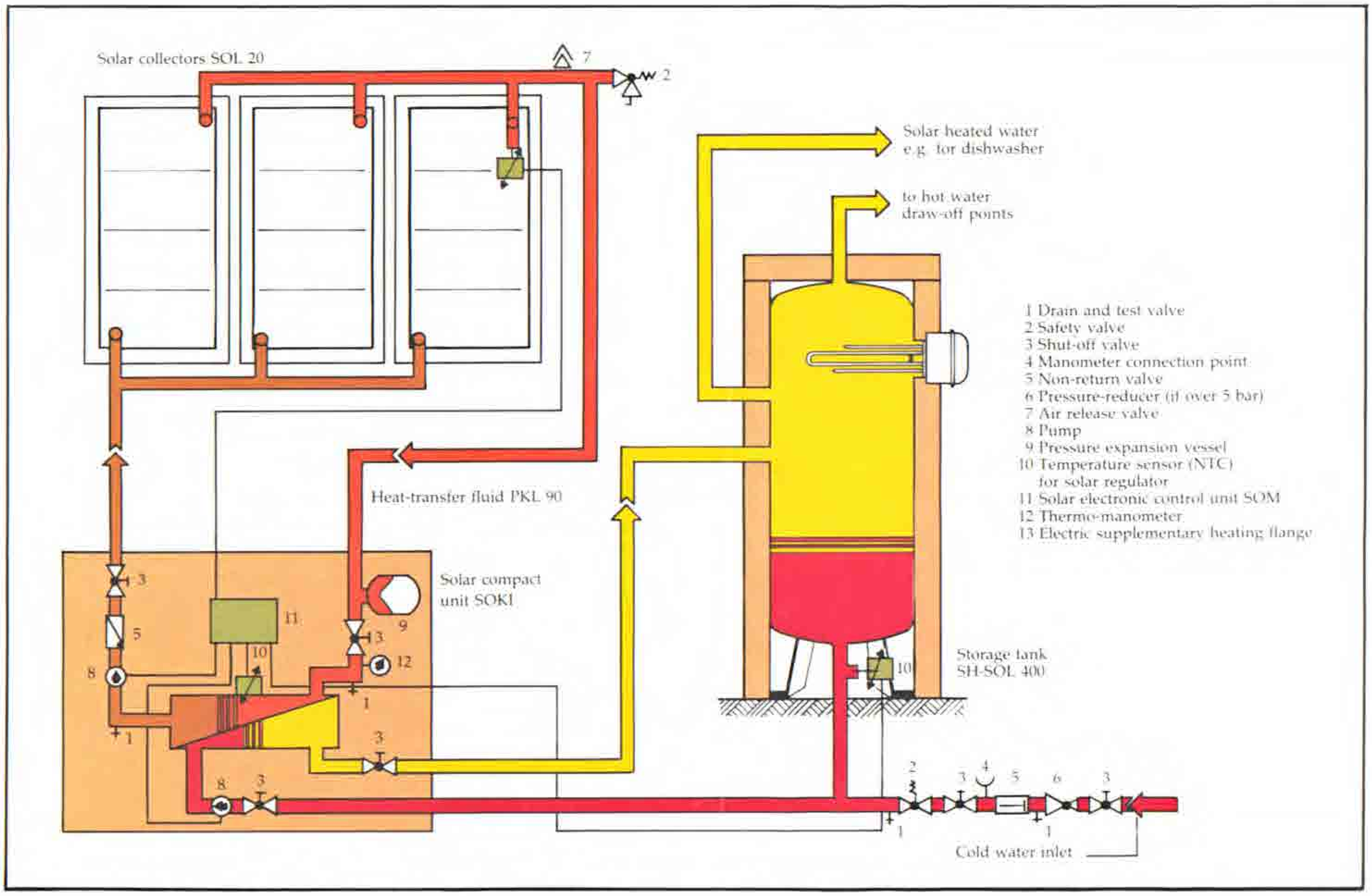


Diagram of a Stiebel Eltron solar hot water system with supplementary heater. Each system is tailored to the customer's needs.

Holzminden, West Germany, is the headquarters of our organization, and we have factories in Holzminden, Berlin, Eschwege, Saloniki (Greece) and the solar factory in Spittal on the Drau in Austria.

Our solar hot water systems must be reliable, they must be flexible to allow tailoring systems to individual needs and must perform under a variety of climatic conditions to serve all of our customers. We have developed a solar hot water system that meets these requirements.

Indirect approach

The design of these solar collector systems is entirely new. We optimized the system to serve the needs of all Europeans, so that we could help people who live in sunny locations without neglecting others who have less sunlight. The way we accomplished this was to develop a collector that gathers indirect sunlight with great efficiency.

Most collectors work well only with direct sunlight, meaning that on cloudy days, or in places where some of the direct sunlight is blocked, these collectors work poorly. Our collectors are designed to gather this indirect, or scattered, light.

Trees, clouds and other objects block solar radiation and create high percentages of indirect radiation. If you are only going to collect direct radiation, you need a very simple collector design. Our collector design is more complex, and is effective for gathering indirect radiation.

These collectors have to perform well under conditions that vary greatly depending on where they are installed. Sunny and hot conditions are much more common in, for instance, Greece, than in Germany. But we sell our collectors in both areas.

We examined the storage of hot water as well. If you attempt to attain very high temperatures in a solar hot water system, as many collectors do, you have a correspondingly high heat loss throughout the system. The greater the temperature difference between the water stored and the surrounding air, the more heat tends to be lost.

Lower temperatures

So we decided to build systems that use water at a lower temperature. We found that it is more efficient to have a larger storage device and operate at a system temperature of 45C (113F). At this temperature you use more hot water, but this is not a problem because there is more. We use a larger hot water storage tank along with the lower-temperature collectors.

While the system is designed to produce large amounts of water at 45C, it will tolerate higher temperatures without trouble. It will operate at up to 90C (194F) before shutting off for safety.

Electronic switches linked to sensors turn on the medium circuit

to the collectors only if the temperature of the medium in the circuit is greater than the temperature of the water in the storage tank. So, while the normal operating range for the collector is 45 to 65C (113 to 149F), it will operate at as low as 20C (68F) if the tank is colder.

Linking the collectors and the water storage tank is the control panel. This small panel is a module that includes the heat exchanger and all gages and controls for the system.

When an installation is designed for a location, it is set up so there will seldom be any need for supplementary water heating by an electric or gas heater. We do, however, recommend that one be kept as a standby in case of prolonged poor weather. Additional heating may never be necessary in Greece, but may sometimes be needed in northern latitudes during winter.

Collectors look more like skylights in this home in Frankfurt am Main, West Germany.

Computer

We have used our desktop computers in a novel way. Our greatest problem is getting information about our solar products to the public. Our Hewlett-Packard System 45 Desktop Computers have provided this link.

A program we developed for the 45, System Stiebel Eltron, makes it possible to give each customer a precise description of a solar water heating system designed for his specific needs. If a customer describes a household, and the information is entered into the computer, we can produce, in seconds, a complete description of a Stiebel Eltron solar hot water system that will meet the needs of that particular family.

Data for different parts of Europe provides us with an accurate picture of sun-hours and seasonal variation in available solar energy. This data is stored as part of the program and is used to help compute the needs of each customer.

If you are a customer seeking specifications for a hot water solar system for your house, we would ask you first for the angle and azimuth of your roof. This tells us how close your roof is to the optimum slant and directional orientation to capture maximum sunlight.

Printed answers

Other information that is needed for the program is the location of the home, the number of people in the household, and an estimate of the current daily consumption of hot water. The computer automatically pulls the additional information it needs from its data files.

The program not only optimizes the system needed, but tells you how large the storage tank should be. The whole system is devised for the customer on the 45. The computer dumps its computed values to an HP 2631A Printer, which prints the answers on a pre-printed form.

This form gives the customer a detailed description of the system needed to do the job for the specified building. The program also can be run with varying numbers of collectors so that a customer can see how the system performance would be affected by changing the number of collectors from the number recommended by the 45. The computer will produce this output in English, German, French,

Shades to screen the sun, and collectors to trap it, save energy in these apartments.

Danish, Italian or Greek, depending on the location of the customer.

In addition to producing this printed report, the computer also controls a 9872A Plotter, which charts a performance curve for the system as specified. This color plot is made on a pre-printed form as well. The chart shows the predicted variation of stored hot water temperature during different seasons.

We have five systems, each of which includes a System 45, a printer and a plotter. We keep three of the systems at our headquarters in Holzminden, and one each in our main offices in Austria and Greece. For meetings and other occasions when we want to take the computers away from our offices, we have two vehicles that can each carry one of the systems to special locations.

Most of our customers want the solar collectors to supply hot water for household or non-process business use, but the collectors are also being used for home heating systems and for swimming pool water heaters.

Acceptance

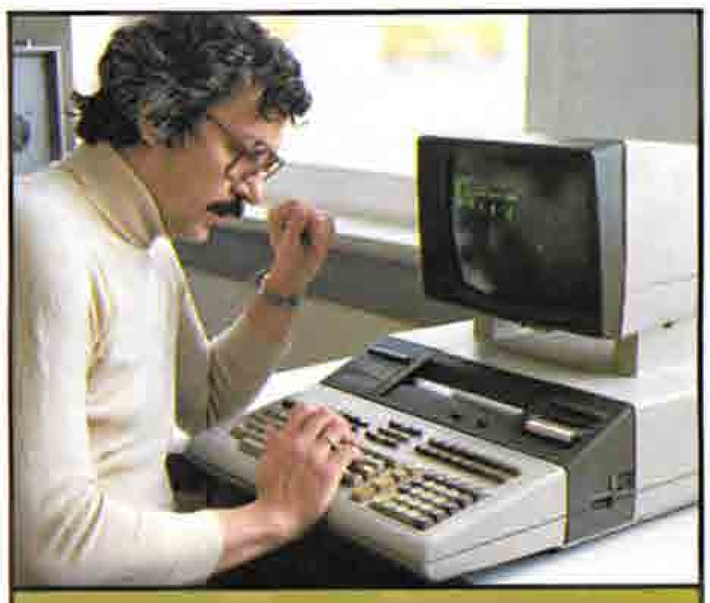
Solar collectors are moving rapidly into the marketplace because they provide people with an increased measure of energy independence. Solar collectors provide a solution to hot water needs at a known cost, eliminating the unpredictable but certain cost increases associated with coal, oil or gas systems.

The relatively high initial cost of solar heating systems is one of the most difficult parts of this solution, but it is an aspect that is declining in importance almost daily. More and more governments are subsidizing solar installations because the conservation they promote benefits the population as a whole.

When we first began marketing our solar hot water system, we estimated that the time required for the systems to amortize would average 10 to 15 years. But with every increase in the cost of oil, the payback period is reduced.

While our first customers tended to be people who just wanted to have the very latest in new technology, we now attract people who recognize the opportunity to save money and ensure that they are less vulnerable to an energy shortage.

For a steadily growing number of reasons, solar energy is becoming an important part of the world energy supply. And because it is not subject to continual price increases or abrupt cutoffs, and as it provides individuals with increased independence, it is rapidly evolving into the solution of choice. K



Christoph Sobotta joined Stiebel Eltron in 1977 and works in the research and development department as a computer specialist.

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Desktop computer applications at HP

Desktop helps diminish EMI

Ray Padilla uses the desktop computer with spectral analysis equipment to measure EMI from new desktop computers. The "quiet" screen room is behind the 9835.

by Christel Stumbough
Keyboard feature writer

EMI, or electromagnetic interference, is an annoying by-product of time-varying electric currents and a pain in the side of computer system designers. When engineers use highly sensitive electronic equipment, for example, EMI can cause output of wrong or spurious characters. In some cases it can cause total shutdown of an electrical system.

One of the many quality control testing procedures performed at Hewlett-Packard's Desktop Computer Division in Fort Collins uses an HP desktop to ensure that the radiated interference level of HP products remains as low as possible. With the help of an HP System 35A Desktop Computer, control technicians perform these "electrical noise" detection tests quickly, and with increased reliability.

According to Ray Padilla, environmental lab supervisor at DCD, radiated interference is just one facet of EMI. The other component, conducted interference, deals with unwanted electrical signals channeled between the noise source and the receiver. However, it is the radiated (or emitted) interference that we perceive as electrical noise and that creates static on our radios, and data interference elsewhere.

To measure this noise, Padilla uses a set of three antennas and three pieces of Hewlett-Packard equipment. A vertical whip, a biconical and a log spiral antenna detect any electrical noise generated by the products being tested. The analysis system itself includes an HP 8568 Spectrum Analyzer, the System 35A Desktop Computer, and an HP 9876A Thermal Printer. An HP-IB Interface links the spectrum analyzer with the System 35 and the printer.

Screen room

As part of the standard quality assurance procedures at DCD, workers take noise measurements in a specially designed, electrically "quiet" test room, called the screen room, or at an open-field test site. The spectrum analyzer takes a reading of the interference radiated by the desktop product in the screen room.

The data from these readings is stored in the System 35, and displayed on the CRT screen of the spectrum analyzer in terms of amplitude (signal level) and frequency. Hard copy samples of the visual data are provided by the printer.

Besides storing noise level data and controlling the thermal printer, the System 35 prompts the computer operator by providing programmed instructions on the correct procedures for taking readings. Padilla set up the system about a year ago, when he ascertained the need for data storage and hardcopy output. Jim Stroh, who works with Padilla, wrote the software.

Time savings and reliability

Padilla also realized the additional benefit of the time savings possible in automating this portion of the quality control testing at DCD. The present test procedure requires two minutes to complete, compared to a previous time requirement of two hours for manual testing.

In addition to saving time, the system has increased test reliability. Since quality checks are performed in such a short amount of time, additional readings are taken to help ensure the accuracy of the results. And unlike the spectrum analyzer, the System 35 stores the data for later reference and for use in quality assurance reports.

Until newer developments increase our understanding of EMI, quality control workers at DCD will continue to use the System 35 to do their best in the fight against electrical noise pollution. K

Application software is available through the program exchange library of the Software Catalog Service. For more details, contact your local HP sales office.

Flexible disc care

by Rick Spangler
Hewlett-Packard Company
Greeley Division

Minimizing media wear is critical to the reliability of flexible disc drives. For this reason, Hewlett-Packard undertakes extensive testing and control over its selection of media for use on the HP line of 5 1/4-inch and 8-inch, double-sided, double-density flexible disc drives.

It is a common misconception that a flexible disc will last forever. When the medium fails, critical data can be lost. You might blame the disc drive. You could point the finger at medium. More likely you should blame yourself. Proper media handling, storage and periodic replacement are critical.

The best way to optimize your success with flexible discs is to treat them carefully. The magnetic coating on the surface of the disc is only 100 microinches thick, so the smallest scratch can ruin it.

A good rule of thumb is to treat your disc as you would a valuable record album. Here are some DOs and DON'Ts to protect your disc.

• DO return disc to storage envelope when not in use — if the disc is laid on a desk unprotected, it will collect dust. This is the most common cause of media failure. Also, the disc is not a frisbee; don't throw it around.

• DO remove disc from drive when not in use. This is especially important on eight-inch media because the disc continues to rotate even if it is not being accessed. This rotation causes wear due to particles trapped in the jacket.

• DO operate your system in a clean environment — a dusty environment is deadly to a floppy disc, causing both data errors and premature wearout. The most common contaminants are dust, smoke, ashes, erasure crumbs, bread crumbs and chemical vapors.

• DO maintain proper temperature and humidity — the proper operating range is 10 to 40C (50 to 104F) and 20% to 80% relative humidity. Variations in temperature and humidity cause the disc to expand, which moves the head off track. High humidity reduces wear. Low humidity allows static buildup which attracts dust.

• DON'T touch the magnetic surface — fingerprints are killers, particularly on the double-sided discs. The thickness of a fingerprint is enough to lift the head off the disc and cause errors.

• DON'T damage the disc — don't bend, fold, staple or mutilate the disc in any way. Label the disc with a soft felt tip pen, not a ball point.

• DON'T try to clean a disc — the inside surface of the disc jacket is covered with a special material that cleans the disc as it rotates. Any other cleaning method may cause solvent damage or scratches.

Besides proper handling, there are two other essential procedures you should follow for successful system operation.

First, always make a backup copy of critical data. Since flexible discs are susceptible to damage and wearout, it is important to have a backup so you won't lose your data.

The second procedure is to replace discs before they approach wearout. Because a flexible disc is in direct contact with the read/ write heads, wear is inevitable. If the medium is used beyond the recommended life span for a given application, it can fail.

The table below gives some recommended replacement times for double-sided media in different applications. Single-sided discs generally wear longer (when in doubt, be conservative). K

Recommended replacement frequency for double-sided flexible-disc media is:

Usage	Example	Media Replacement Frequency
<20 minutes/day	Disc backup, software distribution	1 year
4 hours/day occasional access	Program storage or file access	6 months
4 hours/day moderate access	Business application some use of data base management	4 months
8 hours/day moderate access	Business application some use of data base management	2 months

Shock-testing torpedoes

Keyboard staff article

There is an old joke that usually is recalled only when one is high off the ground and in an unstable situation.

"Don't worry about falling," somebody inevitably says, "just watch out for the sudden stop at the bottom!"

This is true of things as well as people. If an item is fragile or potentially dangerous when handled roughly, you need to be certain that it can handle those sudden stops at the bottom.

It is especially true of underwater armaments. They must be highly sensitive in order to be deployed effectively. Yet they must also be able to withstand the inevitable shocks encountered in shipping, loading and firing without detonating at an inopportune moment.

At the Naval Undersea Warfare Engineering Station (NUWES), Keyport, Washington, USA, shock-testing procedures have been automated through the use of desktop computers and high-speed plotters. The result has been more extensive and more accurate testing with the same manpower.

"Before small computers became sufficiently advanced and low enough in cost for us to use, we had to rely on a cumbersome oscilloscope/camera setup to obtain records of shock testing," says Richard G. Widdifield, senior project engineer for the environmental sciences branch of the Weapons Quality Engineering Center at NUWES.

"It was a very time-consuming process, and because it was sometimes more qualitative than quanititative, the photographic reords we obtained were frequently subject to varying interpretations."

Seeking a system

To find a system that could produce accurate and repeatable results from test to test, Widdifield and Joe Haptas, his senior engineering technician, looked at a number of computers and test components.

Says Haptas, "We wanted something that could give us hard data with a minimum of operator attention."

A combination of devices was selected: an HP 9825A Desktop Computer, HP-IB Standard Interface Bus, Endevco Smart System (accelerator charge amplifier and digitizer) and an HP 9872A Four-color Plotter. This combination produces an average of 50 test plots daily.

A variety of shock tests are conducted at NUWES on electric- and fuel-propelled torpedoes and mines. Target dummies, which are programmed to sound and act like

"Without frequency-spectrum information, there was little we could do to salvage these tests."

enemy submarines, are also checked.

Qualification tests are conducted on representative samples from a purchase lot. The government can only purchase the lot if the samples meet necessary shock-resistance specifications. NUWES conducts other shock tests for design and informational purposes.

"The equipment allows us to produce shocks that may range from 5 to 10 000 gravities for 0.50 to 50 millisecond durations," says Widdifield.

"Generally, the greater the shock, the shorter its duration. For example, a component might be exposed to a 3-gravity force for 50 milliseconds or a 60-gravity force for 8 to 10 milliseconds. Each shock test usually consists of one to three separate shocks along one or both directions of up to three axes of a given component or assembly."

Under the old system, an accelerometer mounted on the test fixture produced a waveform and displayed it on a scope. The image of the waveform was then photographed as a verification of the test.

Calibration factors, test axes, ID numbers and other data were written down on the back of the photograph. Time, film costs and difficulty in duplication were significant problems with this method, as was the absence of numeric data.

"If we were testing a gyroscope at 60 gravities for 8 milliseconds, we would expect a clean half-sine waveshape," Widdifield notes. "If there was something loose in the package, however, it would distort the waveform to the point of being almost unrecognizable. Without frequency-spectrum information, there was little we could do to salvage these tests."

Worker looks at plots from dedicated 9825.

Haptas adds, "The system we constructed to solve these problems gives us more than the time history, or waveform, of a shock test. It provides a frequency analysis of the shock and annotates the resultant plot with information such as the test date, identification number, and test axis."

Shock tests

There are three separate shock testing systems at the NUWES facility. Each includes several components.

A metal shock platform undergoes a freefall drop to produce the shocks. The height of the drop is proportional to the amplitude of the shock produced. The platform includes test fixtures for more than 150 different components and assemblies. These fixtures allow multiple-axis testing.

Each test system includes three shock tables; a four-square-foot version, a two-square-foot version and a six-square-inch version to accommodate different-sized components. An accelerometer, a piezoelectric device that produces a charge when shaken, is attached directly to the test fixture to produce acceleration data. A charge amplifier receives and amplifies signals which then are coupled with a known capacitance to produce an output voltage proportional to the amount of physical shock.

A digitizer or digital voltmeter converts the amplifier's output voltage to a digital quantity, which is relayed via a standard interface bus to the computer. The interface also carries control signals from the computer to the sensors.

The desktop computer provides data collection, manipulation functions and waveform processing. A four-color plotter linked to a second 9825 produces the graphs and annotations for the tests with data tapes taken from the first computer.

Operation

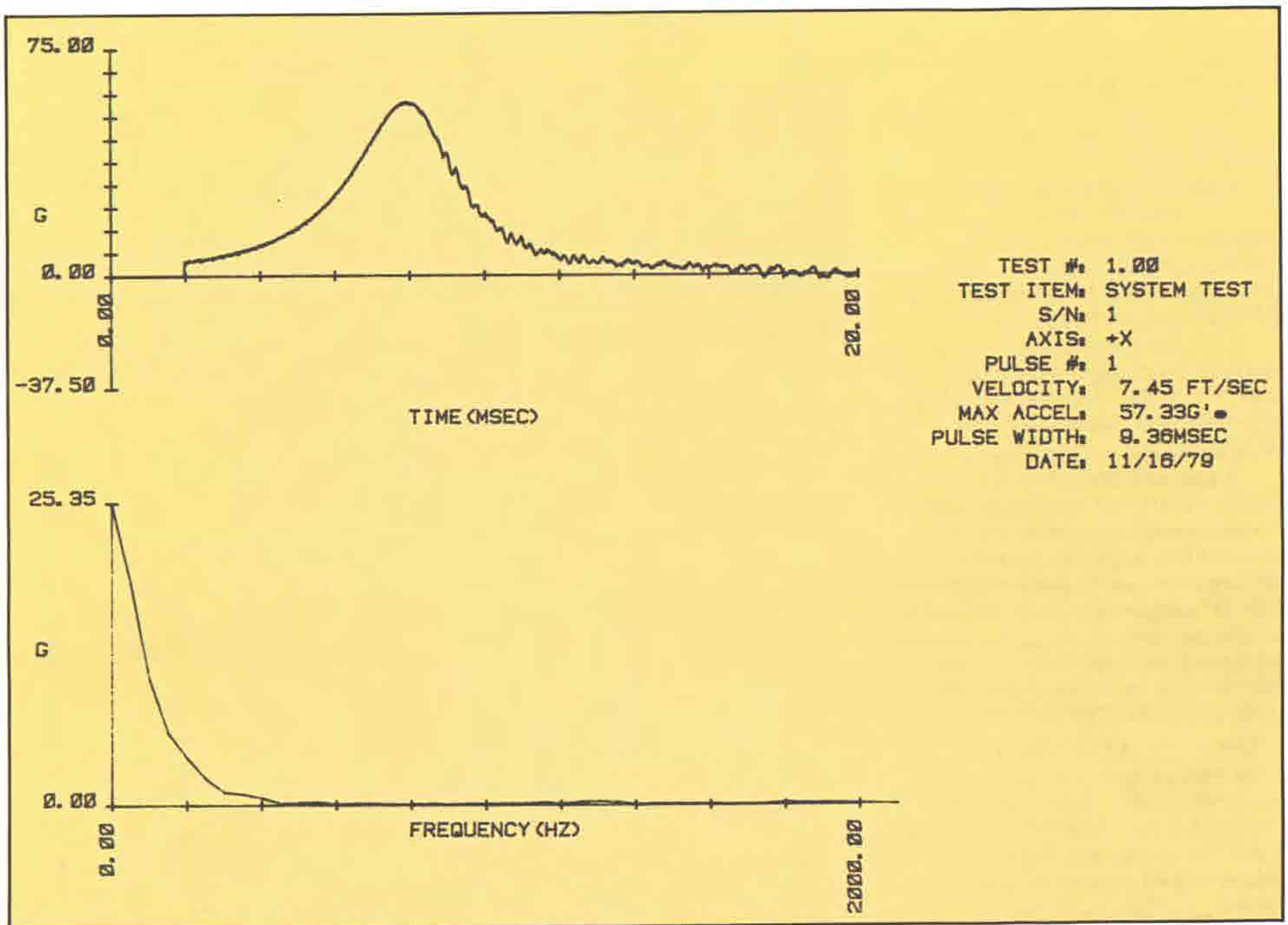
In operation, a test component is placed in the proper test fixture and, depending on its size, is attached to one of the three test tables. The accelerometer is then clamped to the test fixture and the height-drop mechanism of the table adjusted for the proper number of gravities and for test duration.

The test begins when the shock platform strikes a special surface. The waveform of the shock is captured by the fixture-mounted accelerometer, and is then amplified and digitized as a voltage. The digitized value then is relayed to the 9825 via the HP-IB interface.

The desktop computer performs all data manipulation and waveform processing necessary for plotting. It finds peak gravity levels and establishes time bases by measuring from a lagging point 10% above the zero-gravity level to the leading point.

Waveforms are also processed using fast-Fourier transformation. This type of processing is accomplished with HP software supplied in a Waveform Analysis Package.

Transient data is stored in the 9825's internal data cartridge. After



This example of output from the plotter shows an event curve for the duration of the shock, as well as a frequency analysis of the shock experienced by the part under test.

data has been recorded, the cartridges are hand-carried to a plotting room and inserted into a dedicated 9825, which drives the plotter.

"Our plotting setup gives us plots with a time history, frequency spectrum, test axis and directions, item and serial number, number and direction of pulses, maximum acceleration and velocity and maximum pulse lift," Haptas says.

Widdifield and Haptas report that plans are underway to enhance the system's capabilities.

"We have already run data lines from the test floor up to the plotting room, so the need to carry up data cartridges will be eliminated," says Widdifield.

"Other plans call for disc data storage in the plotter room, which will relegate the data cartridge system to the role of a backup. We also hope to add an automatic-feed plotter, which should eliminate the need for a full-time plotter operator. Both improvements should also allow us to plot in real time."

The tests help to make it certain these armaments will detonate only when they must be used. K

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Programming tips

Programs

Keyboard subscribers sometimes submit programs and/or articles about programs that are too long to publish in their entirety, but which may be of use to other *Keyboard* readers. Whenever possible, we will describe these programs and offer copies of the listing and any documentation to readers on request. We cannot be responsible for these programs in any way; we simply make them available to *Keyboard* readers at the request of the author.

Reinforced concrete column design (9820)

The author describes a method he uses to develop designs for "lightened-frame, reinforced-concrete columns using frame analysis" with the 9820. Some of the material with this article is in Czech. The method was developed by Ing. Kvetoslav Zahradnik,CSc., 61600 Brno, P.O. Box 11, Czechoslovakia. The paper, in Czech or English, is available from *Keyboard*. K

Propeller design (9820/9830)

The author reports that this article discusses a program for designing propellers with minimum induced loss. The theory was developed by Professor E.E. Larrabee, and programs using the theory were developed by William H. Phillips.

Propeller planform and pitch distribution can be determined to satisfy given conditions of thrust, airspeed, rotational speed, air density, diameter and number of blades. The programs also compute propeller torque and efficiency under given conditions and plot the blade shape and pitch distribution.

Write to *Keyboard* for a copy of the article. Copies of the program listing are available at no charge from William H. Phillips, NASA, Langley Research Center, Hampton, Virginia 23665, USA. K

Hourly solar radiation (9830/System 45)

This program reportedly computes the total instantaneous solar radiation incident upon a surface of any orientation and angle to the horizontal, situated anywhere in the northern hemisphere. The program computes solar radiation values for clear sky conditions for all months, from sunrise to sunset.

The program requires data on latitude and longitude, local standard time meridian, orientation to south and tilt angle, as well as ground reflectance. If results are desired in any unit other than BTUs per square foot, a conversion factor is required.

Tariq Muneer and Dr. M.M. Hawas have developed the program at the department of Mechanical Engineering, Faculty of Engineering, P.O. Box 9476, University of Garyounis, Benghazi, Libya. A listing of the program and a short explanation are available from *Keyboard*. Please specify whether you would like a listing of the program for the 9830 or System 45. K

Alternative overlays (9830)

Users of the HP 9830 find that program segment overlays allow better use of the computer's available memory. Here is a straightforward approach to structuring overlays.

```
10   REM . . . MAIN PROGRAM
      •
      •
      •
100  ! CHAIN "O'LAY",1000
110   GOSUB 1000
      •
      •
      •
200  ! CHAIN "O'LAY2", 1000
210   GOSUB 1000
      •
      •
      •
```

The overlay module, after being loaded into memory, looks like this:

```
1000   REM . . . OVERLAY !
        •
        •
        •
1200   RETURN
```

This tip modifies another overlay approach featured in the March/April 1979 *Keyboard*.

Tore Persson
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K

Update

Loran linked

In his well-received article on the America's Cup yacht race which appeared in the November/December issue, then-*Keyboard* feature writer John Monahan guessed that before long the LOng Range Aid to Navigation (LORAN) radio network would be linked to desktop computers to make use of the system easier.

Sure enough, we've found from our reader mail that Seimac Ltd. of Canada has linked the 9825 to a Loran-C receiver for Canada's Department of Fisheries and Oceans, while Trimble Navigation, Mountain View, California, has linked a Loran receiver with the HP-85 — happy sailing!

98034B HP-IB Interface

The 98034B HP-IB Interface now is available to replace the 98034A. The new interface offers reduced EMI in many applications, as well as increased immunity to static discharge. The 98034B is completely interchangeable with the 98034A.

As of February 1, 1981, a modification was made to the backplane of new 9825 and System 35/45 Desktop Computers to take advantage of the 98034B improvements. Production of the 98034A will cease July 1, 1981. Without the modification, the 98034B will behave the same as the 98034A.

Statistics at reduced cost

Statistical software for the System 45 Desktop Computer has been bundled into a library which is available at a substantial price reduction.

The Statistics Library includes the following routines which were previously offered only as individual packages:

- Basic Statistics and Data Manipulation
- Regression Analysis Methods
- Statistical Graphics
- General Statistics
- Nonlinear Regression
- Analysis of Variance
- Principal Components and Factor Analysis
- Monte Carlo Simulation Utilities

But that's not all! Substantial enhancements have been made to the data entry and pre-analysis manipulation routines. Improvements have also been added to the graphical routines making them more flexible and easier to use.

The Statistics Library, HP part number 09845-15250, may be ordered from HP sales offices. Required hardware is a 9845T or 9845C.

Our mistake

The March/April edition of *Keyboard* misidentified two photographs. The photo of Frank Berry, which appeared on page 11, was identified as John Gaughan's; John Gaughan's picture, which appeared on page 3, was identified as Frank Berry's. It was also incorrectly reported that a new interface card called the 98037A/S four-channel analog-to-digital converter is available. In fact, that product is obsolete. We regret the errors.

Keyboard

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