tek talk

THE TEKTRONIX, INC. MAGAZINE

SPRING 1965

THE REALLY BIG SHOWS

The lady who works in a soap factory probably dunks her dinner dishes in her company's product. The auto plant foreman drives home through roads teeming with cars he helped build. The power company employee lives his life among appliances and people using them.

Being close to the end use creates an identification of self with product. It's a "fringe benefit" that — let's face it — Tektronix can hardly offer. The Tek employee who fires up a scope after supper is the rare one.

"I often wonder," says the Man in the Warehouse, scratching his head at the shelvesful of instruments, "who uses them all?" He may speak for three-quarters of our employees, who've seldom if ever seen a scope used outside the plant.

If the Man from the Warehouse were to drop in on one of the nation's huge electronics shows, he might come up with an answer: "Why, just about **everybody** uses them."

These shows, like California's WESCON and New York's IEEE, are impressive. First off, they're gigantic. WESCON last August filled not one but **two** of Los Angeles's largest civic arenas, with more than 600 industry booths. First-day registration alone was 18,000. And IEEE is even larger.

Here is wall-to-wall electronics. Here is the whole spectrum of one of the world's greatest industries ($17 billion in sales). Here are components and computers, gadgets and widgets, lasers and masers, TV for today and space systems for tomorrow.

The hubbub is an amazingly organized one. The legendary committee that tried to design a horse and came up with a camel is **not** the one which masterminds either of these shows, among the nation's best-run.

It's a huge and dazzling spectacle, and

the Man from the Warehouse is thoroughly impressed. But one thing is most impressive of all:

The most common instrument—by far—is the Tektronix oscilloscope.

At WESCON (not counting our own display), there was one Tek oscilloscope for about every three booths. Such is the reliance of this giant industry on this one product. The Man from the Warehouse might well suck in his breath and think, "Wow!"

He might find still another cause for pride. That is the show itself.

For the industry spread out there in splendor before him owes a great part of its existence to the fact that there **were** Tek scopes. No technology can progress, no art can expand, until adequate measuring instruments are first available.

Tektronix oscilloscopes have helped bring into being, and extend, large new areas of electronics. And the expanding industry, in turn, requires more and more scopes. The Man from the Warehouse starts to feel smug — but only for a minute.

For here, too, he sees our competitors, more of them than ever. And they are **better** than ever.

That fact, too, makes him feel a little proud. This high technical level means that the leader has set a tremendous pace. And, if competition **is** better than ever, it still remains true that customers measure scope quality against Tektronix' standard.

There are worse wounds, thinks the Man from the Warehouse, than nibbled heels.

Engineers who've attended trade shows for years treasure one story, and tell it in a variety of ways. One year, in our booth we featured a scope with its sides off, to display the superb craftsmanship. The chief engineer of one of our competitors came running up, with some underlings in tow. He pointed to the instrument:

"There!" he said. "**That's** the way I want you to build them. Like **that!**" ■


SONY

THIS SYMBOL, REPRESENTING A HERON, STANDS FOR "LONG LIFE." WHEN USED AT JAPANESE WEDDINGS, IT SIGNIFIES A LONG AND HAPPY MARRIAGE. SO MAY IT BE WITH SONY AND TEKTRONIX IN THEIR JOINT VENTURE.

"Sony/Tektronix" isn't a name that trips along lightly on the tongue.

But what it lacks in euphony it more than makes up in promise. And, if the two names **are** unlike, the companies they stand for are strikingly similar.

The announcement in January that Sony Corporation and Tektronix, Inc. would form a jointly owned Japanese subsidiary signaled a joining of hands by two businesses whose histories, operations and even philosophies parallel one another's to an unusual degree. Statements by spokesmen from one company are hard to distinguish from those of the other.

Sony/Tektronix is now a reality. The necessary formalities were concluded in Tokyo in late March. Production will begin there sometime in May.

Although there are certainly differences between the two parent companies, a quick glance shows that in many, many ways they are alike:

Both companies began in 1945: Tektronix in a corner shop in southeast Portland; Sony, even more humbly, in a boarded-up room of a bombed-out Tokyo department store. (The name "Sony" came later; they began, sonorously, as Tokyo Telecommunications Laboratory.)

Both businesses incorporated in early 1946.

Tek marketed its first oscilloscope in 1947, Sony its first tape-recorder in 1948. While developing these products, both young companies paid their way by electronics sales and service: Tektronix by selling and repairing TV sets; Sony by fixing broken-down phonographs, and converting standard radios to shortwave.

Both now have somewhat similar annual sales: Sony, $92 million last year; Tektronix, currently about $79 million.

Both were founded, and are managed largely, by scientists and technical men. Both plow a very large chunk of their income back into research and development. Both have research-engineering activities of similar size. In both companies the president, rather than being merely an administrator, has remained a strong creative force in product innovation.

Earl Wantland, one of Tek's three ST directors, comments on the similarity between the two presidents: Both, he notes, tend to play the same role in their respective companies: Generation of new ideas; provoking new thoughts, and acting, in general, as a catalyst in engineering and design.

Sony and Tektronix both have displayed pioneering courage, the willingness to gamble on products or techniques that other companies had avoided. "We do what others don't" is a favorite motto of Sony President Masaru Ibuka. A Tek manager said the same thing in different words: "The right idea for others isn't always the right idea for us."

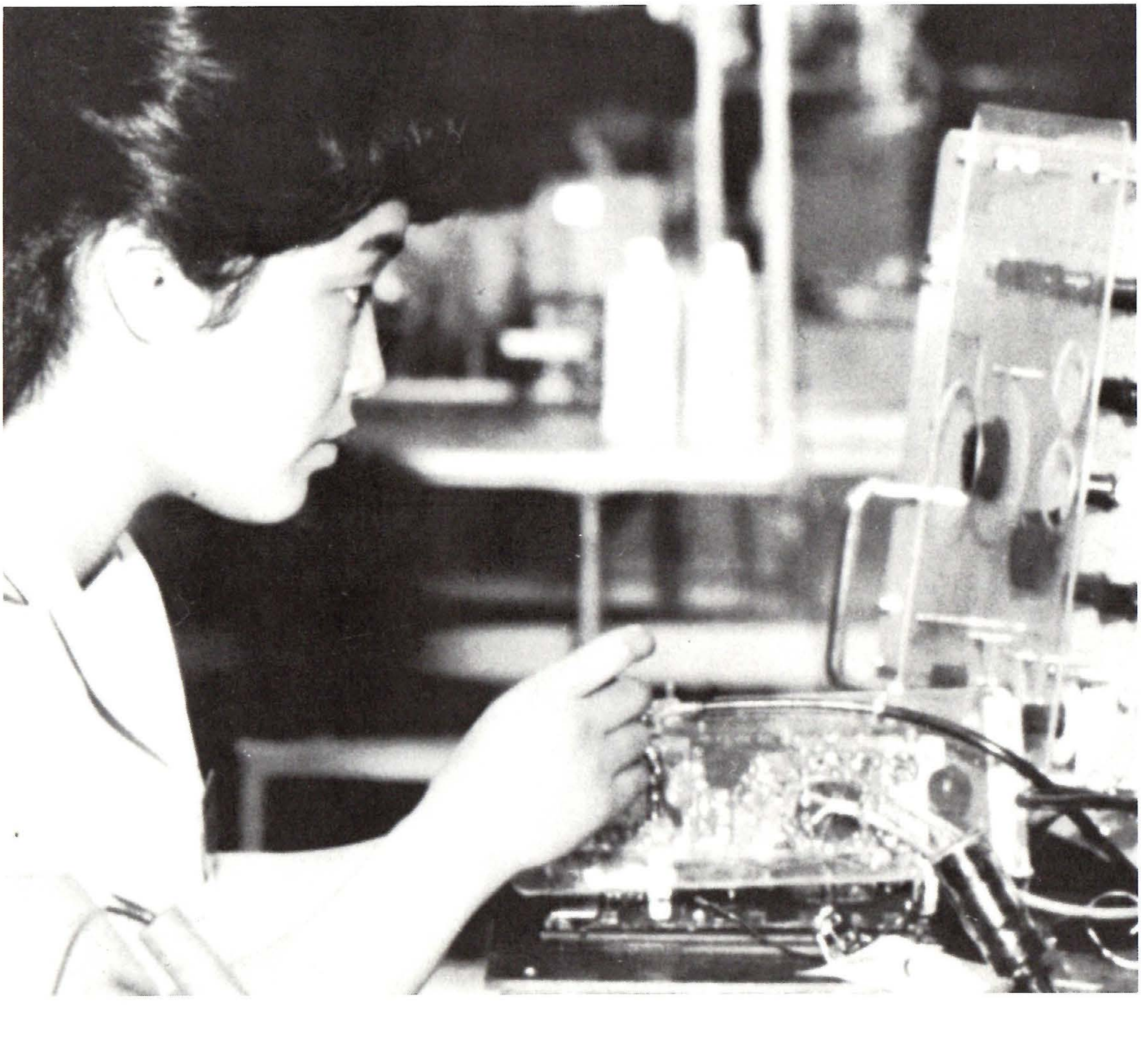
Tektronix' list of "firsts", of breakthroughs in oscillography, is a very long one. Similarly, in consumer electronics, Sony has made radical advances—most dramatically into the area of pocket radios and micro-television. The small Sony sets are familiar worldwide.

It also manufactures recording tape; electronic test equipment; video-tape recorders; and the world's best professional microphones. And it is making its boldest plunge yet: Into color

television, with the Chromatron tube, a device which other world manufacturers regard as impossible to mass-produce.

Sony's success in the area of miniaturized radio and TV has reinforced its belief that it pays to think small. Its latest achievement has been reduction in size—and cost—of video-tape recorders. A 35-pound unit about to be introduced will retail in the US for about $750, and, Sony hopes, make great inroads into the home movie market.

Sony's research into components resulted, in 1957, in development of the "tunnel" diode by its Dr. Leo Esaki. The device, which transmits electrons at extremely high speeds, has been hailed as one of the most significant advances in electronics.



"THERE IS NOTHING MORE PITIABLE THAN A MAN WHO CAN'T OR DOESN'T DREAM. DREAMS GIVE DIRECTION AND PURPOSE TO LIFE, WITHOUT WHICH LIFE WOULD BE MERE DRUDGERY"—MASARU IBUKA, PRESIDENT, SONY CORPORATION.

Both companies rely heavily on exporting. Both have overseas marketing subsidiaries (including, interestingly enough, one in Zug, Switzerland). Both also manufacture abroad: Tek on Guernsey and in The Netherlands; Sony in Shannon, Ireland.

Both have been marketing innovators. Tek was the first electronic instrument manufacturer to set up its own field engineering organization. Sony in 1958 made what was for Japanese home-oriented business a daring plunge into foreign markets. It even bases its executive vice-president and chief stockholder, Akio Morita, in New York City.

To overcome hurdles in the way of continued product advances, both companies manufacture a very large number of their own components: Tektronix, cathode-ray tubes, resistors, capacitors, potentiometers, diodes, ceramic and metal parts . . . Sony, magnetic tape, microphones, CRTs, transistors, diodes, machined parts . . .

"In the beginning, we had so little experience we had no fear of new ideas . . ." says a Sony spokesman. He might as easily have been someone from Tek, reminiscing. Other statements from Sony sound not at all out of place at Tektronix:

"We do what others don't" . . . "Whatever we manufacture must be the best we can make." . . . "A business should seek narrow but deep specialization, rather than broad diversification." . . . "Sit and let people talk; that's where good ideas come from." . . . .

The most significant similarity, President Howard Vollum believes, is that both companies' philosophy is to develop products that create markets for themselves, rather than be content merely to follow other companies into existing product areas.

"Never follow others," Sony has said. "Be different . . . Be original . . . Seek the unknown . . . and with this pioneering spirit, serve the world."

Although both companies emphasize technical superiority rather than price-cutting, both have developed products that command prices which provide healthy profit margins.

Both have impressive labor policies. Tek's long-time creed "Respect for the dignity of the individual" might be embodied in many of Sony's practices. One example: In its semiconductor plant at Atsugi, it has hired 1200 farm girls from an impoverished area of Japan, housing them in company-subsidized dormitories. It provides employees with education through high school, at Sony's expense.

Both companies have a profit-sharing system (although of different types.)

Like Tek, Sony is very informal. President Ibuka at work wears bedroom slippers and the same kind of blue zippered jacket that factory hands do.

Although Sony's emphasis, unlike ours, is on consumer electronics, the two companies share the most significant similarity of all: Each is the undisputed leader in its field.

So strongly does Sony product quality contradict the old "Made in Japan" stereotype that many Sony retailers are unaware it **is** a Japanese company. In one survey, dealers were asked if they handled Japanese radios; many said no.

Then the same dealers were asked if they carried **Sony** radios. And most of them answered yes. ■

take a scope . . . add a SPECTRUM ANALYZER

Far out in space . . . . . .

Tiros, the weather satellite, trains its eye on the earth and sends pictures for man to study. Telstar transmits messages and TV signals from one continent to another. Hanging motionless, Relay expands communications around the world. Ranger IX transmitted pictures of the moon's surface back to earth in the brief moment before it crashed — pictures far better than man had seen through the most powerful telescopes. Sometime next summer, Mariner IV will fly by Mars and send back telemetric information which may answer many questions about the red planet.

Amazing as these space vehicles are, their ability to accurately transmit information of interest to many areas is equally amazing. How can the dozens of electronic measuring devices, powerful transmitters and sensitive receivers operate in a package so small, each circuit accurately handling its signals without interference? How can the ground-control station receive dozens of different faint signals from the satellite without interference from powerful command transmitters or other electrical equipment?

At first this might seem no problem: Each transmitter and receiver is adjusted to a different wave length, or frequency; if the frequencies are separated enough, there should be no trouble. But it's not this simple.

Each transmitter, when sending information, generates additional frequencies. These may be located very close to the carrier (or fundamental) frequency, or they may be widely separated, depending on the information sent. They are constantly changing. In addition, all these frequencies produce "harmonics"—frequencies two, three, four or more times the original frequency. Receivers, too, can reradiate at frequencies other than those to which they are tuned—thus, in effect, becoming miniature transmitters.

All in all, a great mish-mash.

Any time a space vehicle is launched, the entire program may depend on the alignment of receiving and transmitting equipment. A very important tool for such checking and adjusting is the **cathode-ray oscilloscope and a spectrum analyzer.**

What is a spectrum analyzer?

A spectrum is a continuous band of frequencies. It might be the **audio** band, frequencies we can hear—about 50 to 15,000 cycles per second. Or the **radio broadcast** band—½ million to 1.6 million cycles per second. Or one of the **short-wave or TV bands,** with frequencies to several hundred million cycles (megacycles).

Frequencies from about ½ billion to 1000 billion (10^{12}) cycles are called microwaves. Those up to a little over 100 trillion are known as infra-red. Visible light is a narrow band of frequencies, around 500 trillion cycles per second. Frequencies about 1000 trillion (10^{15}) are ultraviolet light. X-rays have frequencies around 10^{18}, gamma rays about 10^{19}.

A spectrum analyzer takes apart a band (or spectrum) of frequencies. It displays the frequencies that are present and shows their relative magnitude.

Nature made the first spectrum analyzer. Drops of water in the air break up the white light of the sun into its separate frequencies—and we see a **rainbow** — red (the lowest frequency the eye can see) on one end; orange; yellow; green; blue, and violet (the highest frequency we can see) on the other end.

The types of spectrum analyzers used with Tektronix oscilloscopes cover the range from short-wave (1 mc) to well into the microwave region (18,000 mc.).

How does a spectrum analyzer work?

The oscilloscope draws a graph—normally a graph in which the vertical axis is the **amount** of something, and the horizontal axis represents **time.** With a spectrum analyzer, the oscilloscope still draws a graph; the vertical axis still represents the amount, but now the horizontal axis represents frequency.

We could draw such a graph without a special spectrum analyzer, but it takes a lot of time. We could get a radio receiver covering just the range of frequencies we're interested in. A meter connected to the receiver's output will tell us how strongly any station is being received. If we start at one end of the dial and record the meter reading, move the dial a little and record the new reading, move the dial again and record again—making several such readings—our plot of the meter reading at each point will be a graph of the **amount** of signal, plotted against dial reading, or frequency. We would have a spectrum analysis, but it would have taken a long time.

If we connected a pen to the meter pointer, and used a motor to drive both the dial and the chart, we would have built a mechanical spectrum analyzer that could draw a complete graph in only a few minutes. Many early spectrum analyzers were just this, and for many purposes they worked very well.

But often we'd like a **continuous** spectrum display so we know what's happening over the **whole** band of frequencies **all the time.** In these cases, we must scan the band many times a minute—or many times a second. A mechanical device couldn't draw a graph that fast. The logical method is to use a cathode-ray oscilloscope to display the pattern.

Spectrum analyzers have been built by wiring several units together: A radio receiver; an electronic method

TEKTRONIX' SPECTRUM analyzer group is formed around three former owners of Pentrix Corporation, which Tek acquired last year. At left, Morris Engelson discusses an analyzer plugin with a trade show visitor. Below are Arnold Frisch (left), project manager, and Larry Weiss, both of Pentrix. Rich Nute (right) is a Tek engineer assigned to the group.

of sweeping the receiver over the desired frequency range, and an oscilloscope to display the output. Such a hook-up works, but is complicated to set up and operate, and not always dependable.

Some of the first spectrum analyzers of this type were home-made by radio "hams" to monitor crowded amateur radio bands. A glance at the scope would tell the operator which frequencies were being used and which were not. Thus he could tune his transmitter to a vacant place before calling "CQ".

The Federal Communications Commission's radio-monitoring stations have used specially built oscilloscope spectrum analyzers for years to monitor broadcast and short-wave bands. A visual check of the "scope" shows where each station is located on the frequency spectrum, and its relative strength. Interfering stations, or stations broadcasting on the wrong wave length, can be quickly spotted. But custom-building special spectrum analyzers is expensive and takes time.

The first audio-frequency spectrum analyzer became commercially available just before World War II. Microwave spectrum analyzers appeared about 1958. By 1960, four or five companies were marketing analyzers.

These instruments were high-priced, bulky boxes that resembled oversize oscilloscopes; in fact, much of their circuitry **was** scope circuitry. They combined the elements of the home-made analyzers: A radio receiver, a sweep mechanism and a scope.

In July 1962, Arnold Frisch and Morris Engelson formed a company in New York City, Pentronix Associates. While doing electronics consulting work, they spent their spare time trying to develop new radio-frequency devices. One result was a compact spectrum analyzer unit that would plug into any of several Tektronix scopes.

If a user already **has** an oscilloscope, they reasoned, why bother building complicated analyzers that incorporate scope features? A plugin would not only be more convenient but also permit all other scope functions. The existing special-purpose analyzers would not.

Also, since many more oscilloscopes are built than spectrum analyzers, they felt use of a plugin would gain the necessary scope features at much less cost per unit than by building special-purpose analyzers.

In mid-1963, Pentronix, to avoid confusion with "Tektronix", renamed itself Pentrix Corporation.

Although our engineers had never worked on spectrum analyzer development Tektronix had recognized the feasibility of such an accessory to our oscilloscopes. Here was a good unit, engineered by spectrum analyzer specialists. It was to our advantage, and theirs, to pool our talents.

In May 1964 Tektronix acquired the assets of Pentrix for an exchange of Tek shares. The three owners (Arnold, Morris and Larry Weiss) joined Tek's engineering staff in late June. Arnold is project manager for the spectrum analyzer group; the others are on the engineering staff.

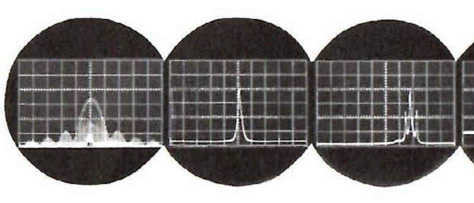
At first, Pentrix production was located in Assembly West, Bldg. 47, and engineering space was provided in Engineering Bldg. 81. When Plant 4 was established, spectrum analyzer production was transferred there.

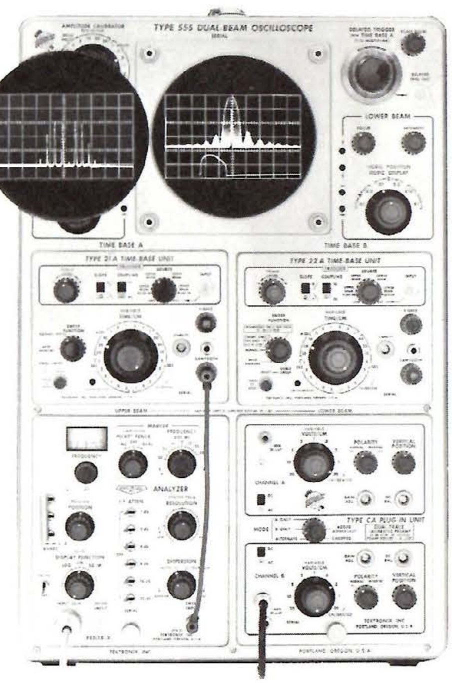
The Spectrum Analyzer group in Engineering now has eight engineers. In addition to the three who came with Pentrix, Dan Delano, Bob Gault, Gene Kaufman, Gordon Long, Rich Nute and Bob Rullman work on spectrum analyzer development projects.

Scientists and technicians are becoming increasingly aware that it's important to know what's happening in a **complete** spectrum, to look at many frequencies at once and tell, rapidly, how they interrelate.

Many uses are production-line applications: Faster alignment of radio transmitters or receivers; on-site checkout of communications systems and radar; general laboratory "troubleshooting" of microwave equipment.

"As a matter of fact," Arnie points out, "a spectrum analyzer has much the same kind of uses that an oscilloscope does."



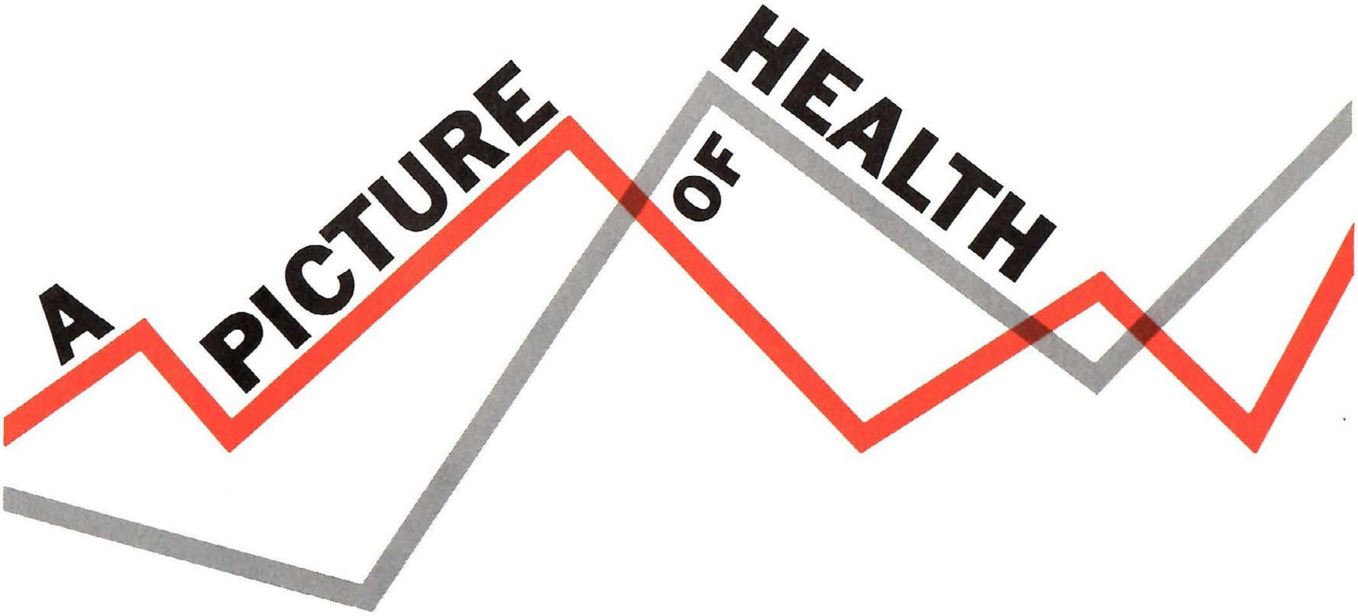


Some use analyzers in more dramatic ways:

The designer or operator of electronic equipment for a space probe; the astronomer with a radio telescope, searching for radio waves from distant galaxies; the engineer designing better communications equipment—for radar, navigation, electronic computers — all find the spectrum analyzer an instrument of increasing value.

The scientist has a new tool at his disposal. How he will use it, what new discoveries it will lead to, no one knows. We know only that a new door has been opened. ■

A PICTURE OF HEALTH



(To succeed, a company must be more than strong. It must be flexible, able to change with a changing market.

To measure this flexibility, it often helps to look backward. In this regard, Systems & Planning Director Frank Consalvo presented a series of graphs and charts at a recent Council meeting. They reflected a survey of the US electronics industry, made to obtain some indications of how Tektronix is doing.

Several Council members wondered if this kind of information couldn't be made available to other employees. Indeed it could.)

Company health is like personal health.

Sometimes it shows up as signs you can see: In a person, bright eyes, rosy cheeks, a muscular physique. In a company, busy employees, new products, a brisk order rate.

But these signs don't tell the whole story. Individual indicators can mislead. (Not all muscular people, for instance, are healthy.) Even taken all together, surface signs aren't sufficient—or there would be no need for a person to have regular physical checkups.

In a way, a survey of company performance indicators **is** a physical checkup.

And, just as the physician checks blood pressure, temperature, reflexes, weight and so on, so must an analyst of company performance weigh not one but **many** factors, to get a composite picture that is more likely correct.

In interpreting even the composite picture, Frank emphasizes, you must be somewhat cautious; for each company has unique characteristics that make it unlike any other. Similarly, a physician interprets his findings in light of what he knows of the individual. A blood-pressure reading that would be alarming in a young man, for instance, might be highly acceptable if he were 65.

With this caution in mind, then, let's look at the survey.

Twenty-one US electronics firms were studied, including all recognized industry leaders. Companies ranged from as large as 236,000 employees to as small as 300.

In addition a second, limited, sampling was made, comparing Tektronix with five other closely comparable companies—comparable in that their relationship to the electronics industry is very much like our own.

The findings in both surveys were similar. And they were encouraging.

Some of the "indicators" used tend to be **internal;** that is, they let us know how we're doing in relationship to what we **have** done.

Others are **external,** telling us how we're performing in comparision with other electronics leaders. Together, these groups of indicators present a picture of Tek as a historically healthy company, one that's growing even healthier, and one which has shown resilience in response to a radically shifting market.

In both the overall and the limited surveys, Tektronix ranked as an outstanding company. Specifically:

1. Our **overall** health, throughout our history, has exceeded the industry average, in most indicators.

2. Recently, our ability to react to a major change in the US electronics market has been good, in comparison with other industry leaders.

3. A downward trend in some indicators has been reversed in the last four years, and signs now abound of increasing health.

4. Never is there room for complacency. Competitors are aggressive, and the electronics market is a demanding and volatile one.

. . . unfortunately for rhetoric, the main "secret" of our success lies in the overworked phrase: strength in product and people . . .

As to overall health, in the last four fiscal years:

1. Our **annual sales growth** generally has been better than most companies', except for those which increased their sales largely through mergers and acquisitions.

2. **Growth in income** also shows us healthy.

3. Almost since our inception, **ratio of income to sales** has been higher than in the industry as a whole. In short, we are a very profitable company. Frank offers two possible reasons for this high ratio:

One is that we not only assemble instruments but also manufacture many of our own components, not the usual approach in the industry. This lets us realize profit on both the instrument and the parts.

A second reason is continuing strength in product and people. Unfortunately for rhetoric, the main "secret" of our success lies in this somewhat overworked phrase. But in view of continuing company health in a demanding market, it's worth saying again.

When comparing Tektronix with other leading companies, the two most significant indicators are: Net income as a percentage of sales; and net income as a percentage of total assets.

Net income as a percentage of net sales is one important indicator of how efficiently we're operating. In the last four years, Tek ranked higher than the other five comparable companies, and was exceeded in the large list of 21 leaders by only one company.

Net income as a percentage of total assets shows, in simplest terms, how much return we're getting from our total investment in buildings and equipment. In this indicator also, Tek has ranked high—next to the top of the 21 industries, and ahead of the five comparable companies in four of the last five years.

(Other "indicators" which employees will probably interpret as they see fit include: An upward swing in profit share; continuing high orders; and increased signs of organizational firming-up. If these aren't heady wine, the sight of the new Technical Center may be. Or the campus, for that matter, in the spring.)

Historically Tek has spent a high portion of its income on research and development. Other studies, not part of this survey, show that this planning has paid off in market strength.

Net sales have shown a steady growth in each of the last five years. **Net income** has increased every year, except for a slight dip in 1962. (Four of the five other comparable companies suffered severe drops in income in one or more of these years.)

In the early 1960s a major—and harsh—fact of life for US electronics was the abrupt change in military procurement practices, and a sharp curtailment in the rate of increase of defense-oriented R & D spending. The move caught many electronics companies flat-footed—particularly those most deeply involved in military contracts. Reacting, they passed the curtailment on to **their** suppliers, and the entire industry felt the shock wave.

How Tek reacted is a matter of recent memory. It wasn't long ago that we went through a stage (variously described as "retrenchment" and "cutback") in which a new emphasis was placed on economy, certain nonessential activities were eliminated and total personnel was reduced (largely through attrition). If these moves caused some employee apprehension, as they did, it was slight compared with the wrenching and tearing which many other companies felt.

Throughout the industry, severe drops in income were widespread, as companies began to channel their productive efforts into something other than military development. Large layoffs were common. But Tek held, instead, to its strategy of attrition.

The survey shows that we came through the trial with few scars, by comparison. Management's decision, years before, to steer clear of direct military R&D contracts stood us in good stead. Other companies which had decided differently bore the brunt of the Defense Department's shift in policy.

By comparison, our work force was relatively undiminished, due in part to an effective management decision: In the interests of maintaining stability of employment, we chose to allow inventory to climb to levels previously considered unthinkable — reaching a high, in period 212, of three times the desirable level.

This was preferable, the company felt, to the human consequences of the alternative: Layoff of employees.

The high inventory carried risks, not the least of which was obsolescence—the worry that instruments piling up in the warehouse would become outdated and never sold.

But the mix of instruments in inventory was soundly chosen, and has been converted to sales—without obsolescence.

This calculated risk — which carried a strong possibility of dollar loss had the instruments become obsolete—is one measure of Tektronix' willingness to protect the job security of its employees, Frank believes.

Other than general good health, and a strong rebound from the industry doldrums of the early '60s, the survey shows another good sign: A steady move upward, in several indicators, from a low point in about 1961.

One such indicator is **sales per employee,** which had declined from a high in 1951 of $18,195 to a low in 1961 of $13,320. Since then, each year has seen an improvement, and conservative short-range forecasts indicate the trend upward will continue.

Frank credits this reverse in direction in part to recognition of company operational problems in the early '60s and a general organizational strengthening.

(In a speech to TEKEM shareholders in 1962, President Howard Vollum listed these company "weaknesses": Some inexperienced managers; a tendency to do things the nicest and best way; a tendency to overconfidence; some inadequate facilities, and occasional neglect of important items through over-attention to details.

(He also expressed confidence that these problems were on their way to solution. "Sometimes," he said "I feel we become so aware of our weaknesses that we fail to see our strengths. Especially those strengths that more than balance the weaknesses. We tend to get a little bit of an inferiority complex. This is not good—but it's not as bad as being inferior.")

On the side of caution, Frank notes two possible areas of future concern. One is that our recent growth rate is not as great, particularly in the US, as it has been historically—due in part to increased competition and in part to slower growth of the whole US electronics industry, in particular the test and measuring market.

Also, if it's true that Tek ranks as an outstanding company in the performance indicators analyzed, it's true also that Hewlett-Packard, our leading competitor, rates the "outstanding" designation.

This should be cause not for dismay but for confidence. Success in the face of worthy opponents is a measurement of real ability. By contrast, there is little cause to boast in leading a slow race.

The moral seems clear: Electronics is a rewarding master, but also a demanding one. Its challenge is that it **must** be served.

Good health will accrue only to those companies who respond. ■

Building a building to house an organization that keeps changing is like trying to fit a suit on a little kid who won't stop squirming.

But that's what Tek has done.

The five-story, 230,000-square-foot Technical Center, rising on schedule in our industrial park, was conceived, and its construction begun, to fit an Engineering organization whose exact shape no one could predict. That organization has changed several times since. And still the building fits.

When the Tech Center — or "Engineering Building," as we called it — was first contemplated, as far back as 1961, Tektronix' design and related technical activity was split four ways. The need was pressing to bring the groups together. Reorganization was in the wind — but you can't build on the wind.

Managers involved came through with building designs reflecting their own views of what the organization should be. Designs ranged from rectangular to round, from flat to tall, from single buildings to complexes of two to four structures. Taking all their desires into account would have resulted in a building much larger than we would need.

Our dilemma had two horns. To delay the building until the new organization took shape would waste years, at the expense of efficient engineering effort. On the other hand, to tailor it to the existing groupings — a Research, a Future Products and an Instrument Design division, plus Manufacturing's staff engineering group — would mean it would soon be obsolete and require remodeling.

But there was an out.

"We knew we would need a **build-**

THE BUILDING THAT WAS MADE TO CHANGE

ing," recalls Operations Vice-President Bob Fitzgerald. So he asked Facilities Manager F. W. "Beich" Beichley to gather from each of the three engineering divisions enough information on space needs to let us design a building to accommodate **any** foreseeable engineering and research organization.

Beich asked them:

How adequate is your present space? How many square feet would you have to add to **make** it adequate (in "wet" areas and "dry" areas)?

From these figures, compiled in May 1963 by Facilities' Mel Lofton, plus a "guesstimate" by Fitz for expansion (including space for IMSE), a plan was developed for a building shell; bids were let and excavation begun for a building that would fit, **however the organization might change.**

Now, what we needed was a way to get the construction started. Our answer was a "two-phase" planning and bidding system.

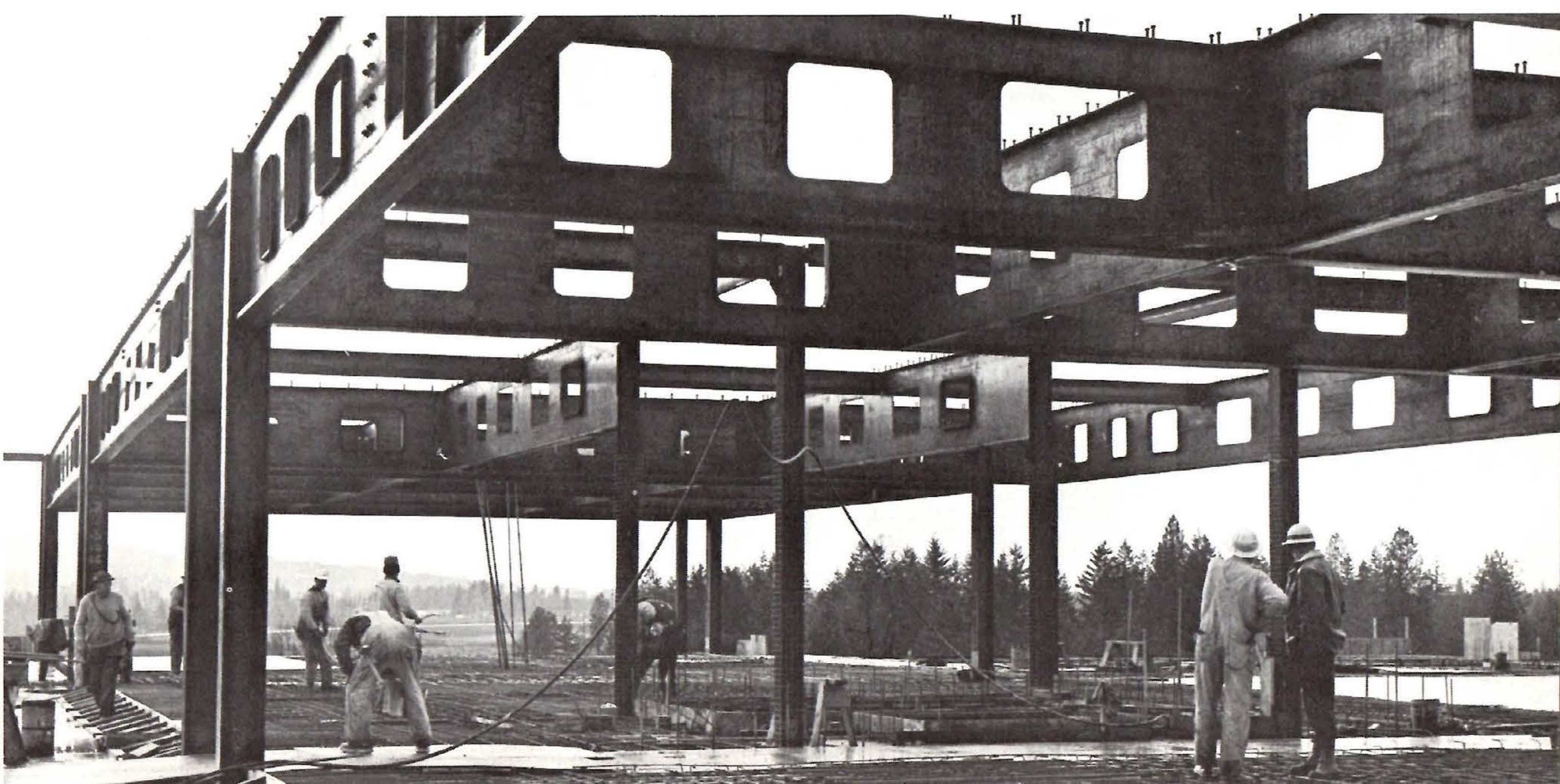
Normally, an architect will draw a complete plan of the finished building, inside and out. When it's approved, construction starts. The **total** job is let on a single bid.

It's easy to see that an architect able to foresee in 1963 the needs of the changing Engineering organization in 1966 would have to be clairvoyant. Hence the two-phase system: A plan was drawn for the building's shell, plus such related basics as outside stairs, large air-conditioning fans and exterior finish. The plan was approved, bids accepted, and excavation started. What would go inside, and where? We didn't know.

But now we do. The four former engineering areas are now under a single direction, that of Engineering Manager Bill Polits. And Phase II, "Who goes where?" has begun.

And if the organization should change again, as it may? Even so, the building will adapt. It has been **built** to change.

No spot on any of the first four levels need be more than 25 feet from complete utilities hookups; hot and



cold water, chemical and sanitary drains, de-ionized water, electricity, hydrogen, nitrogen, oxygen, CO_2, natural gas. In Tek's terms, the building is "potentially 100 per cent wet."

All interior walls — except those lining the four main corridors on each floor — will be portable. A wall may be put anywhere without interfering with any installation. For example, fluorescent lights will be plugin units. (Merely adjust any section of lights that's in the way.)

"We decided," Beich says, "that the building would be capable of being whatever it needed to be. In this way, the **building** wouldn't affect the **organization**—I doubt there's a more flexible building in the country. It was the brainchild of the architects (Wolff & Zimmer) and the structural engineers (Cooper & Rose.)" This is Wolff & Zimmer's sixth Tektronix building. Builder is Ross B. Hammond Co. It is their ninth Tek job.

Is the flexibility costing us? Sure, Fitz says. But so would having to remodel. (For example, the costs of remodeling Sunset alone totaled $107,000 in the last four years — about $27,000 a year.)

Even if it **hadn't** had to fit a shifting organization, Tek's new center would still be quite a building.

It will be roomy, functional, strategically located. And beautiful. They call it "monolithic", but it's not an apt word.

The building is a giant—73 feet from the ground to the top. The Center is 213 by 271 feet, roughly the size of our assembly buildings.

But "monolithic" suggests a Gibraltar-like hulk. Far from it, the Center will appear mostly glass. Bronze-tone windows will cover the east and west sides and two-thirds of the north and south walls. The corner columns and narrow vertical shafts will be brick-faced.

Karl Braun drive will be extended and surfaced, and will loop around a parklike island in front of (north of) the building.

Landscaping to "translate" the tall structure into the forested park will include "wraparound" parking. Rather than have one large lot, parking areas will wrap around three sides of the Center, so employees won't have to walk far. Parking eventually will be for 900 cars, but at first the lots will handle only about 600. Where possible, large existing trees will be left in the parking areas. Forested buffers will separate the lots. Employees inside, through expanses of glass, will look out on vistas of park and woodland.

Beauty aside, the building will give many operational advantages. The main one is bringing together our engineering groups. It will be the first time in years that all engineering managers will be in one place. In addition, the building will house Tektronix' corporate management.

The resulting improvements in communication can only be guessed at. As it is now, corporate meetings mean several miles of auto travel — mostly by engineers, the "off-campus" group.

"The organizational piecing-together we've done the last couple years," comments Bill Polits, "hasn't been matched by physical regrouping." So, here and there, where there's a nook or cranny, you're likely to find an engineer working away: In the quonset, in north and south Sunset, in Plant 4, in Ceramics, in Utilities . . . . .

The Center will also provide enough room—a "luxury" not every engineer now possesses. The net result will be closer contact, better communication, greater efficiency and, ultimately, better products.

Looking to year's end (move-in may begin as early as November and last as late as March), here's what the Tech Center residents will live in:

The building has five air-conditioned levels, or floors — the daylight ground floor three-quarters underground, the top one a "penthouse" cafeteria and corporate conference rooms.

One-third of the first floor will contain mechanical equipment to make the building light, cool (or warm) and liveable: Valving, piping, water meters, fans, deionizers, phone relay equipment, transformers and motor-control centers.

Also there will be those unique engineering support groups whose function demands they be on the ground floor. One is the environmental test laboratory, which will include a pad-mounted shock-test machine. Mechanical Engineering and other noisy shop-type activities will be on this level also.

The crashing of shock tests shouldn't cause any problems; the Center is designed to be "shockproof". The 50-foot span length of the steel-and-concrete flooring was carefully selected to limit vibration. High-magnification work, such as diode production involves, is difficult in a vibrating area. In some buildings, Beich points out, a heavy footstep at one end would make it impossible to carry out certain activities at the other.

Hot (and cold) water is supplied through a tunnel from the Utilities building, to heat and cool the Center. New boilers and chillers, costing $242,000, will be installed in Utilities to support the new building.

Outside the ground floor is a covered dock (about 50 x 75 feet) in which Volkswagen buses and small delivery trucks can park out of the traffic.

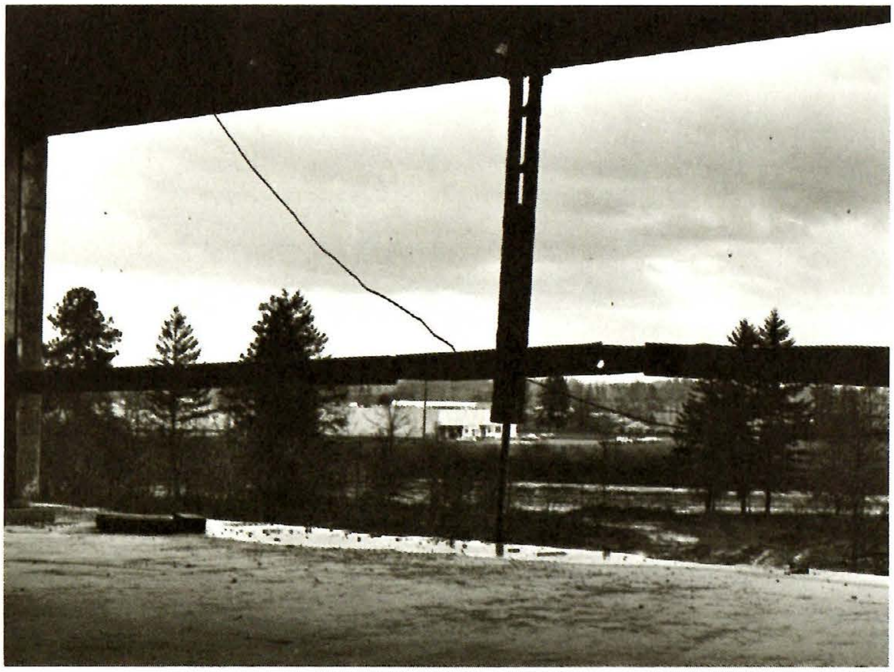
The second floor will contain Display Devices Development (3D); all our Purchasing activity; the engineering library, and a 150-seat auditorium, adaptable for lectures, motion pictures, conferences and product displays.

Floor 2 will contain small "buffer" conference rooms, near the receptionists, where outsiders may be met without having them interfere with (or get an unnecessarily close look at) our engineering activities.

The next level, floor 3, will house Instrument Engineering; engineering drafting (other than 3D drafting); Standards and Specifications; Industrial Design; Systems Engineering and project support activities. Most Engineering managers will have offices on this level.

Part of the fourth floor will be occupied by corporate offices, select managers and key staff. Few or no office functions will be carried on there, Fitz stresses.

AS THE TECHNICAL CENTER progresses, close and constant attention is paid to each phase of construction. Here, one of the many building drawings is given a final check by (from left): Chuck Brown, Engineering building coordinator; Joe Almand, Tektronix projects manager; Carl Jonasson, Facilities Engineering manager, and Larry Frost, Mechanical Design manager.



In this area, plans are to situate all the desks in a large open space, with offices available for use on a shared basis. "It's felt," he explains, "that this arrangement will facilitate cross-communications, and bring individuals together who in recent years have met only on occasion."

The fourth floor also will house Product Evaluation, Material Product Information and some Engineering.

Floor 5, the 10,000-square-foot "penthouse", comprises the employee cafeteria and two conference rooms. The corporate conference room is 24 x 24; the other, 12 x 16. Wood decking will provide outside eating area, with panoramic views to east and west. The cafeteria will seat about 250 people, compared with 350 to 500 in the Assembly cafeteria, and be of comparable quality and decor.

A nine-domed 50 x 50 skylight crowns the fourth story, so daylight will filter down the center stairwell to the ground floor.

You'll have your choice of five stairways, in the corners and center of the building. If you're in a rush, take an elevator — there will be four, all electric, two of them high-speed, one for combined passenger-freight use. It opens front and back, to load from the ground-level dock south of the building.

Except on the ground level, connections for power, phones, water and process utilities are brought up through the floor. This means you'll see no lights dangling from cords, and that sort of thing. There will be no connections inside the portable walls, which means they may be quickly put up or taken down, to make rooms bigger, smaller or nonexistent.

Main utility sources, in the floors, run around the rim of the 50 x 50 bays which make up the building. Lights and ceiling air-conditioning units are placed off the 4 foot, 2 inch "module" lines; thus a new wall may be run along at any 4′2″ interval and hit nothing.

The 50-foot span of four-foot-deep open-web steel beams means we're using as few supporting columns as we could get away with. We could, on any of the first four levels, have three 70 x 200-foot unobstructed rooms — if necessary. The floors are designed to bear 125 pounds per square inch, adequate for light manufacturing.

The early phases of the Center combined a wide variety of scientific know-how, including such unlikely fields as geology, meteorology and computer technology.

For the first time in Tek's building history, planners used a computer and what's called the "critical path" method. Ralph Pratt (Systems manager) explains it:

Each of the project's 350 separate detail jobs was plugged into the computer, which analyzed them to identify the **key ones** — those on which no delay could be tolerated.

The jobs were first laid out on a giant chart, in the sequence in which they would have to be done. In the resulting complex network of parallel "paths", one "path" of sequentially connected jobs is the longest — that is, it will take the most total hours to complete. This becomes the "critical path"; a delay in completing any step in it will delay the entire project. Other paths are less critical; that is, they have some slack.

The computer output provides a dead line date, and allowable slack time, for each step. Thus we have a way to see that each job is done within present limits.

Even before plans were approved, excavation began, to take advantage of the nice fall weather. It almost worked; although winter rains came before the excavation was completed, we'd laid in a drain line that carried off much of the water. By spring we had a mudhole, which required draglining to clear out. But we'd gained time.

We laid in a gravel base, which allowed heavy equipment to get in and begin work. Then began the tedious job of driving piles — a job no Tek employee on the 300-acre tract was unaware of. For three months, the bang-banging of hammer on steel went on. Nearly 600 steel cylinders were driven, 80 to 95 feet into the ground.

It came to about eight miles of piling — enough, if stacked on end, to reach as high as Mt. Everest and halfway down.

The Center is the first Tek building requiring piles for support. First, test holes as deep as 120 feet told us the soil was a fine sand-clay, and that piles would "go down like butter." Then we drove a series of test piles of varying lengths and measured the slippage under pressure. Our plans were to drive 80-footers; we quickly changed half of them to 95-footers. Piles are held by side friction; if they're too short, there's not enough friction, and the building sinks a little. An unexpected settling of 1½ inches could crack the windows, break the concrete, keep the doors from fitting, make the floors slant and wreak other havoc.

The piles, 10 inches in diameter, were then filled with concrete and capped. The flat concrete caps, each covering 25 to 50 piles, provide the base for the steel erection.

When it came to spending a company's money, planners felt, gambling on the weather wasn't enough. So they retained Bob Lynott, KOIN-TV's "Mr. Weatherman", to make special weather predictions in advance of planned week-end work, or before such critical steps as large concrete pours. On six to eight occasions, he lent a hand; one weekend alone, this advance weather information saved us $1000.

After the piles were capped, the steel exterior was erected and floor pouring started — ground floor last, to allow for settling. This job was completed in February. Now, tubing for air ducts and electrical lines is being installed;

brick work is soon to begin; the first bronze-tone windows are already in.

By May the building exterior will look nearly finished, and the question will arise from employees: "Why can't we move in?"

There are thousands of man-hours worth of reasons: We call them "Phase II." This involves hooking up the water, electricity, utilities, gas and exhaust to fit the operations each floor will house. It includes piping, painting, welding, ceiling hanging, steamfitting, balancing fans, erecting inside walls, plumbing, lighting, wrapping pipes with insulation. This activity will require nine to 12 months, and account for $1,392,000 of the building's total cost.

Joe Almand, project manager, is in charge of setting up and coordinating meetings. The Facilities committee meeting provides a means of top management communication about the building. Irreguarly — at Joe's call — status meetings are held among architect and contractor representatives and Facilities and Engineering people. "Site-meetings" every second Wednesday at the building include subcontractor foremen, Ross B. Hammond's project manager and Tek Facilities and Engineering representatives: Joe; Carl Jonasson and Chuck Brown, Engineering building coordinator.

Guidance throughout was provided by Vice-President Bill Webber, as Facilities committee chairman, and Engineering's Dick Rhiger, who paid constant attention to the overall problem of building layout.

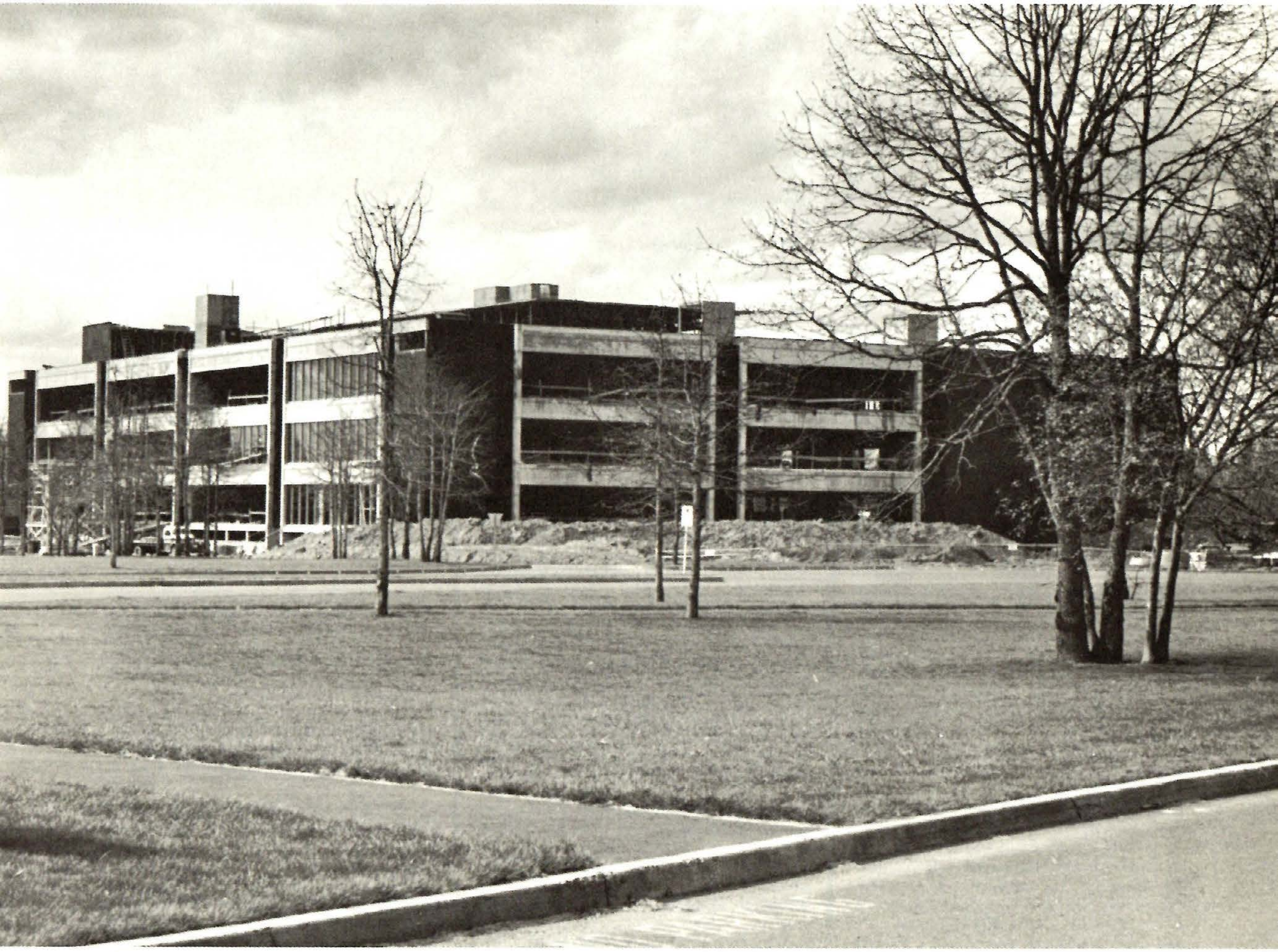
"The idea is," Beich says, "to get management's wants, the users' needs and the architect's aesthetics—and from these build a building so that **Tektronix** will benefit."

The total cost — $4.8 million — may be broken down into these percentages:

Building, 80 per cent; grounds, 6 per cent; additional Utilities building equipment, 4 per cent; tunnels, 1 per cent; process work, 9 per cent.

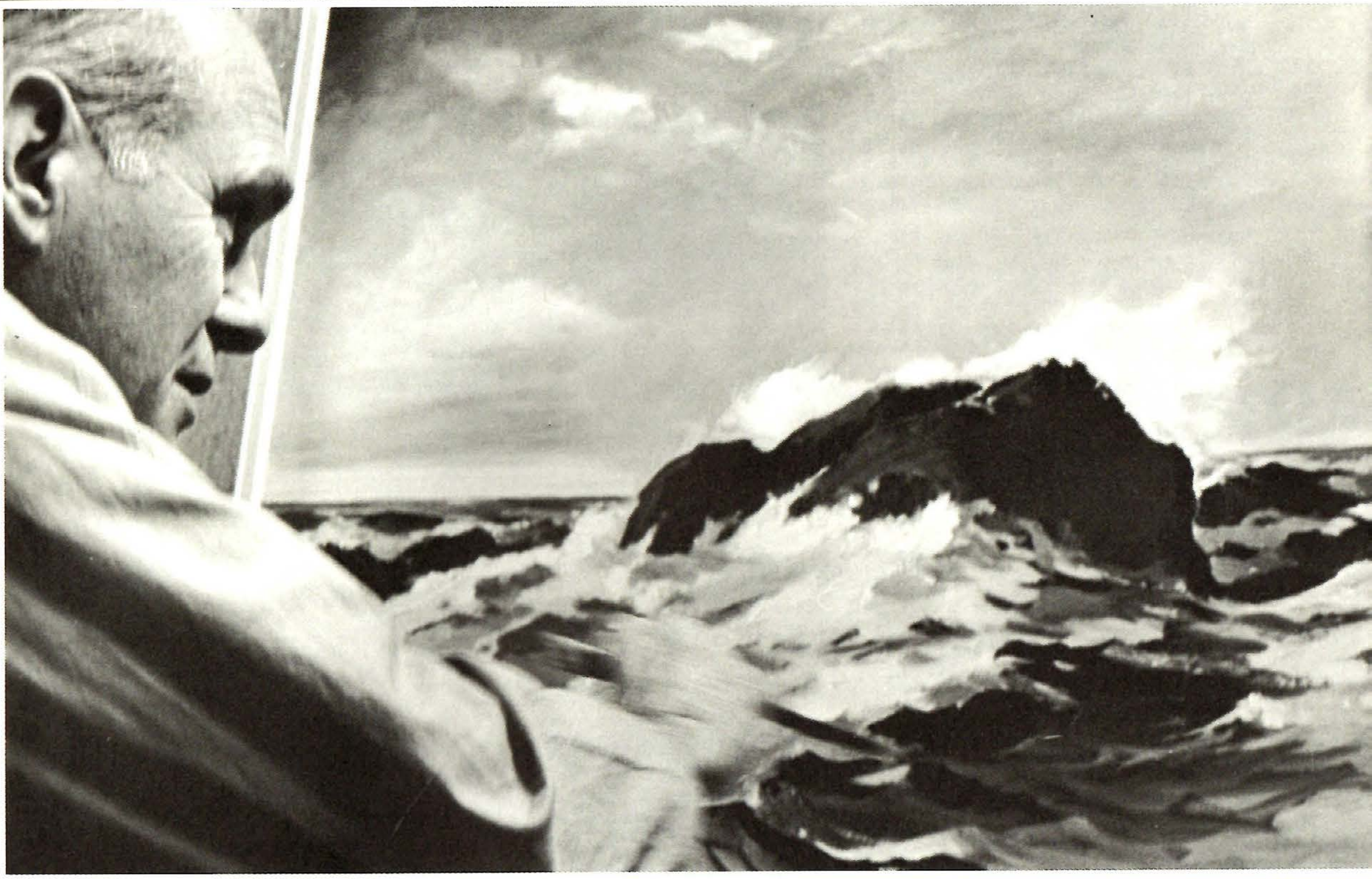
The giant Center will soon, from the outside, reach a stage of apparent dormancy. Only the sound of workmen inside will indicate to the passerby that activity is still going on.

And in late fall our newest building will be ready for its first occupants. About 550 Tek employees, who have been housed too far apart for too long, will be glad to call the place home.■



THE INDIVIDUAL

"If we draw our strength from the uniqueness of each individual, together we become more than the sum of our numbers"
—Tektronix philosophy statement, February 1962.



CHET MURPHY
painter of the sea

Chet Murphy is one of the Northwest's best-known painters of bold seascapes. Still he complains that his ocean scenes won't do what he wants:

"I want 'em to roar—to make a whole lot of racket." And he'll be satisfied with nothing less.

Chet has painted for 41 of his 57 years; for the last 10 he's concentrated on seascapes. His canvases have brought him honors and awards. He's had at least 15 one-man shows and has completed over 100 oils. But he's not satisfied. They won't roar, and that's what he's after.

Self-taught except for six lessons as a boy, Chet has always painted only the outdoors: No portraits, no still lifes, no abstractions. Nor is he about to diversify now. "You have only so much time left . . . ." he explains.

He loves Nature, the sea in particular. It's strong and beautiful, and he likes the technical challenge it hurls at him; the reflectiveness of water makes stern demands on the painter's use of color.

Chet is painting now more than ever before, more boldly, more freely, on larger canvases. He uses no preliminary sketches, but works rapidly and directly onto the canvas, finishing a large painting in about 15 hours.

He feels a painting shouldn't be an illustration, but should be timeless. "I want it to **be** there," is how he puts it.

"The sunny-day scene you paint isn't what you're really after—it's something else . . . It's darn near like a religion."

When it comes to discussing abstract art, Chet is kinder than most representational painters. That is, he'll put up with it. All he asks is that art—of any kind—be beautiful.

His favorite painters are Edward Hopper; Norman Rockwell ("sort of a cartoonist, but with excellent technical workmanship"); Ted Kautzky for watercolor; Frederick Waugh "for sheer beauty of landscape", and, locally, E. B. Quigley.

Chet, Customer Service Technical Research manager, has been at Tek 10 years. Like many Teks he's a radio ham. His hobby is eavesdropping on airplane pilots.

But his abiding delight is painting. When he retires he wants to be able to **afford** to paint. "I don't want to depend on painting for a living; I wouldn't trade the joy I get out of it for anything."

"A guy is nothing," says Chet Murphy sincerely. "But what he paints—**that's** the real McCoy."

FRANK WARREN
his community: the northwest

Frank Warren is a tall, friendly man with a warm handshake. The newest member of Tektronix' board of directors seems to fit closely an early company philosophy statement: "Your real status is the status you've earned—and when you've really earned it, you don't need the status symbols."

As president of Portland General Electric, and throughout his 28-year career in management, he has contributed a large part of his efforts to the growth and welfare of his community and to the development of Oregon's industrial climate.

There were other Frank M. Warrens before him, and the Warren story really begins when Portland was a yearling city and "community affairs" included Indian wars.

His grandfather, Frank M. Warren, was born in New England in 1848, the year gold was discovered at Sutter's Mill and the Oregon Territory was organized. He arrived in Oregon with his mother in 1857 to join his father who had traveled across the plains by wagon and four-horse team to settle in 1852. A pioneer packer on the North Pacific Coast, his Warren A-1 brand of salmon later became nationally famous. He was one of the 1513 passengers aboard the Titanic who died when the ship met disaster April 15, 1912. Our new director's grandmother, also a passenger, was rescued by lifeboat.

Frank M. Warren, our board member's father, was born August 25, 1876, attended the old Portland high school and Pacific University and was graduated from Amherst in 1898, a Phi Beta Kappa. In addition to his many other business and community activities, he was one of the few licensed Willamette River tugboat pilots. (A tug which sank and was recovered during the recent floods was named for him.)

Frank Warren, today's PGE president, was born at the family home on Westover Road September 10, 1915. His education began in Portland at Miss Jewell's (later to become Catlin-Gabel). He graduated from Stanford School of Engineering (as a civil engineer) and Harvard Graduate School of Business Administration. After joining PGE in 1937 as a statistician, he progressed to assistant to the president in 1940; vice-president in 1942; executive vice-president in 1947, and president in 1955, at 39.

In July 1942, as Captain Frank M. Warren, Jr., he left for Washington, D.C. to join the US Army Supply Service's transportation division, a research organization concerned primarily with planning troop landings. He also served as member of the Pacific Warfare Board. He advanced to the rank of major during his three-year service; soon after discharge he was appointed lieutenant colonel.

After returning to his PGE post, he became deeply involved in planning and implementing the growth of the utility's power resources and markets. Included in the projects constructed in recent years are North Fork dam on the Clackamas, Pelton and Round Butte dams on the Deschutes, and other developments augmenting power supply. In addition, the company has joined with other agencies in joint ventures on the Columbia and the High Mountain Sheep project on the middle Snake river. Litigation is now under way to protect a license issued a year ago to Pacific Northwest Power Company, a four-utility group; PGE is committed to the largest single portion of the Mountain Sheep project's output. Mr. Warren has appeared before Congressional committees on behalf of the Columbia River Treaty, Pacific Northwest-Southwest intertie and other projects which now benefit or later will benefit the area.

By appointment of then Governor Douglas McKay, Mr. Warren succeeded Henry L. Corbett as member of the Port of Portland commission in June 1951. He became commission president in 1957—a post held by his father 25 years earlier.

Owner of a private pilot's license and an Aero Commander, he logs about 250 hours a year on business flights.

As a director of Tektronix, Mr. Warren brings to each regular monthly and all special board meetings his many years' experience in business management and development, and a tradition of not merely watching the Pacific Northwest, its people and industry, grow—but helping it, in as many ways as possible.

WALTER DYKE

photographer, plus

When you buy a scenic post card of the Oregon coast, chances are the color photo on it was taken by a Tektronix director.

Dr. Walter P. Dyke is more at home behind a camera than in front of one. He's nationally known for his color photography, and used to earn a good living at it: Traveling for ad agencies; photographing Glacier Park for railway billboards; doing work for newspapers, calendars and national magazines, including assignments for **Holiday** and **Colliers** and a couple for **This Week.**

But now, at 50, he limits his photo work mostly to "family stuff". His reason: "I just got so busy with other things."

"Other things" include presidency of Field Emission Corporation, McMinnville, manufacturer and worldwide distributor of high-speed x-ray machines. They also include membership on Tek's board (since November 1963).

Walt Dyke first knew Tek as a user of one of our early 511 scopes. He has served with President Howard Vollum on the board of Linfield Research Institute and the Governor's Committee on Science, Engineering and New Technologies. Both men have been chairmen of the latter.

He is director of Oregon Graduate Center for Study and Research, and trustee of Linfield college. He has served as director of LRI; staff member of MIT radiation laboratory; professor of physics, head of the Physics department and director of research at Linfield.

He received the Presidential Certificate of Merit and Oregon Academy of Science citation, and IRE's achievement award in 1958. He has published papers in a variety of scientific fields, and presented a series of technical lectures in Europe in 1963.

Walt's photographic career grew out of his love of skiing and climbing. (He's scaled all the major Cascade peaks.) He passed through the "35-mm slide stage" into the professional aspects of the art. After the war, he taught at Linfield and free-lanced summers doing color photography.

An electron physicist who has specialized in pulse techniques, he was educated at Linfield (BS, 1938) and University of Washington (PhD, 1946).

Field Emission Corporation (Femcor) grew out of LRI, itself an offshoot of a college research project he began while head of Linfield's Physics department. He got a $5000 grant in 1948 (later renewed four times) to study field emission, then a basic science rather than a practical technology. The study sought to train students to do research, but by late 1955 it had accumulated a half million dollars in contract support, and involved 50 persons. The college then split the project into a separate corporation, LRI, with Walt as director.

In 1958, when the project had 70 persons, the Institute developed a new

Photo courtesy Salem Capital Journal

flash x-ray tube. The Navy liked it, and ordered 50 for ballistics research—but no one could be found to build them. So the Institute formed Femcor to make them, in a converted downtown garage.

The college felt that, although research and teaching were compatible, hardware development was something else again. So in 1961-62 Femcor was divorced from the Institute. Now it boasts the world's foremost collection of field-emission scientists, and has outlets in Washington, Los Angeles and several European countries.

A major development, in 1963, was the high-speed portable x-ray, which operates from any standard electrical outlet. These lightweight units have extended medical diagnosis into hitherto inaccessible regions. A chest x-ray in the backwoods of Haiti in 1963 was a dramatic example.

A field emitter, very small and requiring little energy, provides high current density and short pulse length, thus allowing very fast x-ray photos (something like a million times faster than the conventional "take a deep breath — hold it" x-ray devices.) Thus it offers great advantages in recording high-speed events, as in ballistics research.

One of Femcor's newest products is a 2-billion-volt flash x-ray machine that can penetrate 6 to 8 inches of metal to record high-speed phenomena.

So Tek's director is, indeed, busy with "other things." But how about photography? Will he resume it as a profession — ever?

"Some day," he says vaguely, like a man with a lot of "other things" he wants to do first.

VURDA LEE
good neighbor

"Services 6" was her name; downtown buildings, her beat; money, her motive.

For 11 weeks last fall, Vurda Lee, Systems & Planning secretary, served United Good Neighbors as one of Tek's four loaned exectives. She was the third consecutive Tektronix woman "loaned executive", the fourth in company and local UGN history.

Tektronix has always supported the community charity drives, and participated in the tri-county UGN campaign since 1957. Total corporate gifts have been about $294,600; employees' gifts exceeded $491,300—a combined contribution of over three quarters of a million dollars. Tektronix has provided 19 loaned executives to UGN campaigns—keeping them at full pay.

The campaign began with a one-week intensive training program for the 39 loaned executives. They learned what UGN **is.** They toured agencies; they learned how to present the solicitation, how to call on company presidents. Finally they were given their assignments. Vurda was responsible for Services 6—downtown building managers and maintenance staffs, real estate, title & trust and insurance companies.

Vurda recalls her first day: "We started the campaign the Tuesday after Labor Day. It was raining. I was scared to death. My car broke down and I had to get a loaner. Then the loaner broke down and I had to get a second loaner. As I walked up to the president of the first firm I called on I was thinking 'What am I doing here?' But you gain confidence after your first film rally."

Vurda had 52 firms to contact. She made initial contacts with them all during the first three weeks. For some she scheduled film rallies. During the rest of the campaign she made additional contacts, supplying pledge cards, picking up contributions and supplying extra materials. After the campaign was over, she wrote thank-you letters to each firm.

Was it worth while? "Every bit of it. UGN to me was always something that 'just happened'. I didn't really know what it was all about. But seeing the agencies and the dedicated people working in them opened my eyes.

"Another thing: I didn't realize so many leading businessmen devoted so much time to this community-wide effort. When I saw their enthusiasm, I got more enthusiastic. I think all the loaned executives discovered this—the more you did the more you wanted to do."

And Vurda did more than enough. She exceeded the dollar quota for her area, as did the other three loaned executives from Tek: Ted Hiatt, Ira Alkire and Dave Spinks.

"Another thing," Vurda smiles, "I learned to park my car on both sides of the street without smearing the white sidewalls."

She feels it was a privilege, and a challenge, to be the only woman in the loaned executive program. Her first reaction was, "Good grief—how can I ever hold my own with them?" But she found the other loaned executives helpful, and before long she forgot she was the only woman.

The past two years Tek has assigned four loaned executives each year; in 1961-62 we loaned three employees each year; in 1960, two; and 1957-59, one each year. Women who have served include: Maryellen Stevens, Tek's first loaned executive, in 1957; Marybelle Rash, 1962; and Betty Henry, 1963.

Bob Fitzgerald, vice-president, Operations, said: "The UGN organization has provided an excellent means by which business and we, as individuals, can effectively fulfill our responsibility to the less fortunates in the community. UGN is an organization of and for givers . . . ."

And Tektronix continues to give, in money and men, to UGN. ■

MORE BOOKWORK THAN BEAKERS

Some people may picture a chemistry laboratory as a Frankenstinian lair: In a room stuffed with Bunson burners and beakers, scientists—white-gowned and unsmiling — glower and squint into test-tubefuls of untrustworthy looking liquids.

But in truth a chem lab involves far more study than it does drama, more work with books than with beakers. It is a quiet place, test tubes and all, a place of study and hard work.

The Analytical Chemistry Lab in Bldg. 46, headed by Chet Schink, is such a place. The lab is part of Display Devices Development in the Engineering operation.

The Chem Lab is a service group, but not a direct function of research, engineering, or production. However, these areas often ask help on chemical problems, large or small.

Most chem lab projects are of short duration. Information is gathered to help solve the problem and made available to the persons requesting help, and the lab's project usually ends. As Chet states: "About the best way to put it is that we're general chemical consultants for the whole company. Our projects run from the sublime to the ridiculous, everything from monitoring clean-room environments to monitoring the sewer."

Chet has been at Tek 8½ years. A native Oregonian, he graduated from Franklin high school in Portland, obtained his BA from Reed college in 1941 and his PhD from Oregon State college in 1947. From 1947 to 1951 he worked for DuPont in New Jersey and Pennsylvania. He returned to Portland in 1951 to work in several small labs. He came to Tek in 1956.

Three people work for Chet: Marion Peterson, Verna Harris and Lorraine Mercer. Marion has been at Tek nearly 10 years, Verna and Lorraine more than eight years.

A new responsibility involves the electron microscope, a device to study particles, films and surfaces not visible through optical microscopes. Our electron microscope at present will magnify from 1800 to nearly 25,000 times; maximum magnification with an optical microscope is about 1500 times. The electron microscope can study such problems as treating metal surfaces or phosphor for CRTs. The microscope is located in the Ceramics Bldg. #13. Lorraine works with this equipment.

One of the lab's continuing jobs is monitoring the waste from Tek's sewer and chemical treatment plants, which eventually dumps into Beaverton Creek. Facilities tests the sewage disposal plant; the Chem Lab is consultant. They monitor BOD (biological oxygen demand), which means the amount of organic matter in the water (vegetable matter, paper, natural waste and so on.) If there is too much organic matter in the water released to the creek, the bacteria use most or all of the dissolved oxygen and the fish die. The solution is to keep the bacteria alive and healthy.

In the past, people have dumped trichlorethylene down some of our drains. The result has been mass extermination of bacteria (who in this case are our friends) and a high BOD count for our effluent. The lab also monitors pH (acidity) and chlorine content.

The Chemical Treatment plant is monitored for cyanides, chromium, pH and heavy metals which are toxic to fish. To be "safe", concentration must be about one part per million; one pound to 125,000 gallons of water. Treatment has adequately removed these materials.

The state requires monthly reports on both operations for pollution control and protection of marine life.

A major (though unspectacular) service is providing information on purchased chemical supplies. Any area which requires chemical supplies or equipment can use the service to determine the best and most economical product.

One typical analytical problem involved the type of solder used on ceramic strips. The strips are dipped in silver-bearing solder; for proper adherence, the solder must contain 3 to 4 per cent silver. Ceramics was having trouble — the solder wasn't sticking. An analysis showed it contained only 1 per cent silver: Now, every batch of solder is routinely tested. Nothing exciting, but it saved the company a lot of money.

Some time back we were having a flare problem with cathode-ray tubes. Stray electrons were being emitted to the phosphor, causing small random spots to appear on the screen; many tubes had to be rejected; this was very costly.

A material was developed that could be applied over the helix lines (black spiral lines of conductive ink than run around the inside of the bottle) to bleed off the spurious electrons. The resistance of the coating had to be greater than that of the helix lines, but low enough to conduct the electrons away. The material was developed and the problem was eliminated.

Chet also spent a good deal of time working on the automatic etch-bath system in what was then (in 1958) the F & M division. The high quality of our instrument demands high-quality aluminum. Most aluminum manufacturers have considerable leeway in the specifications they use in production. Since most Tektronix aluminum parts are visible to the customer, bubbles and runs around screw holes look second-class and can't be tolerated.

It was found that with some alloys used in making our chassis, the alloy properties had to be in a rather narrow range at the low end of the specifications.

Because Tektronix, in its world-wide operations, purchases supplies by their trade names, we often run into another problem: What's called Hi-Octane Glob in Beaverton may be called Model Airplane Glue in New York or London. For example, the material we use to clean ceramic strips after soldering is called SOCAL

"GENERAL CHEMICAL CONSULTANTS" is how Chet Schink describes the role of Tek's analytical chemistry lab. Shown are Marion Peterson (left) and Verna Harris.

(for Standard Oil of California). It's used to clean resin from the strips after they're soldered. An FE on the east coast may want to use some. At a local supply house he gets a blank stare when he asks for SOCAL, because there is it called ESSO solvent 150-2. The Chem Lab determines the trade name used in each part of the country so the product can be obtained wherever it is needed.

A lot of work is done with Purchasing to analyze trade-name products to see which one is best; to determine whether they contain the properties specified and whether they can be purcased more cheaply in bulk. Some trade-name products could turn out to be the same material or liquid we already have barrels of.

An important responsibility is writing chemical safety procedures, describing the properties of chemicals used in many areas of the company. This service is also used by the nurses in the First Aid room. A separate sheet is written for each chemical and trade-name mixture. Usually trade names give no clue to what's in the mixture. More than 110 items have been covered, but many new items are continually being added.

Two procedures are written for each mixture, one for the work area and one for the nurses, the nurses' copy being more technical. The Safety Data Sheet lists hazardous properties; toxicity; flash point, and other pertinent data, and steps to take in case of accident or emergency.

Supplying information on materials to export is another service. This is done at the request of Materials Management, which sends paints or solvents to our overseas plants. The information (flash points, boiling points, etc.) is available for those who handle the shipments, as well as for our own use. Also, the chem lab attempts to determine an overseas source for the material, to save shipping costs.

Probably one of the more difficult jobs is analyzing unknowns. Someone will bring in a few drops of liquid in a bottle and ask, "What is this stuff?" It may take a few minutes or several days to discover what the unknown consists of.

Service groups, because they're often out of sight, are often little known. Yet the service they provide **is** measurable. To the company's operating areas, engaged in a wide variety of activities, the chem lab's "service" shows up as dollars saved, safer work, faster jobs, better products . . . . ■

Technicians aren't born...

"vocational school" label no longer adequate for booming OTI

In his message on education to the 88th Congress, the late President John F. Kennedy said:

"There is an especially urgent need for college-level training of technicians to assist scientists, engineers and doctors. Although ideally one scientist or engineer should have the backing of two or three technicians, our institutions today are not producing even one technician for each three science and engineering graduates. This shortage results in an inefficient use of professional manpower—the occupation of critically needed time and talent to perform tasks which could be performed by others—an extravagancy which cannot be tolerated when the Nation's demand for scientists, engineers and doctors continues to grow. Failure to give attention to this matter will impede the objectives of the graduate and post-graduate training programs mentioned below."

Oregon Technical Institute in Klamath Falls is dedicated to meeting this need.

During World War II a rapid increase in industrialization occurred in Oregon. With it grew the need for skilled workers and technicians. After the war the influx of veterans returning home and demanding rehabilitation training taxed the abilities of Oregon's educational resources. An unprecedented challenge faced Oregon's educational leaders.

In early 1946 the facilities of the Marine Recuperational Barracks at Klamath Falls were demobilized and made available for other use. In October 1946 the State Emergency Board voted $75,000 to the State Board of Education to take possession of the barracks for a state vocational and technical school.

Dr. Winston D. Purvine, state supervisor of Trade and Industrial Education, was appointed director of the new school. He has guided it through its rapid development into one of the better technical schools in the US. A 1933 graduate of Albany college, Dr. Purvine has extensive experience in vocational and technical training, including: Superintendent of the Vocational Mining school at Grants Pass, 1936-37; administrative assistant to the Director of Vocational Education in Salem, 1937; director and founder of Eugene Vocational school, 1938; state supervisor, Public Service training, 1939-45; and state supervisor, Trade and Industrial Education, 1945-47.

In 1960 Dr. Purvine was awarded an honorary LL.D. degree by Lewis and Clark college in recognition of his outstanding work in the field of technical education.

The school began classes in July 1947 as "Oregon Vocational School". Thirty-one students registered in three courses: Auto Body and Fender; Auto Mechanics, and Cooking. An estimated attendance of 400 was forecast for the first year. However, by April 1, 1948, less than 10 months later, more than 500 students—from 23 states in addition to Oregon—were in daily attendance in more than 30 courses.

In December 1948 the name was changed to Oregon Technical Institute, to better describe the long-range aims of the school, and to avoid the detrimental association of the name Oregon Vocational School with first-offender prisons and youth reformatories in other states.

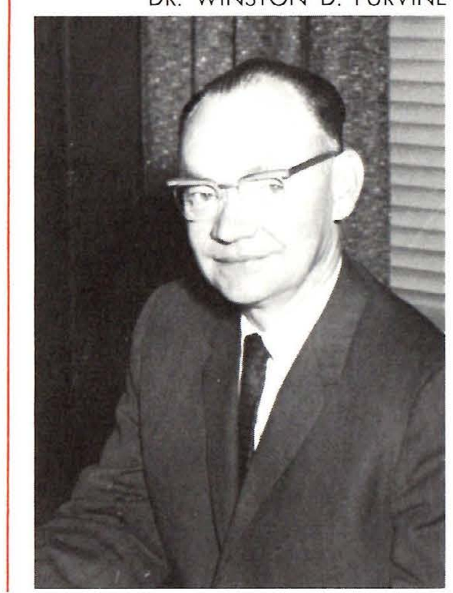
In the years that followed, OTI evolved from a vocational school, operating under the State Board of Education, to its present status as a polytechnic college under the Oregon State Board of Higher Education. As a vocational school, OTI was restricted to providing a program of skills training at the secondary school level. Under the Board of Higher Education each change in curriculum moves OTI closer to the objectives approved last July by the Board, which read in part:

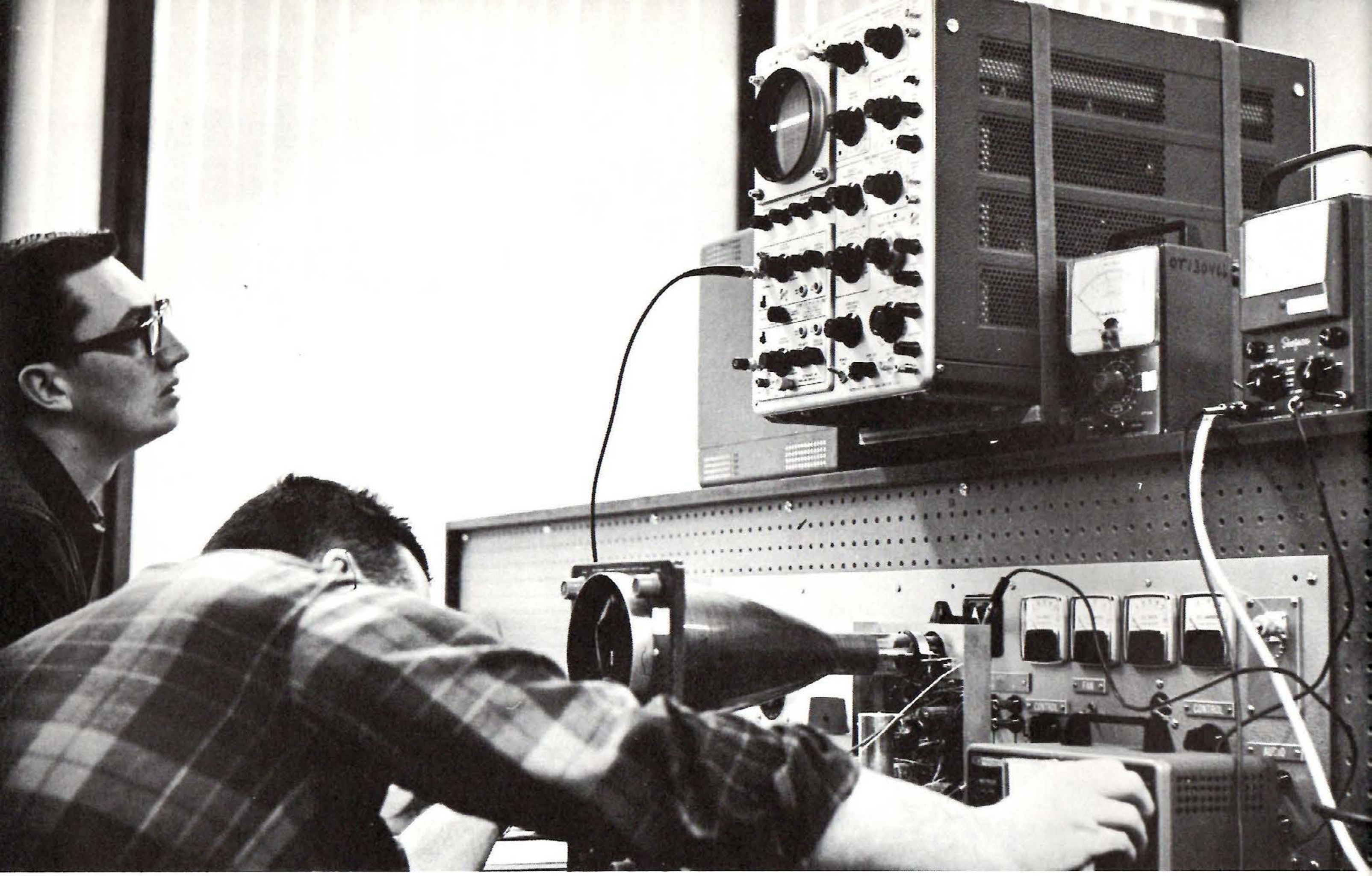
To provide college-level programs designed to meet the current and emerging needs of science, business and industry; to provide the quality of technical and applied science programs which will enable its graduates to be immediately employable and to be advanced within the occupation; to provide its students with requisite non-technical education to contribute toward their ability to participate as responsible members of a democratic society.

An important part of Oregon Tech's story is its accreditation—the whole school by the Northwest Association for Secondary and Higher Schools, and certain curricula by national accrediting agencies. Oregon Tech is proud that its electrical engineering program is an accredited engineering technology curriculum by the Engineer's Council for Professional Development. ECPD is supported by nine professional organizations, among them the American Society for Engineering Education, the American Society of Mechanical Engineers, the Engineering Institute of Canada, the Institute of Electrical and Electronics Engineers, Inc. (IEEE), and the National Council of State Boards of Engineering Examiners.

The Electrical Engineering Technology program at OTI is one of 19

DR. WINSTON D. PURVINE





offered during the 1964-65 school year. Chairman of the department is Professor Robert Baird, B.S.,E.E.,M.A. 163 students are enrolled in the EET program.

Professor Baird is enthusiastic about OTI's Electrical Engineering Technology program, about the opportunities for OTI graduates in industry—and about Tektronix instruments. He pointed out that more than 50 per cent of the total inventory value of instruments in the EET department are Tektronix-manufactured—27 oscilloscopes, plus plugins and accessory instruments.

The electronics labs give evidence of this. In a fourth-term electronic-circuit applications course, students use Tek 515A scopes to check circuits on radio sets they are constructing. Each of the lab's 14 benches houses a 515A.

Next door, students use a 545B/CA to check components of a kit oscilloscope, as part of an evaluation assignment. In addition to these Tek scope types, students have at their disposal a 570, 575, 561A, 533A and 565.

Although Tektronix, Inc. and Tektronix Foundation donated some scopes to OTI, most were purchased by the school.

In addition to Tek scopes, students use as one of their texts **Basic Semiconductors and Transistors,** a programed instruction series written by Jerry Foster of Field Training. Several Tektronix-produced films are used each year in electronics classes. The programed texts, which are still in early revision stages, and the films are provided to OTI at no charge.

The Electrical Engineering Technology program provides training for individuals preparing to enter the field of electronics as engineering technicians, such as: Calibration specialists, quality-control technicians, research-and-development team personnel, electronic draftsmen and industrial instrumentation and control technicians. The two-year program leads to an associate degree in engineering.

Its objectives are to provide training in theory and practice that will develop in the student knowledge and understanding of mathematical and scientific concepts, together with communication techniques; the ability to use modern methods and instruments in the analysis, design, layout and/or fabrication of projects; and an appreciation of his cultural heritage, of the broader aspects of education and of the continuing need for further technical study, so that he may grow with the rapidly changing world of today and of the future.

Professor Baird has been at OTI since 1958. Nine instructors and assistant professors complete the department staff. Nearly all came to OTI from jobs in industry and are aware of the priorities industry places on technician training. In addition to classroom instruction, several of the EET staff engage in research projects encouraged by the school's institutional research director.

Professor Baird explained the difference between a bachelor's degree in electrical engineering at a four-year college or university, and OTI's associate degree. The difference is one of depth, he said. For instance, the OTI program doesn't cover as much math. OTI puts emphasis on application of principles rather than on intensive and extensive engineering level education. As an example, OTI students put in about three times as much lab time as a BSEE student would in comparable courses.

Does OTI train students for specific industry need? Are there special courses to prepare students to be electronics technicians at Tektronix?

No. Professor Baird said experience has shown that industry doesn't **want** specialists at the technician level. Most companies prefer a technician with a broad general background, who can quickly grasp the specialized information supplied in company training programs. OTI students receive this broad background.

Dr. Purvine commented further on this. He cited an instance of a company which employed 60 technicians in one area, 20 of them from OTI. When the area was forced to halve the number of technicians, only one OTI grad was released. He also mentioned that 25-40 per cent of OTI graduates are in supervisory positions within five years after graduation.

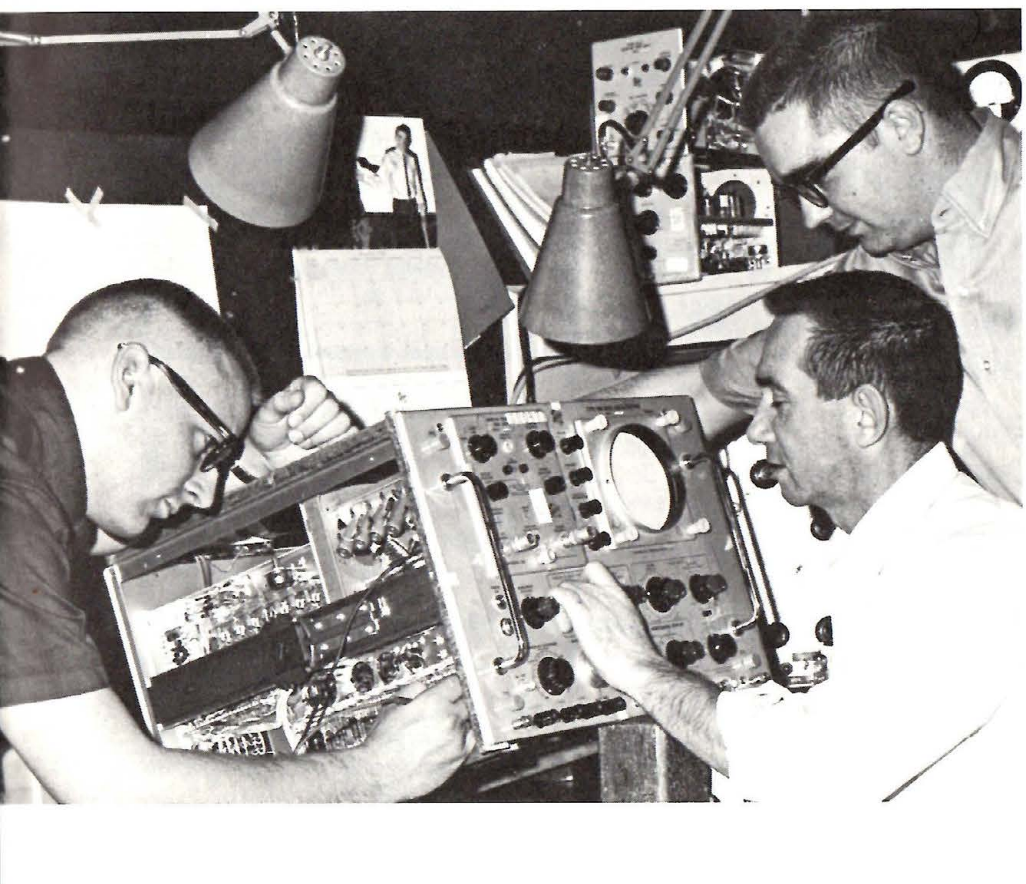
Oregon Technical Institute is the only institution of its type in Oregon, and it has no parallel in the 13 western states.

At present OTI offers two-year programs leading to associate degrees in engineering and applied sciences, and a three-year program leading to an associate degree in medical technology. The associate degree program is designed to qualify graduates for technicianship in semi-professional careers, rather than to be preliminary or partial training for the professions. While both approaches are necessary for industry, OTI is dedicated to technician training.

What are technicians? A report prepared in 1958 by the Veterans Administration in cooperation with the US Department of Labor, entitled "Employment Outlook for Technicians", described them like this:

"One of their largest and best-known areas of employment is research, development and design work. Technicians in this type of activity who have titles such as laboratory technicians, physical science aide, or engineering aides generally serve as direct supporting personnel to engineers or scientists. They conduct laboratory experiments or tests; set up, calibrate and operate instruments, and make calculations. They may work on fabrication and assembly of experimental equipment and development of models, do drafting, and in some instances do design work.

AMONG GRADUATES of Oregon Technical Institute working at Tektronix are (from left): Marshall Christensen, Bob Lilly and Allen Phillips, of Plant 3 Test.



"Technicians in jobs related to production usually follow a course laid out by the engineer or scientist, but they often work without close supervision. They may aid in the various phases of production planning, such as working out specifications regarding materials and methods of manufacture. Sometimes technicians serve as production supervisors or inspectors, perform tests to insure quality control of products, or make motion and time studies designed to improve the efficiency of operations. They may also perform liaison work between departments such as research or engineering and production . . ."

Among the 28 OTI-trained employees at Tektronix Beaverton plants are several managers, including: Larry Berry, Plant 4 Test-Final group manager; Gene DeShon, Metal & Plastic Components Mechanical Design Engineering manager; and Vern Isaac, CRT Test group manager. Other alumni work in Test departments in all four Product Manufacturing plants, in CRT and in Engineering.

About 85 per cent of the students enrolled at OTI are Oregon residents. Of the 1040 students enrolled in fall 1964, 913 came from 34 of Oregon's 36 counties, 109 from 20 other states, and 18 from 14 foreign countries. Nearly half of the out-of-state students are from California, most of these from the Klamath Basin. About 60 per cent of OTI graduates accept jobs in Oregon.

What does the future hold for OTI? In December Dr. Purvine presented to the Board of Higher Education a proposal to authorize four-year programs leading to degrees of Bachelor of Science in Technology, Bachelor of Technology and Bachelor of Science in Technology (Medical Technology). These programs entail addition of several courses to the curriculum, among them applied sociology, applied psychology and applied political science. If the Board approves the proposal this spring, the program could go into effect in the fall.

He emphasized that the **goals** of Oregon Technical Institute will not change with the proposed expansion of curricula. Addition of a bachelor's program is another step in the long-range program to develop the unique educational area lying between the vocational and semiprofessional work offered through high schools, vocational programs and community colleges, and the traditional programs of the universities and regional colleges.

Oregon Technical Institute will continue to train skilled, competent technicians—capable of meeting the present needs of electronics firms such as Tektronix, and other specialized industries, and of adapting to changes dictated by new technology. ■

PICTURE a wild, reedy marshland, shaggy with head-high swampgrass. In the spring sky a falcon wheels and dives. Wild birds trill in the trees and brush. At night, owls hoot and nocturnal critters, of assorted sizes and brands, sneak and squeak about the premises.

A pair of mallards breaks the pond surface. Deer tracks lead to the water's edge and disappear. The ground is cross-hatched by footprints of other animals: Weasel. Muskrat. Raccoon. Rabbit. Squirrel. Fox. And nutria; more about them later.

In the background you can hear a familiar sound: Someone in the Tek warehouse talking.

WELL, 'TAINT exactly the North Woods, but the unspoiled 40 acres in the midsection of Tek's industrial park is a primitive area in its own right, chock full of fish and game, reports Don Postlewaite (Landscaping and Grounds). It borders both sides of what's charitably called Beaverton creek, a sludgy waterway that pokes along through the lowland. Such as it is, the "creek" is home to catfish, who gurgle in its murk.

Most employees pass close by without realizing that Tek's premise-sharing plan includes thousands of fish, fowl and fur-bearers. Yet deer have been seen as far east as the sewer plant, and a weasel once was gutsy enough to live, part-time, right under Karl Braun drive.

There even once was a rumor that a bear was making the rounds of the property. One grounds man spotted an animal which he described as black, furry and about the size of a big dog. His conclusion, that it was a bear, wasn't unanimous with other crew members, according to Don.

OF THE BOG BIRDS and beasts, most are decorative, musical, tidy, harmless or otherwise tolerable. Not in this category are moles, gophers—and nutria.

Don has become, in an informal sort of way, a wildlife management specialist. His general approach is positive: Live and let live. Although one of the guards is currently trying to rub out a fox that's chewing up Tek's quail and pheasant population, Don's own attitude is a gentler one: "Nature put each animal on earth for a purpose."

But — surely — he can't include nutria.

teks

IF THE NUTRIA has a role in the great Drama of Life, he apparently can't read his script. Musical, he's not. Lovable, no. Neither sightly nor kempt, he breeds profusely and has a huge appetite, devouring anything he can remotely interpret as vegetable. He has been known to stretch this category to include laundry soap, leather harnesses and rope. (Small animals unfortunate enough to resemble potatoes are also in danger.)

The nutria is a huge bucktoothed rat who looks like nothing so much as a reject beaver. He has yellow teeth and greasy pelt. He enjoys living in and around Beaverton creek; which says all that needs to be said about his personal hygiene and life philosophy.

So, along with moles and gophers, the nutria has been marked by Don for removal from the industrial park. Local farmers warn that the job won't be easy. The beasts are equally resistant to persuasion and poison. Informal tests using strychnine-coated carrots showed only that nutria (appear to) prefer carrots **without** strychnine. (Also, the tested group had 23 per cent fewer cavities.)

At any rate, Don points out, no poisons are used on Tek property. And any trapping will be with cage traps, so desirable animals that wander in can be turned loose.

AS TO MOLES and gophers, who make dirt piles of what would otherwise be Tek lawn, our champion trapper is Chris Schindler (Grounds Maintenance) who has single-handedly done in 64 moles and 98 gophers in a year.

PUBLIC RELATIONS has many faces. One unexpected public is composed of local nature lovers, who have written to compliment Tek for keeping part of its property wild.

* * *

A CATCHY HEADLINE in the New York Times reads: "Dolphins Seem to Want to Talk."

A Florida researcher named Dr. John Lilly claims these brainy fish aren't just making noises but are actually trying to **say** something to him. What makes this Tek news is that he's using a 503 and a deck of 160-series instruments to measure their talk.

Folks have known all along that dolphins mimic human speech—like parrots, only better. (This is in addition to the usual dolphin prattle, which, the Times swears, includes "whistles, creaking doorlike noises, barks, grunts, raspings and other utterances.")

The star dolphin is one Elvar, who is eight years old and would be six feet tall if he stood up. When he's waiting around, impatient-like, for the experiments to begin, he reportedly says something that sounds just like "All right, let's go."

DOLPHINS, WHICH normally blub their words underwater, have learned to talk with head above the surface. This **proves** they're trying to communicate, says Dr. Lilly. Otherwise, why bother? It's about as sensible as a man speaking with his noggin in the fishbowl.

Elvar has a brain as big and complex as those of the humans who stand around his tank and gawk and run the show.

"They **seem,**" he may be thinking as he listens to them, "to be trying to **communicate** with me . . . ."

TEKROSTIC NO. 4

INSTRUCTIONS

1. Fill in the word blanks A through Y. (We've done word F as an example.) Do as many words as you can, then . . .

2. Transfer the letters from the words into the indicated spaces on the acrostic square. (The letters in word F have been transferred, to start you off.)

3. The acrostic square—when completed—will spell out a complete quotation about Tektronix. The message reads left to right across the puzzle. It does *not* run up and down like a crossword puzzle. Words in the quotation are separated by dark square *only*—not by the end of a line.

4. Puzzlers often find it easiest to work not only from the word list to the acrostic square, but also back *from* the square *to* the list. That is, when you can guess a word in the quotation, fill it in and transfer the letters to the proper blanks in the word list.

5. When the puzzle is completed, the first letters of words A through Y, read from the top down, will spell out the source of the quotation (the person who said it, or the publication it came from, or both.)

A 121 6 58   60 134 2 113 126 — Couple units of Injun message (2 words)

B 94 105 131 — Imaginary sprite; part of yourself

C 20 140 42 86 51 — Work dough

D 16 147 75 — Filler of teapots

E 25 117 — Exclamation

F L A T H E (74 148 3 81 28) — Device that spins wooden legs

G 97 21 43 17 — Name of dog owned by 16th employee on page 10 of Tek directory

H 83 24 52 153 32 150 — Be quiet

I 18 114 136 53 5 95 — Morning in Tampico

J 76 100 26 123 93 4 — Don't do this to a hornet who's down your back

K 125 33 68 145 — Common openers

L 9 45 101 119 1 132 154 14 89 — Bob Fitzgerald and Jim Castles are ______ of Tektronix

M 104 70 29 73   11 128 67 — Falter; become tired (2 words, slang)

N 22 77 139 85 61 99 15 118 — Montana city, pop. 11,254

O 8 71 149 38 112 34 107 143 36 13 142 — Build again

P 135 47 44 69 129 90   19 64 80 91 — Sounds just like naughty Otto (2 words)

Q 78 56 31 84 30 116 130 110 65 — Purpose

R 50 57 96 102 — Scenter of face

S 146 137 103 63 41 — This couldn't be empty, but may be filled (by D.D.)

T 46 27 109 — Future turtle

U 12 92 141 106 — Almost crude; not polite

V 54 66 23 40 133 37 98 49 — Avenue in St. Peter Port, Guernsey; queen of England

W 115 79 152 7 62 59 124 82 48 — Explain

X 55 72 35 108 87 144 155 88 — Aperture and shutter speed

Y 138 120 151 39   122 111 127 10 — Redundant commentary by Kemo (2 words)

	1-L	2-A	3-F T	4-J	5-I	■	6-A	7-W	
	8-O	9-L	■	10-Y	11-M	12-U	13-O	14-L	
	15-N	■	16-D	17-G	■	18-I	19-P	20-C	
	21-G	■	22-N	■	23-V	24-H	25-E	26-J	
27-T	28-F E	■	29-M	30-Q	■	31-Q	32-H	33-K	■
34-O	35-X	36-O	37-V	■	38-O	39-Y	■	40-V	41-S
42-C	■	43-G	44-P	45-L	46-T	47-P	48-W	■	49-V
50-R	51-C	■	52-H	53-I	54-V	55-X	■	56-Q	57-R
■	58-A	59-W	60-A	61-N	62-W	63-S	64-P	65-Q	66-V
67-M	68-K	■	69-P	70-M	■	71-O	72-X	73-M	74-F L
75-D	76-J	77-N	■	78-Q	79-W	■	80-P	81-F H	82-W
83-H	84-Q	■	85-N	86-C	87-X	88-X	89-L	■	90-P
91-P	92-U	93-J	94-B	■	95-I	96-R	97-G	98-V	99-N
100-J	■	101-L	102-R	103-S	104-M	105-B	106-U	■	107-O
108-X	■	109-T	110-Q	■	111-Y	112-O	■	113-A	114-I
115-W	116-Q	117-E	■	118-N	■	119-L	120-Y	121-A	■
122-Y	123-J	124-W	125-K	126-A	■	127-Y	128-M	129-P	■
	130-Q	131-B	■	132-L	133-V	134-A	■	135-P	
	136-I	137-S	138-Y	■	139-N	140-C	141-U	■	
	142-O	143-O	144-X	145-K	146-S	■	147-D	148-F A	
	149-O	150-H	■	151-Y	152-W	153-H	154-L	155-X	

tek talk

Published every three months by Tektronix, Inc., 13955 SW Millikan Way, Beaverton, Oregon. Address mail to Communications department: Joe Floren, editor; Nancy Sageser, designer. Other contributors: Josef Oswald, Becky Weber, Willie Henning, Jane Martin, Frank Hood, Arlan Evensen. Photomechanical production by Tektronix Photography department; printing by Printing department.

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