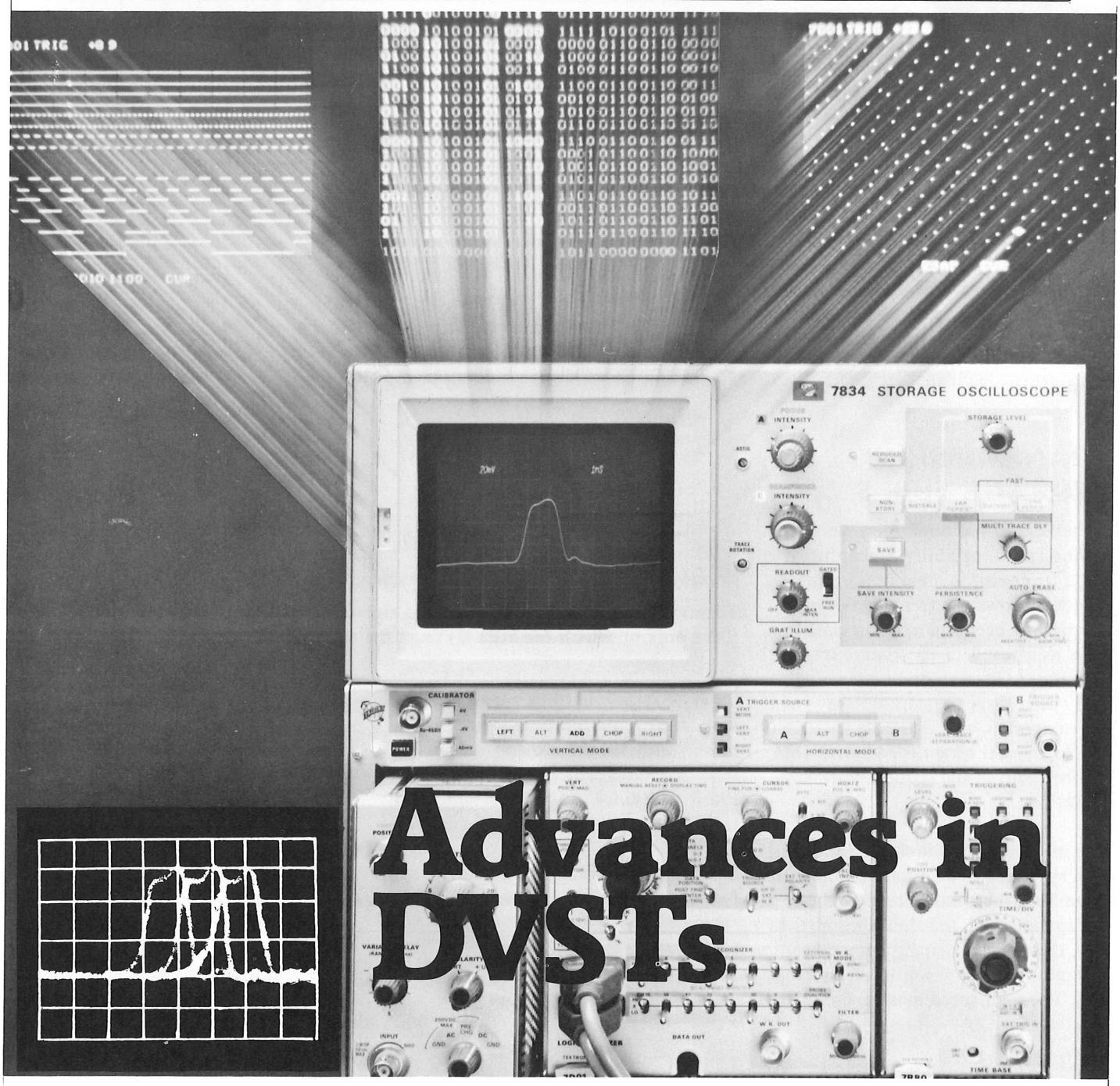
COMPANY CONFIDENTIAL

Engineering News

January 1978



Advances in DVSTs

RECENT ADVANCES IN DIRECT VIEW STORAGE TUBES

Chris presented this paper at the 1977 Society for Information Display conference.

Chris Curtin, Display Device Engineering, ext. 7591.

INTRODUCTION

Direct-view storage CRT's have been in use for many years, but significant advances have taken place in the last few years. These developments have helped to increase the CRT's usefulness and lengthen its lead over competing technologies.

TRANSMISSION STORAGE TUBES

In the field of oscillography, the **stored writing speed**, or ability to capture a single transient, is most important. Figure 1 shows the tremendous gains which have been made in the past few years as a result of the **charge transfer technique**. This technique uses a very high speed target to capture the information, which is then transferred to a low speed target for viewing [1]. Figure 2 shows the sequence of operation.

The information is first written on the high speed mesh with the writing beam (time T^1), then transferred to the storage mesh by the flood beam (time T^2), then viewed using the flood beam, storage mesh and phosphor screen (time T^3). The high speed mesh is optimized for high sensitivity, but at the price of very short retention time. The storage mesh can be optimized for long retention time rather than high sensitivity, since the high current flood beam is used to write the information.

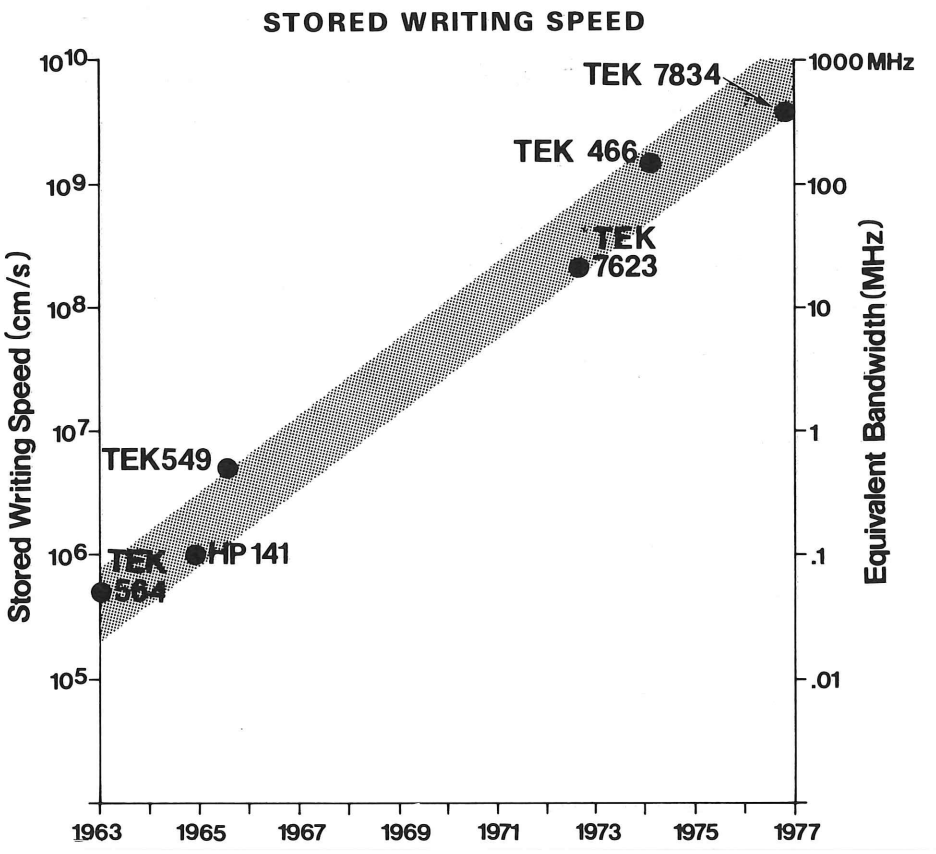


Figure 1. Dramatic improvements in stored writing speed have resulted (at Tektronix and with the HP141) from the use of the charge-transfer technique.

Storage CRT's with a mesh-supported dielectric are called **transmission tubes** since the flood (viewing) current is transmitted through the target to the phosphor screen. These tubes are capable of storing halftones and operating in a variable persistence mode.

While for many years there has been a small market in radar display applications for magnetically deflected CRT's, recent developments have been seen in electrostatically deflected CRT's. Two instruments are now available which offer 50 lpi resolution in a 4″ diagonal CRT. A major use area is in medical imaging where gray levels similar to photographic film are important.

PHOSPHOR STORAGE TUBES

In the information display field, information capacity is one important requirement. Using the screen area as an indication of capacity, figure 3 describes recent trends in bistable **phosphor storage CRT's**. Since the screen is not quantized, the amount of information displayed depends upon the quality required, with some users storing 34,000 characters on a 19″ diagonal CRT. This capacity is equivalent to 18 characters per inch as shown in figure 4.

Initial users of bistable CRT's for computer output utilized a 5″ diagonal CRT which had been built for oscilloscopes [2]. This was obviously too small, but due to the low cost was a practical method of displaying computer messages. Because of the inherent simplicity of this device [3] compared to mesh storage (transmission) tubes, the scale-up (shown in figure 3) was accomplished at a reasonable cost to the user. The rapid growth in computer graphics is primarily a result of the very high resolution, stable display offered by these CRT's.

The operation of a bistable CRT using a phosphor storage target is diagrammed in figure 5. The writing beam deposits a positive charge image by bombarding the dielectric (phosphor) target with a secondary emission ratio greater than one (time T^1). The flood electrons bombard the positively charged areas, with a secondary emission ratio equal to one (time T^2). No net charging occurs, and a continuous light image is emitted by the phosphor.

continued

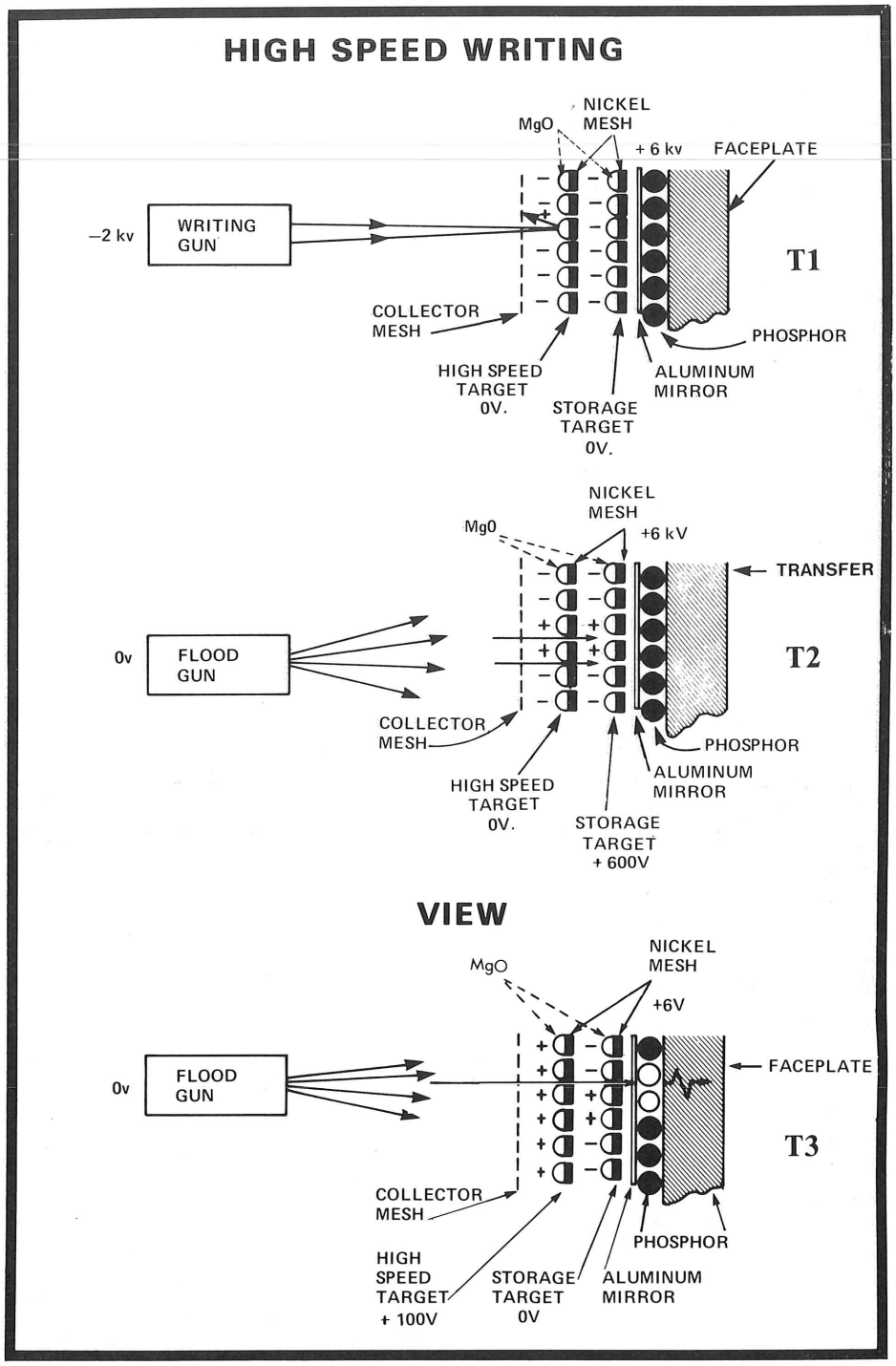


Figure 2. Transfer tube operation begins when the information is first written on the high-speed mesh with the writing beam (in time T^1), then transferred to the storage mesh by the flood beam (in time T^2), then viewed using the flood beam, storage mesh and phosphor screen (in time T^3).

The intensity of the light emitted is proportional to the phosphor efficiency, the incident current density, and the energy of the electrons. Newer phosphors with higher efficiencies have recently been used, resulting in much greater light output, as shown below:

	Zn_2SiO_4:Mn	Rare Earth Oxysulfides
Luminance	8fl	20fl
Contrast Ratio	10:1	8:1

In addition to increased efficiency, these materials also exhibit increased stability under electron bombardment. Reductions in aging rates of three to four times compared to the standard material have been measured in accelerated tests.

Another improvement has been implemented by the circuit designer rather than the device designer. With some local memory, the **write-thru** mode is utilized to provide both storage and refresh operation on the same display [4]. The write-thru mode presents a refreshed image at a current density that is too low to store, and when the picture is correctly formatted or placed, the current is increased to the level needed to store.

Although the phosphor storage CRT is intended for bistable applications, its widespread popularity has resulted in attempts to use it as a halftone display device. Some workers [5] have found that acceptable halftones can be generated by varying the written area and hence the apparent luminance.

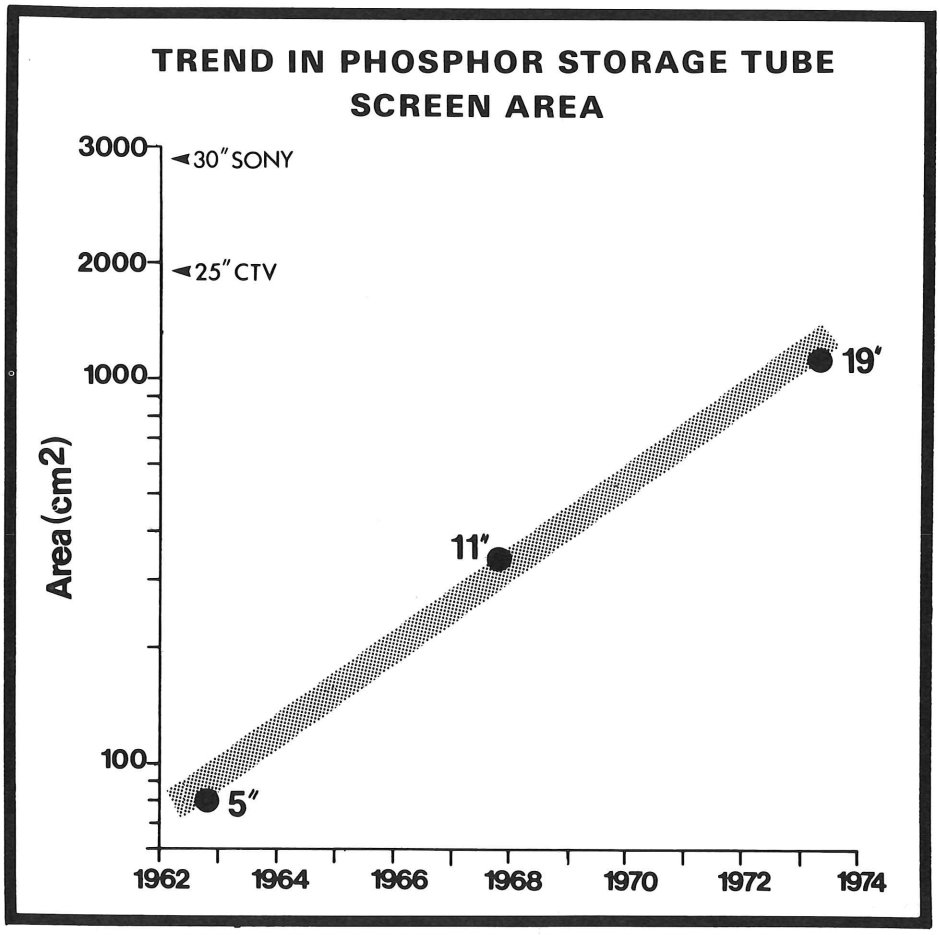


Figure 3. The trend line shows clearly that there has been a ten-fold increase in phosphor storage tube screen area over the last decade.

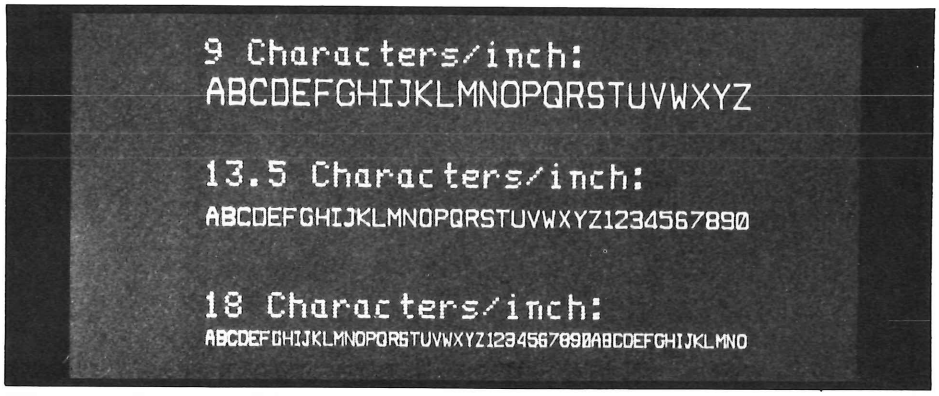


Figure 4. This photo shows examples of different character spacings.

CATHODOCHROMIC CRT'S

Another class of DVST which features dark trace storage, rather than bright trace, is the **cathodochromic CRT**. CCRT's utilize a screen material which darkens under electron beam bombardment. The dark trace is retained until the material is heated to 300° C. Recent material developments [6] allow erasure with the writing beam rather than external sources. A 3 x 3 inch screen can be erased in six seconds using a 20 kV electron beam. These improvements should increase the usability of this very simple and potentially inexpensive storage CRT.

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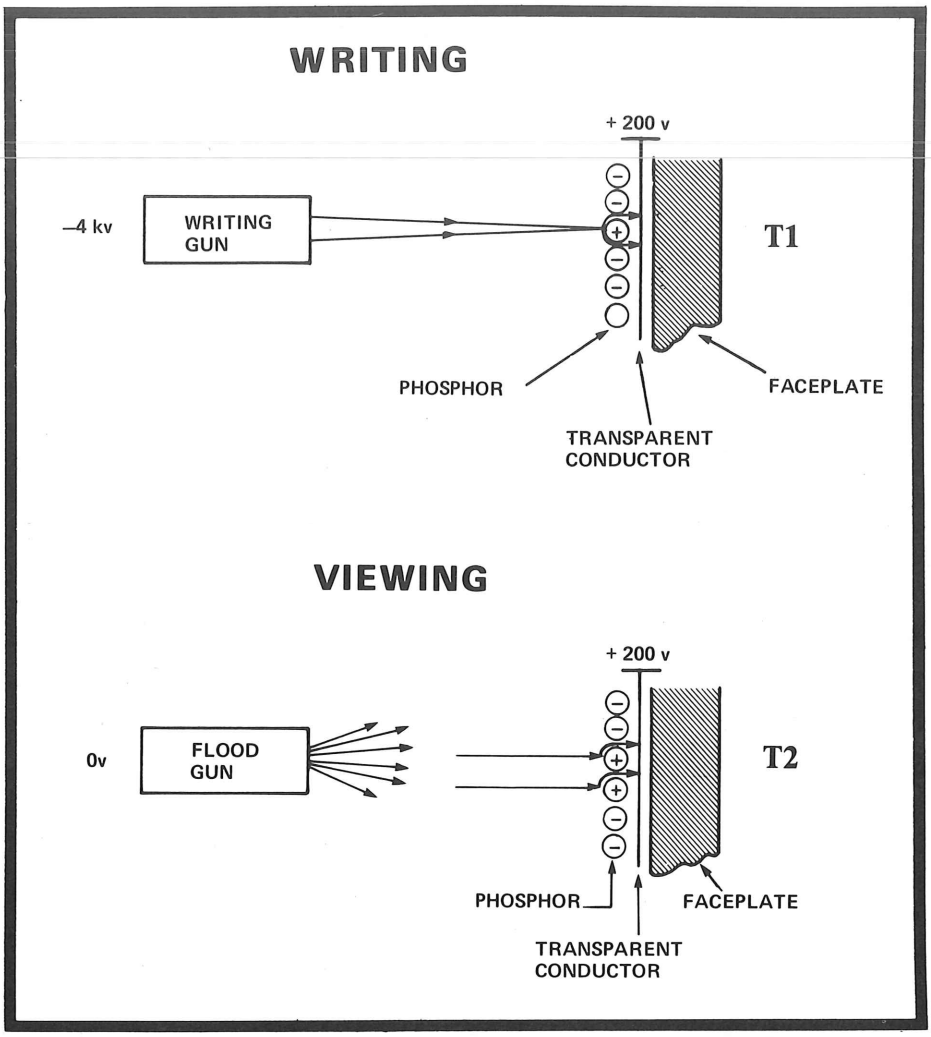


Figure 5. The operation of a bistable crt using a phosphor storage target begins when the writing beam deposits a positive charge image by bombarding the phosphor with a secondary emission ratio *greater* than one (in time T^1). The flood electrons bombard the positively charged areas with a secondary emission ratio *equal* to one (in time T^2). No net charging occurs, and a continuous light image is emitted by the phosphor.

SOLID-STATE STORAGE... A THREAT?

With the price of solid-state memories declining rapidly, their competitive threat to storage crt's is becoming serious.

In the information display market, Hewlett-Packard and Tektronix have recently announced terminals which provide refreshed graphics at a price comparable to our storage-tube products. Although their resolution is marginal for complex graphs (see figure 6), solid-state storage will provide increasing competition as the price of memory drops and high-resolution refreshed monitors become available.

In the single-shot oscillography field, the situation is different. Solid-state memory systems become competitive today only for signals below 1 MHz because of the severe speed requirements at higher frequencies (see figure 7).

This technological barrier appears to be more resistant than the price, but it will slowly yield with continued development. Products like the 466 Portable Storage Oscilloscope and 7834 Fast Storage Oscilloscope which store 100 and 250 MHz single-shot waveforms appear to be reasonably secure for a few more years.

WRITING A PAPER?

One of the main functions of the Technical Information Department is helping Tektronix engineers communicate with the technical world outside Tektronix.

If you are writing a paper for a conference, an article for a magazine, or presenting a technical talk, give Technical Information a call (ext. 5674). We provide editing, typing, and illustrating for papers and articles, and coaching and graphics for slide shows.

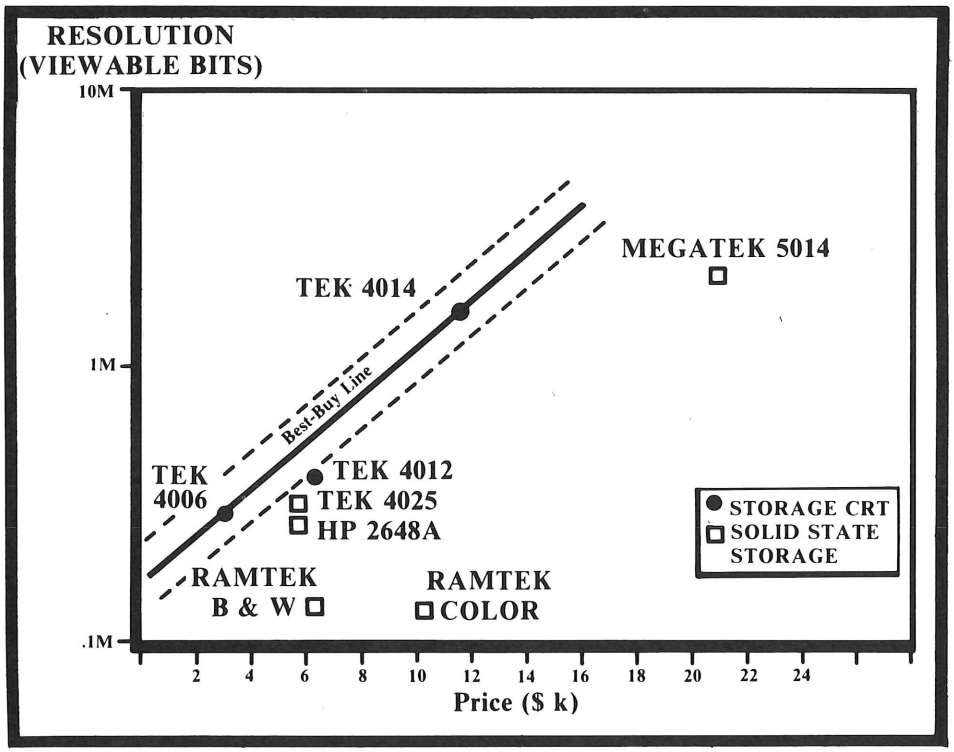


Figure 6. Price/resolution trade-offs still favor storage crt's, but solid-state storage will provide increasing competition as the price of memory drops and high-resolution refreshed monitors become available.

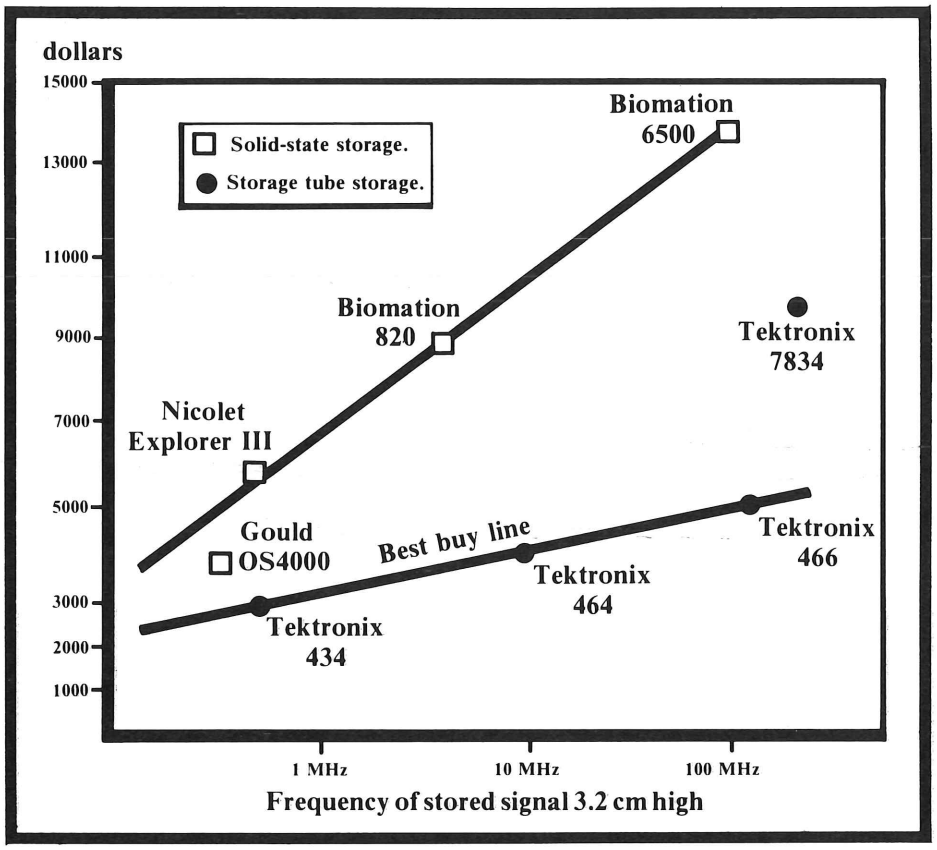


Figure 7. Today solid-state storage systems become competitive with storage tubes only for signals below 1 MHz because of the severe speed requirements at higher frequencies.

CONCLUSION

In their historical area, DVST's have shown remarkable gains in writing speed during the last few years. Further improvements are possible but are not expected to continue at the same rate as seen in the last few years. In the area of low speed oscilloscopes, solid state memory is already making inroads into markets served exclusively by DVST's in the past.

The availability of transmission and cathodochromic CRT's is expected to remain in the smaller sizes (less than 10" diagonal)...the transmission tubes, because of the cost and fragility of the mesh, and the cathodochromic CRT because of the power needed for erase. In the area of computer graphic display, the phosphor storage CRT is expected to maintain its lead by providing both low cost storage and a high resolution display.

References

[1] Andrews, G., "A 1000 cm/ s Storage Oscilloscope," Tekscope, Vol. 6, No. 2, March/April 1974.

[2] Winningstad, C.N., "The Simplified DVST in Computer Output Applications," SID Digest, May 1967, p. 129.

[3] Anderson, R.H., "A Simplified DVBST," IEEE Transactions on Electron Devices, Vol. ED-14, No. 12, December 1967, pp. 838-844.

[4] Cheek, T., "Improving the Performance of DVST Display Systems," 1975 SID Digest, p. 60.

[5] Gordon, R., et. al., "Halftone Graphics on Computer Terminals with Storage Display Tubes," Proceeding of the Society for Information Display, Vol. 17, No. 2, 1976.

[6] Todd, L.T., et. al., "Cathodochromic CRT Employing Faceplate Deposited Sodalite and Electron Beam Erase," IEEE Transactions on Electron Devices, Vol. ED-22, No. 9, September 1975.

LOGIC ANALYZER DIGITAL LATCHES ANNOUNCED

Logic Development Products Marketing has announced two new products: the DL2 and DL 502 Digital Latches. These plug-in units detect narrow pulses that cannot be captured by a logic analyzer alone. The units can latch asynchronous glitches as narrow as 5 ns, or less than one sample interval. The DL2 plugs into 7000 series mainframes, and the DL 502 plugs into TM 500 mainframes.

For more information about these two new units, contact Jack Scribner (LDP Marketing) on ext. 6420 or drop by D.S. 39-282.

AUTOMATIC WAVEFORM DIGITIZER AVAILABLE IN SPRING '78

Signal Processing Systems Marketing, at the WESCON '77 trade show, presented an Automatic Waveform Digitizer, a new 7000 series programmable mainframe. Programmable plug-ins for the 7912AD Digitizer include the 7A16P Amplifier and 7B90P Time Base.

As a measurement technique, waveform digitizing has been widely accepted in the form of the Tektronix R7912 Transient Digitizer, the Digital Processing Oscilloscopes and in the form of competing models. But, automatic control was missing; the operator who made the measurements also had to set all the controls. Now the instrument settings can be controlled over an IEEE-488 General Purpose Interface Bus...which means a wide range of minicomputers, microcomputers, intelligent terminals and calculators can be used as controllers.

For more information about the automatic waveform digitizer, call Bob Roberts on ext. 1150.

NEW BOOK ON DIGITAL SIGNAL COMPUTERS AND PROCESSORS

The publication of **Digital Signal Computers and Processors** has been announced by the IEEE Press. This collection of reprints was edited by Andres C. Salazar of Bell Laboratories.

This book is a compilation of papers on digital signal processing hardware. It emphasizes the architecture and use of high-speed computers and processors to implement digital signal algorithms. The 44 papers are organized into these categories: economics, comparisons and trends; architecture; elements of a digital signal processor; and applications.
The subjects discussed in the applications section include: computing units for digital filters, FFT computing, multiply configurations, A/A and D/A conversion.

This 352-page volume is $12.95 for the paperbound edition (for IEEE members only). A clothbound edition is available for $25.95 (discounted to $19.45 for IEEE members).

This book can be ordered postpaid from the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. Payment should accompany the order.

IN PRINT

Bob Ross (Information Display Systems) is the author of an article, "An Interactive Software Program for a Standalone Graphic System," in the September 1977 issue of **Computer Design.**

The article describes PLOT 50, a program that works with the 4051 BASIC Computing System to analyze circuits with two-port parameters that define the input and output variables of the circuits. PLOT 50 displays the results in either tabular or graphic form. The user may enter, edit and store code and data; select circuit analysis sequences; and choose different output presentations.

If you would like more information about the program, call the library on ext. 5388 for a copy of the article. The article appears on pages 114-118.

IEEE PUBLISHES BOOK ON CRYSTAL AND MECHANICAL FILTERS

The IEEE Press has published **Modern Crystal and Mechanical Filters**, a collection of reprints edited by Desmond F. Sheahan of GTE Lenkurt and Robert A. Johnson of Collins Commercial Telecommunications Division of Rockwell International.

The book covers the latest bandpass filters: ladder networks using input and output electromechanical transducers, resonators and acoustic coupling elements.

continued

The crystal filters discussed are generally monolithic or polylithic filters with deposited electrodes on quartz-crystal substrates. The mechanical filters examined are metal-alloy filters using discrete resonators (rods, disks, or bars) of wire-coupled design.

This volume of 49 reprinted papers begins with a tutorial on crystal and mechanical filters.

There are 24 papers on mechanical filters in these categories: historical and review papers, filter synthesis, channel bank filter design, low frequency mechanical filters, use of multiple-mode resonators, models and circuit element descriptions.

Twenty-five deal with crystal filters in these categories: historical overview, analysis of acoustically coupled systems; crystal filters containing acoustically coupled resonators; manufacturing techniques; materials, properties, and filters with non-quartz materials; nonlinear and tolerance effects.

The book includes the first extensive bibliography available on the subject.

This 464-page book costs $12.95 for the paperbound member edition and $25.95 for the clothbound edition (discounted to $19.45 for IEEE members).

The book can be ordered postpaid from the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. Payment should accompany the order.

THE ENGINEERING ACTIVITIES COUNCIL ...a Year Later

IN THE BEGINNING

In October 1976, Bill Walker, Test and Measurement Group vice president, asked representatives from the engineering areas to participate in an Engineering Activities Council.

"The basic purpose of the council is to provide engineers with a forum in which they can present, to multiple levels of management, what engineers themselves consider to be important in their areas of technology," Walker explained in a letter to **Engineering News.**

COUNCIL MEMBERS

The areas the council members represent are shown in Table 1.

The members of the Engineering Activities Council have sponsored eight engineering forums. The council appointed two co-chairmen for each forum, as shown in Table 2.

COUNCIL OPENINGS

The Engineering Activities Council (the Forum organizing group) has now reached the end of its first full year. Some members are leaving and Bill Walker is looking for replacements. If you are interested in contributing to better engineering communications and would like to be considered for one of these openings, call Bill's secretary, Karen Hall, at 7009 or drop him a note at 50-475.

FOR MORE INFORMATION

The Technical Information Dept. (part of T & M Operations) has published reports on the first three forums. If you would like a copy of a forum report, call Jane West on ext. 5674 or drop by 50-462 (across from the central elevator).

Fendall Winston	FDI Eng., Communications Div.
Joyce Lekas	Technical Information, T & M Operations.
Bob Burns	Hybrid Circuits Eng., Tek Labs.
Robert Chew	Instrument Research, Tek Labs.
Bob Nordstrom	Monolithic Circuits Eng., Tek Labs.
Phil Crosby	TV Eng., Communications Div.
John Addis	Lab Scope Eng., LID.
Dave Lowry	Logic Development Eng., LID.
Dave Chapman	STS Eng., MSD.
Bob Oswald	SPS Eng., MSD.
Paul Williams	SPS Eng., MSD.
Mike Boer	Accessories Engineering, SID.
Cal Diller	SID Eng., SID.
Steve Joy	IDO Eng., IDG.
John Mutton	IDP Eng., IDG.

Table 1. Bill Walker (vice president, T&M) asked these 16 people to represent their areas on the Engineering Activities Council.

FORUMS	CO-CHAIRMEN
1 General Purpose Interface Bus	Paul Williams, Robert Chew
2 A-D and D-A Converters	Bob Nordstrom, Mike Boer
3 Video Display Techniques	Steve Joy, Phil Crosby
4 New Technologies: I	John Addis, Bob Burns
5 New CRT Technologies	Bob Oswald, Cal Diller
6 Creative Microprocessor Hobby Projects	Dave Chapman, Joyce Lekas
7 Managers Talk to Engineers	Mike Boer, John Mutton
8 Microprocessor Design Pitfalls	Robert Chew, Paul Williams

Table 2. The Engineering Activities Council has sponsored eight engineering forums in the past year.

Front row, **seated (left to right): Robert Chew, Joyce Lekas, Fendall Winston (chairman), Linda Mattson (secretary), John Addis and Steve Joy.**

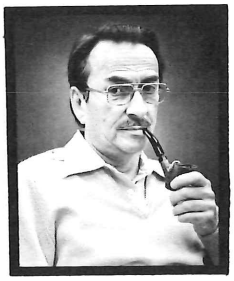
Back row, **standing (left to right): Phil Crosby, John Mutton, Dave Chapman, Paul Williams, Bob Burns, Bob Nordstrom, Dave Lowry, Mike Boer, and Cal Diller. Bob Oswald is not shown.**

PATENTS RECEIVED BY TEKTRONIX

To further promote internal technical communication, Engineering News *will publish abstracts of patents received by Tektronix engineers.*

All back up material for the patents is on file in the Patents and Licensing Office (D.S. 50-419). For more information about patents in general, call ext. 5266.

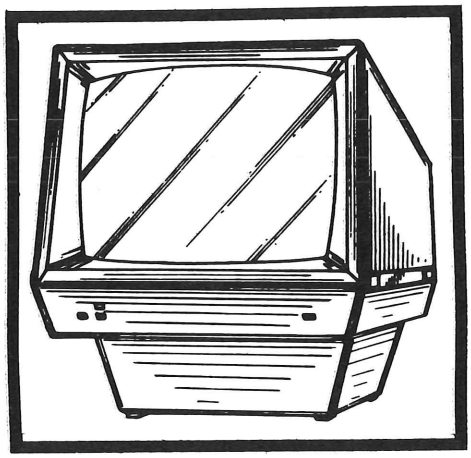
A DISPLAY MODULE



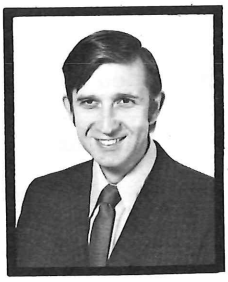
Richard E. Hansen, IDP Eng., ext. 2508.

David R. Smith, IDP Eng., ext. 2506.

This patent is for an ornamental design for the display module shown below.



THERMAL PRINTING HEAD

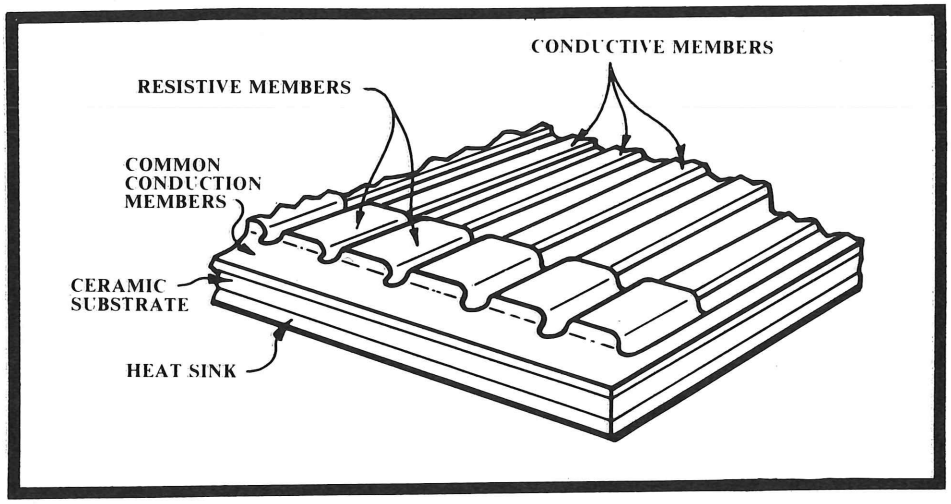


Jerry E. Turnbaugh, Corporate Safety, ext. 7777.

Patricia A. McLaughlin, Portable Patient Monitors, ext. 6379.

Earl W. Stapleton (deceased)

The thermal printing head consists of a row of thick-film resistors connected by thick-film conductors on a ceramic substrate. Power applied to the resistors creates heat. When thermally sensitive paper contacts the resistors, the paper changes color at the contact points. The result is an array of dots. Several arrays combine to form an alphanumeric character.



THE TEKTRONIX PATENT PROCESS

As a follow-up to the discussion of engineering notebooks in the 1 November 1977 issue of Engineering News, *the Patents and Licensing Department has answered the following commonly-asked questions.*

Who is responsible for notifying the Patents Department about new inventions?

You, the inventor. Fill out an Invention Disclosure form, have it witnessed by someone who understands the invention, then take or send the form to the Patents and Licensing group at D.S. 50-419. To obtain Invention Disclosure forms, call Carolyn at ext. 5385.

What happens then?

The invention disclosure is reviewed by the Patent Committee at one of their periodic meetings. The Committee is composed of various engineering managers and members of the Patent Department.

If the Committee decides that Tektronix should try to obtain a patent on the invention, a "novelty" (patentability) search is made in the U.S. Patent and Trademark Office. This is done to see if someone already has a patent on the same or a very similar invention. If the search results look good, a patent application is prepared and filed by the Patent Department.

What if the Patent Committee decides not to seek patent protection on an invention?

Some inventions are more valuable to Tektronix as trade secrets and are classified as such by the Committee. Chemical processes often fall into this category. The Patent Committee may decide to put a disclosure on "hold" and review it again later. This may happen if an invention is not going to be used in a product in the immediate future but may be used later on. If the Patent Committee decides Tektronix has no interest in an invention, the inventor may then request that it be released to him (or her) to pursue as he or she wishes. Tektronix retains "shop rights" in released inventions. This gives the company the right to make and use the invention on a royalty free basis.

Could you be more specific about the kinds of things Tektronix patents?

The majority of Tektronix patents are on electronic circuits and instrument components, such as crt's, switches, attenuators, and similar devices.

What is the life of a patent?

United States patents last for 17 years from their issue date, except for ornamental design patents, which have a life of 3½, 7 or 14 years. Foreign patents vary, but typically last for 20 years from the application date.

How long does it take to obtain a U.S. patent?

It varies greatly, but two to three years is typical.

How many patents does Tektronix have?

At present we have more than 400 U.S. patents and about 600 foreign patents. About 650 applications are pending worldwide.

If two people, working independently, come up with the same invention and both file patent applications, who gets the patent?

In the United States, the first inventor is entitled to the patent, even if the inventor was not the first one to file the application. *This makes routine, careful use of engineering notebooks vitally important.* If properly witnessed, these notebooks are considered the best evidence of when an invention was made.

In foreign countries, the first one to apply gets the patent.

If I want to write an article or present a paper on a potentially patentable idea, must I file a disclosure first?

Yes—to preserve our rights in foreign countries, we need to have a patent application on file before the invention is publicly disclosed.

For further information, call John LaRue, ext. 5266; John Winkelman, ext. 7675; Tom Noe, ext. 5290; or Ken Durk, ext. 5403.

PCC SHARES MANAGEMENT COURSES WITH TEKTRONIX

A cooperative effort between Tektronix and Portland Community College is making three courses from the PCC Supervisory Development Program (SDP) available on Tektronix, Beaverton campus.

The cooperative program, started in September 1976, offers Principles of Management/Supervision, Human Relations, and Math 103 (Probability and Statistics). The math course is an elective, but the other two are required for the assoicate degree offered with the program.

Most of the SDP courses included in the associate degree program are offered in the evenings because the students are usually full-time employees (some courses are offered in the mornings for people who work swing shift).

The instructors for the classes are part-time PCC instructors, but full-time managers for Portland-area companies. That means that the students have contact with instructors who are daily involved in the real world of management. The instructors bring to their classes their own experience with the kinds of situations their students will face as managers.

If you have questions about the PCC classes generally or management/supervisory classes in particular, contact Marilyn Bernert (Education and Training) on ext. 5224.

PRODUCT DESIGN STANDARDS

A company-wide committee of 35 people are working with Dwain Hall (Technical Standards) to create and review special standards whose product is to enhance our commitment to product excellence.

Present environmental test standards include:

062-2842-00 Atmospheric.

062-2853-00 Product Classification.

062-2866-00 Electromagnetic Compatability.

062-2858-00 Dynamics, Shock, Vibration, and Transit.

062-2862-00 Electro-Static Discharge.

These standards are all available by part number from Reprographics (ext. 5577), except 062-2862-00 which is in the final stages of approval.

Projected standards include such subjects as engineering instrument specifications, modular packaging systems, static awareness, and microprocessors.

For more information or to discuss needed product design standards, call Dwain on ext. 6823.

Vol. 5, No. 1, January 1978. Editor: Burgess Laughlin, ext. 5468. Art Director: Scott Sakamoto. Published by the Technical Information Dept. (part of Test and Measurement Operations) for the benefit of the Tektronix engineering and scientific community in the Beaverton, Wilsonville and Grass Valley areas.

Why EN?

Engineering News serves two purposes. Long-range, it promotes the flow of technical information among the diverse segments of the Tektronix engineering and scientific community. Short-range, it publicizes current events (seminars, new services available, and notice of achievements by members of the technical community).

Contributing to EN

Do you have an article or paper to contribute or an announcement to make? Contact the editor on ext. 5468.

How long does it take to see an article in print? That is a function of many things (the completeness of the input, the review cycle and the timeliness of the content). But the *minimum* is three weeks for simple announcements and about five weeks for articles.

The most important step for the contributor is to put his message on paper so that the editor will have something to work with. Don't worry about problems with organization, spelling or grammar. The editor will take care of those when he puts the article into shape for you.

Maureen Key If you have moved, please call Ext. 5407
60 553