RCA Engineer

Vol. 26 No. 5 Mar./Apr. 1981

Increasing Your Effectiveness

Cover Design: Mike Sweeny and Louise Carr

Increasing Your Effectiveness

Integrator *n.* **1.** one who or that which integrates. **2.** an instrument for performing numerical integrations.

One dictionary defines an integrator as a computer unit that totalizes variable quantities in a way comparable to the mathematical integration or solution of differential equations. But returning to the word's Latin roots, we find that an integrator is also a person who forms or blends the elements of experience into a unified whole.

Our cover design and the contents of this issue highlight both definitions. The iterative quality of the cover design evokes a world of computers where the machine solves quickly because it can repeat quickly. And inside this issue, papers on highly effective computerized tools for the engineer merge with papers that point the way to an engineer's professional and educational development.

Maybe the scenario starts something like this.

Your boss says: "I want a clearcut, black-and-white solution to this problem by Monday, down on paper."

All of the colors of the rainbow are "hidden" in black and white. That's like your engineering problem. There's an *infinite* amount of research on your subject (too much to know) and yet there are *zero* answers to your particular problem (nothing known). So you start looking for patterns. You use your engineering tools—your own files, your peers, computers, mathematical formulae, your understanding of underlying principles of physical science and engineering, previous experience that might apply, management and organizational skills, literature searches, continuing education experiences, recollections from professional society conferences, and even this issue of the *RCA Engineer*. You begin to find a way to integrate what you know with what you don't know and you start finding a pattern.

Eventually you'll resolve the cluster of random information into an orderly concept, and you'll have something in your head—a profile of the problem and its possible solutions. Like the profile on the cover, the solution to the problem facing you—your concepts to enclose it—will "pop out," becoming unrelentingly visible areas, once seen. You will wonder why you failed to see the solution before. But that's why engineering is a satisfying challenge, and why you always work to increase your effectiveness. Your integrity in responsibly fulfilling your mission for society is on the line.

—MRS

"It is worth noting that there are no natural resources until humans discover a use for a particular substance. Until then the substance is merely a part of the scenery."

—Edward Teller, *The Pursuit of Simplicity,* Pepperdine University Press

RCA Engineer

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•To disseminate to RCA engineers technical information of professional value •To publish in an appropriate manner important technical developments at RCA, and the role of the engineer •To serve as a medium of interchange of technical information between various groups at RCA •To create a community of engineering interest within the company by stressing the interrelated nature of all technical contributions •To help publicize engineering achievements in a manner that will promote the interests and reputation of RCA in the engineering field •To provide a convenient means by which the RCA engineer may review his professional work before associates and engineering management •To announce outstanding and unusual achievements of RCA engineers in a manner most likely to enhance their prestige and professional status.

J.D. Rittenhouse

A shared engineering and management responsibility

A generation ago the engineer often could be seen as a solitary figure bent over a drafting table. There was little to work with except his hard-won technical competence and a few basic tools — notably the faithful slide rule.

In contrast, today's engineer is surrounded by a spectrum of new and efficacious electronic tools, a seemingly limitless variety of devices and systems that both inspire and enhance creativity. Indeed, each engineer's initial challenge is to recognize the potential of these electronic helpmates, to understand their limitations, and to select those he can best use to achieve his objectives. Thus, as always, the indispensible ingredient is really the experienced individual who has the motivation and the common sense to apply a combination of his training and the correct electronic tools in a synergistic fashion.

In this decade, the new-generation partnership of engineer and computer supports the nation in a world of constantly shifting competitive forces. But that partnership stands not naked and alone — management must be there too. Engineers and management must share the responsibility for improving our nation's competitive punch in the world market. Management must provide the needed tools, and the engineer must make the most effective use of them.

Management must recognize its obligations to be sensitive to the changing human and technological needs of our engineers, to make learning programs available on and off the job, and to provide modern facilities and equipment essential to effective performance.

This issue of the *RCA Engineer* illustrates how this shared responsiblity works. Six articles on computers as tools for the engineer, with topics ranging from software to personal computers and literature searching, cover a small sample of the myriad computer-based tools available to the creative engineer.

In a "Future Shock" world where it often is necessary to run just to stay in place, improving our efficiency is no longer a matter of choice. We simply must increase our personal and collective productivity to keep pace with — and surpass — those of our aggressive and dedicated foreign competitors. Together, management and engineering can meet that imperative need by making the most imaginative and effective use of the professional tools available to do our jobs.

J. D. Rittenhouse

John D. Rittenhouse
Division Vice-President and General Manager
RCA Picture Tube Division

RCA Engineer

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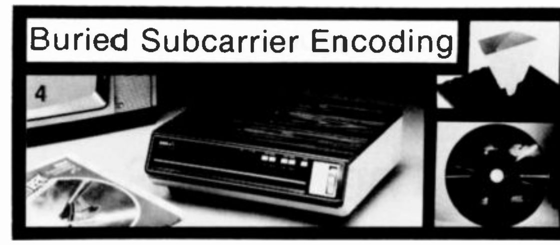
in this issue...

Increasing Your Effectiveness



■ **Crooks** "This article will provide RCA personnel with added information so that they can talk knowledgeably about the VideoDisc System with their friends and neighbors."

■ **Miller|Kelley** "The key factors in the acceptance and use of MUSCLE have been its simplicity and accuracy, as well as the emphasis placed upon the human aspects of the system."

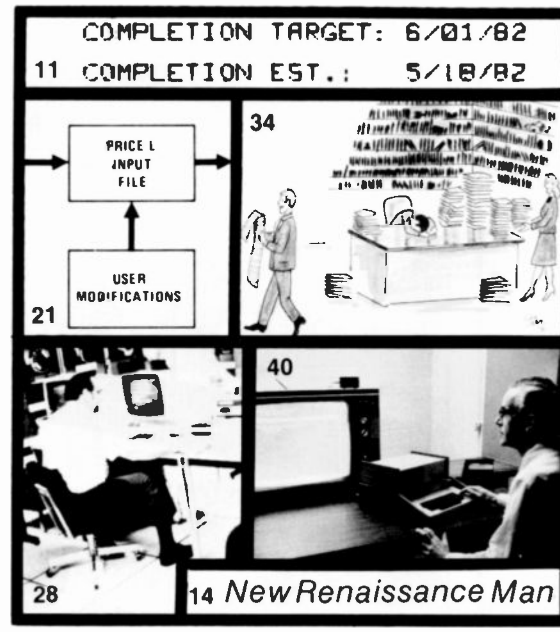
■ **Tindall** "We have no alternative but to produce better management through training over the full spectrum—program management, software management, and hardware management."

■ **Burmeister** "Using PRICE, you can determine the most cost-efficient way to proceed and still meet specification requirements."

■ **Steinmeyer** "In addition to its extensive computing capacity, CISS provides numerous software packages designed to increase productivity."

■ **Chu|Honig** "The computerized search is cost- and manpower-effective and will, when properly executed, produce literature surveys far more complete than those produced by manual means."

■ **Jenny** "This growing computer literacy may have a profound and positive impact on future engineering job assignments and conduct."



■ **Adams|McGough|Rogers** "Employee morale has shown a perceptible upsurge, indicating an increasing sense of involvement."

■ **Buckley** "Monetary reward is not the long suit of professional societies and neither, with rare exceptions, is fame. But there are definite pluses, and they are substantial."

■ **Tripoli** "My intention here is to provide a practical guide to the patent process and possibly increase participation."

■ **Burris** "RCA was among the first to use a videotape-based educational delivery system to provide continuing education programs for technical personnel in widely scattered locations."

■ **Eisenstein** "I believe that industry and universities should unite in a program to improve engineering education and to assure continuity of the research-oriented departments."

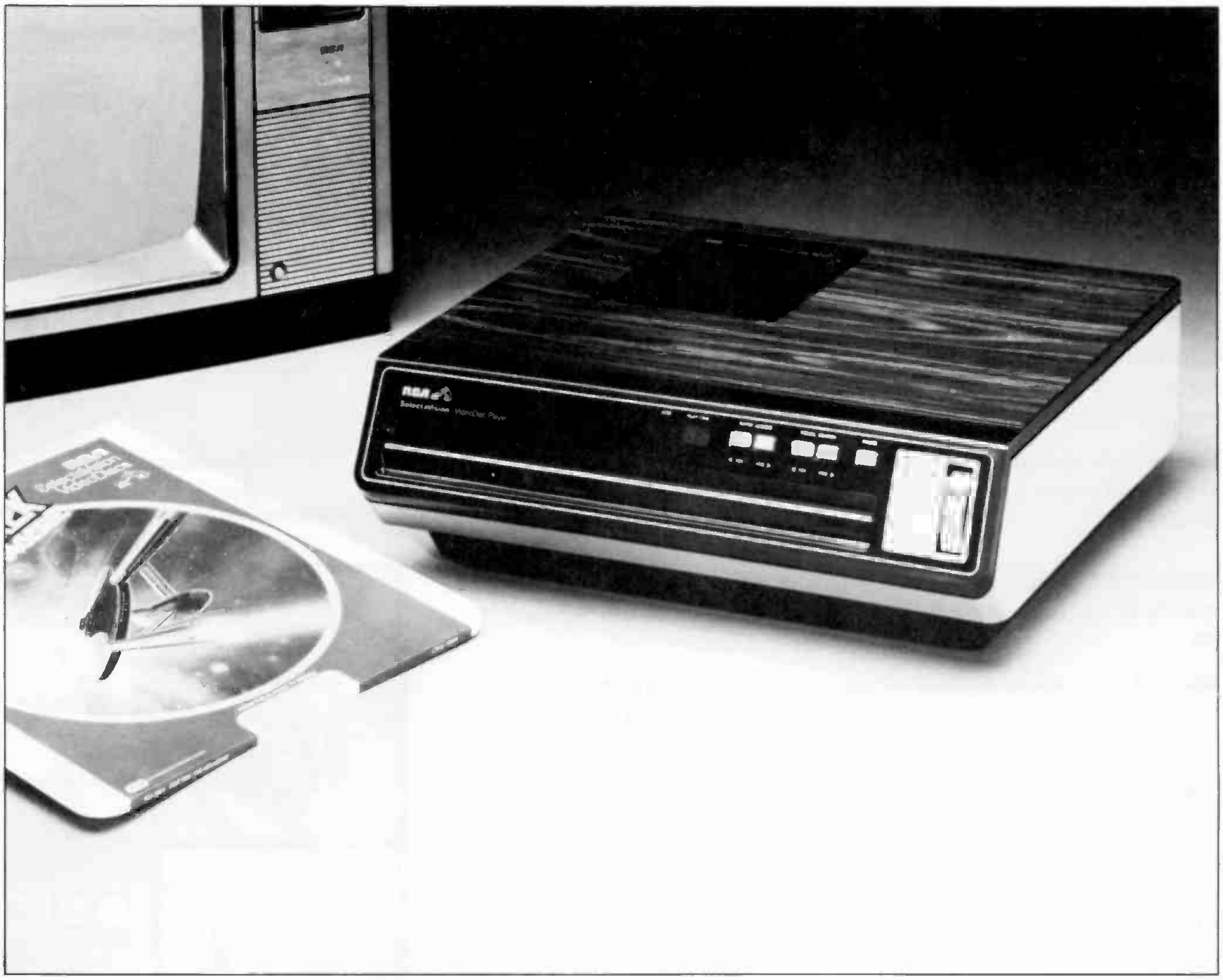
■ **Traub** "The construction of the entire circuit can be accomplished in roughly an hour's time...."

in future issues...

computer-aided design and manufacturing,
anniversary issue,
microprocessor applications,
SelectaVision® VideoDisc,
manufacturing engineering

H.N. Crooks

The RCA SelectaVision® VideoDisc System



In March 1981, after years of research, development, and design, RCA put the CED (Capacitance Electronic Disc) SelectaVision® VideoDisc System on the American market. The system is for sale at approximately 5,000 RCA dealerships across the United States. The most massive advertising campaign ever undertaken by RCA to introduce a new product is now underway. This article will provide RCA personnel with added information so that they can talk knowledgeably about the VideoDisc System with their friends and neighbors. The Nov./Dec. RCA Engineer *will be a comprehensive special issue devoted to in-depth SelectaVision® VideoDisc articles on the design and manufacturing engineering achievements described here.*

Abstract: *The author gives a technical overview of the RCA SelectaVision® VideoDisc System, including the concept, the disc, the stylus, buried subcarrier encoding, the player and the operation.*

The system

The SelectaVision® VideoDisc System comprises a disc upon which television signals have been prerecorded and a player that reads those signals from the disc and converts them into a form suitable for driving TV sets found in American homes.

To make installation quick and easy, the VideoDisc player is designed to connect to the antenna terminals of the TV set. In turn, the antenna connects to the VideoDisc player. When the player is turned off, antenna signals are fed through the player to the TV set so that it operates normally. When the player is turned on, the antenna signals are disconnected and replaced by signals from the disc on either channel 3 or 4—at the discretion of the owner—to avoid possible interference from other TV signals in the area.

Except when being played, the discs are housed in protective sleeves or caddies to protect them from dust, fingerprints, and other contaminants. The disc is deposited on the player turntable, ready for play, when the loaded caddy is put into the player. An empty caddy inserted into a loaded player retrieves and stores the disc. Each disc will play for up to an hour on each side, depending upon the length of the program on the disc.

The disc

Information appears on the disc as frequency modulated vertical undulations in a V-shaped spiral groove. A small portion of the disc is shown in the disc-stylus model, Fig. 1. The signal pattern is recorded initially on an electro-deposited copper surface. Then, the recorded pattern is replicated by one or more successive nickel electroplating operations to produce a negative—or stamper—which is mounted in a multi-ton compression-molding press on which records are molded of carbon-loaded PVC (polyvinyl chloride).

Copper is used for the original recording because of our ability to cut very smooth surfaces in it. A diamond cutting stylus with a V-shaped cutting surface is driven perpendicularly to the copper surface by a piezoelectric transducer to cut the modulated groove in response to signals derived from a taped program via a video tape machine. The recorded wavelengths vary from 0.5 to 1.5 micrometers. As the copper surface rotates in a clockwise direction past the stylus, the stylus advances radially from outside to inside with about a 2.5 micrometer advance per rotation so as to provide about 10,000 grooves to the inch. The disc is designed to be played back at 450 revolutions per minute, at which speed the signals from the disc vary from 4.3 MHz at sync tips to 6.3 MHz at peak white. The discs are 12 inches in diameter and 70 mils in thickness, roughly the same dimensions of an audio LP disc.

The stylus

During playback, a metal electrode attached to a diamond stylus, as shown in Figs. 1 and 2, reads signals from the disc. The end of the diamond fits the groove cross-section and is long enough to cover several of the longest recorded wavelengths. As a result, the diamond rides on the crests of the recorded waves much like a sled runner rides over small hillocks. As it does so, the surface of the disc rises and falls under the end of the stylus electrode, causing variations in electrical capacitance between the electrode and the disc surface. The disc is made conductive by the addition of carbon to the compound from which the disc is pressed in order to enhance these capacitance variations.

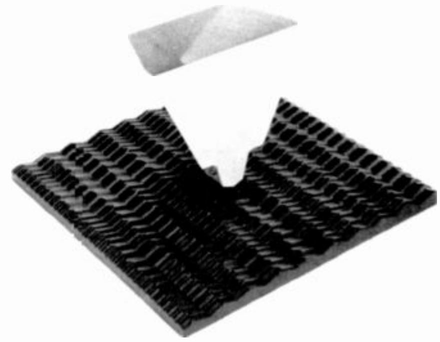


Fig. 1. Disc-stylus model. A diamond stylus rides in a "V" shaped groove on the disc. Because the end of the stylus extends over several of the longest recorded waves, the stylus rides on the crests like a sled runner riding over small hillocks. As the groove undulations pass under the stylus, a metal electrode on the trailing edge of the stylus experiences capacity variations, which provide the signal readout. The "Keel" shape of the stylus tip reduces the tendency for it to become wider and read signals from adjacent grooves as the tip wears. The discs are coated with about 300 Å of oil to lubricate the disc-stylus interface in order to extend the playing life.

As shown in Fig. 2, the end of the stylus electrode is about 2 micrometers wide by

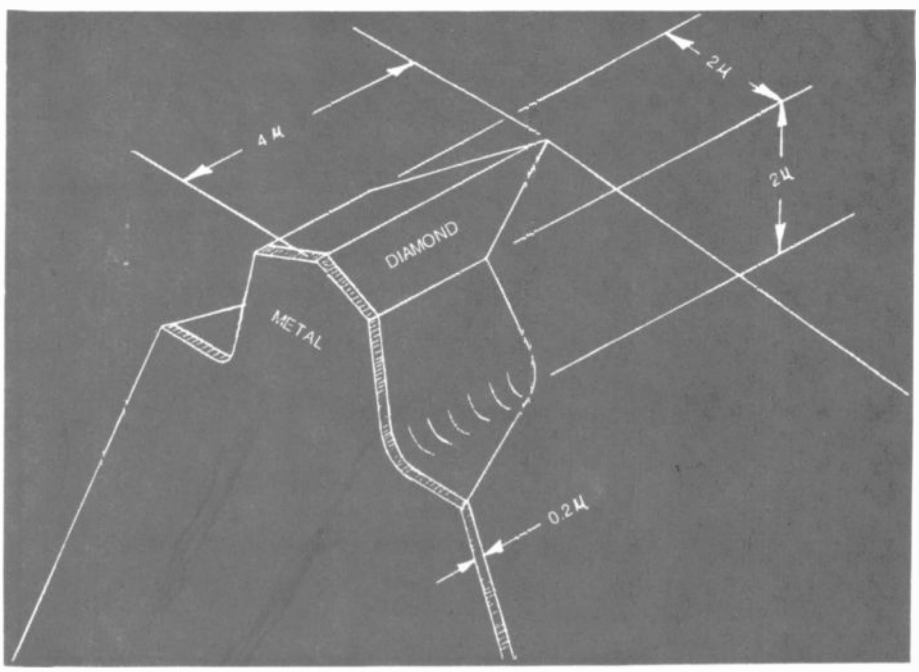


Fig. 2. Stylus tip. This inverted view of the stylus tip shows the relative sizes of the diamond tip and the readout electrode. Since the wavelength on the disc is 1.5 μm maximum, the stylus shoe always rides on the crests of several waves. The end of the metal electrode acts as one plate of a capacitor; the disc is the other plate. As the surface of the disc rises and falls under the stylus electrode, the varying capacitance provides the readout of signal information.

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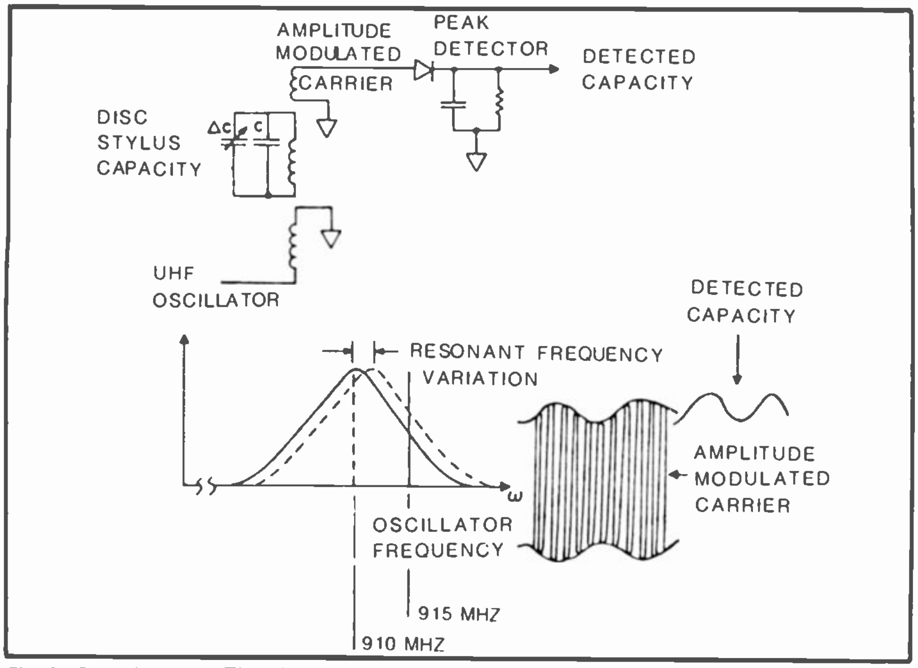

Fig. 3. Signal pickup. The disc-stylus capacitance is made part of a tuned circuit resonant at 910 MHz. This tuned circuit is excited by a signal from a 915 MHz oscillator. As the disc stylus capacitance changes, the resonant frequency and the response to the 915-MHz signal also change, causing amplitude modulation of the 915-MHz signal passed through the circuit. The amplitude modulation is detected by the diode to provide a voltage that rises and falls as the disc surface rises and falls under the stylus.

0.2 micrometers thick. The sides of the stylus tip are cut away as shown, providing the "Keel Lapped" shape, to prolong the useful life of the stylus as the tip is abraded during play. The waves pressed into the disc have a peak-to-peak amplitude of about 850 angstroms. The change in capacitance experienced by the stylus electrode is very small, perhaps 1×10^{-16} farads, or about a ten-thousandth of one picofarad.

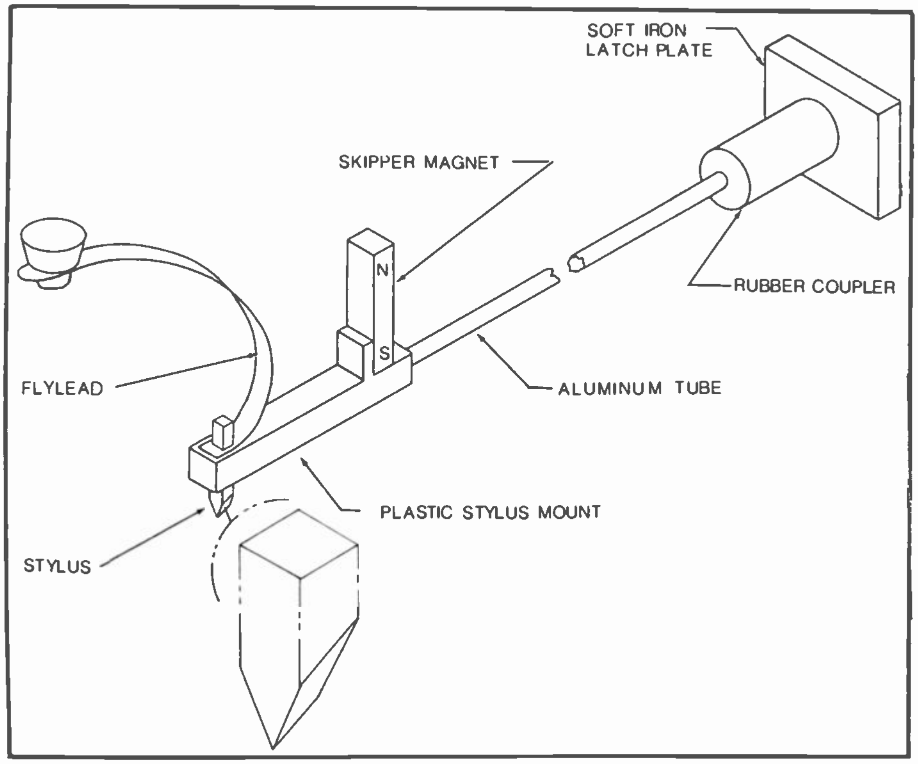

Fig. 4. Stylus arm. The diamond stylus is held in a plastic member attached to a 3-inch-long thin-wall aluminum tube. The rubber coupling provides high compliance so that the stylus can track the groove properly. The flylead provides coupling to the pickup circuitry and also serves as a spring to hold the stylus against the disc with a force of 65 mg. The small permanent magnet reacts with magnetic fields of skipper coils to cause sideways motion of the stylus as required to provide visual search and to correct locked-groove conditions.

The stylus-disc capacitance is made part of a resonant circuit with resonance peak at about 910 MHz, as shown schematically in Fig. 3. As the disc-stylus capacitance changes, the frequency of the resonant peak changes. Signals from a 915-MHz oscillator are coupled through the resonant circuit and amplitude modulated by the varying response of the resonant circuit at 915 MHz as the stylus-record capacitance changes. The amplitude-modulated 915-MHz signal is then demodulated by a diode detector to provide a frequency modulated signal that rises and falls in voltage as the surface of the disc rises and falls under the stylus.

The diamond stylus is mounted on the end of a 3-inch-long stylus arm made from thin-wall aluminum tubing , as shown in Fig. 4. A flexible rubber mounting supports the stylus arm with enough compliance at the stylus end so that the stylus will follow irregularities in the disc in both the vertical and lateral directions. A small permanent magnet mounted on the stylus arm near the stylus imparts small lateral motion to the stylus when acted upon by the magnetic fields of the stylus kicker coils (see stylus kicker discussion later). The rear of the stylus arm is fitted with a soft iron plate that is attracted to and held by a cup magnet on the arm-stretcher transducer (see arm-stretcher discussion later). The electrode on the diamond stylus is connected to the circuitry by a flexible flylead, which also serves as a spring to hold the stylus against the disc with about 65 milligrams of force. The stylus arm, flylead, and compliant support are mounted in the stylus cartridge, shown in Fig. 5, a plastic case that allows easy replacement of the stylus in a player. The replacement of a stylus cartridge requires no tools or adjustments of any kind. The stylus is designed to provide years of service in normal use.

Buried subcarrier encoding

To provide a color television signal matched to consumer-TV receivers, VideoDisc engineers limited the luminance band to 3 MHz and the color band to 0.5 MHz. Limited bandwidth on the disc required compacting the color television signal to the 3-MHz luminance band using "buried subcarrier encoding." Buried subcarrier encoding depends for its operation on the fact that the luminance signals on one horizontal line tend to be very similar to those on the adjacent line. In other words, much of the signal repeats at the horizontal line rate.

As is well-known from Fourier analysis, a periodic waveform contains only frequency components that are harmonics of the fundamental frequency. In a quasi-periodic waveform such as a television video waveform, the signal energy is contained in narrow frequency bands centered on the harmonics of the fundamental, which in this case is the horizontal line frequency. Because of this, the video signal can be passed through a comb filter having passband peaks at multiples of line frequency and nulls at intermediate frequencies without suffering serious degradation. Such a comb filter is applied to the luminance signal before recording. A frequency at one of the nulls, namely 1.53 MHz, is chosen as the color subcarrier and this is amplitude modulated by the color signal. Because the color signal also repeats at horizontal line frequency, its spectral energy is bunched at multiples of the line frequency. Thus, when the color subcarrier is amplitude modulated by the color signal, sidebands fall at multiples of line frequency on either side of the subcarrier. The color sidebands fall on the nulls of the combed luminance signal. The same situation applies when we use two subcarriers in phase quadrature and two independent color signals.

The modulated color subcarriers are subjected to comb filters with nulls at multiples of line frequency. The combed luminance and combed color signals are then added together to form a composite video signal in which the luminance and chrominance spectral components are interleaved. We have called this process buried subcarrier encoding because the color subcarriers are located in the middle of the luminance band. The composite video signal is applied to a frequency modulator such that a peak white input produces an output frequency of 6.3 MHz, black level produces 5.0 MHz, and sync tips produce 4.3 MHz, as shown in Fig. 6. Because the composite video signal contains components as high as 3 MHz, the first-order sidebands of the video FM signal extend from 2 to 9.3 MHz, as shown. The audio signal is applied to a second frequency modulator with center frequency at 716 kHz and produces a maximum deviation of ±50 kHz. The audio FM signal is added to the video FM signal to provide a single voltage waveform, as shown in Fig.

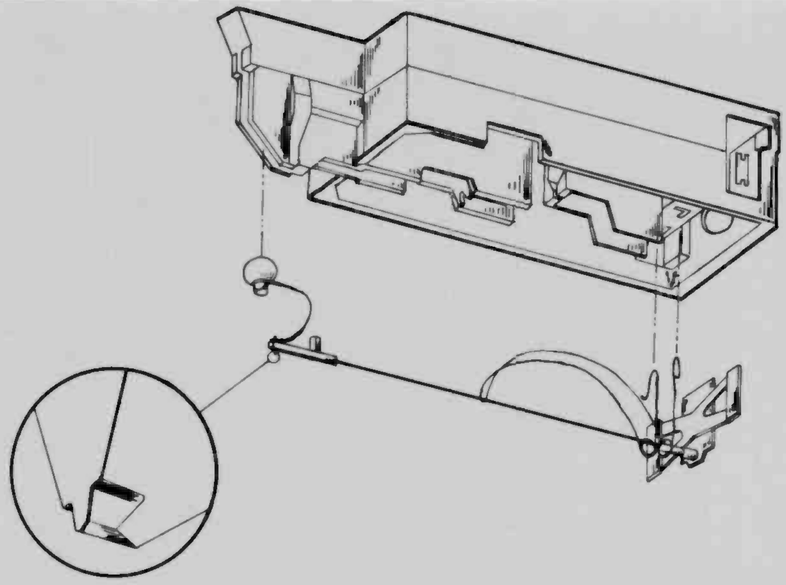

Fig. 5. Stylus cartridge. The stylus-arm components (see Fig. 4) are mounted in a plastic housing for ease of handling. The semicircular spring holds the stylus arm firmly in place during shipping and handling. When the cartridge is installed in a player, the spring is depressed to allow the stylus arm to move freely and track the groove.

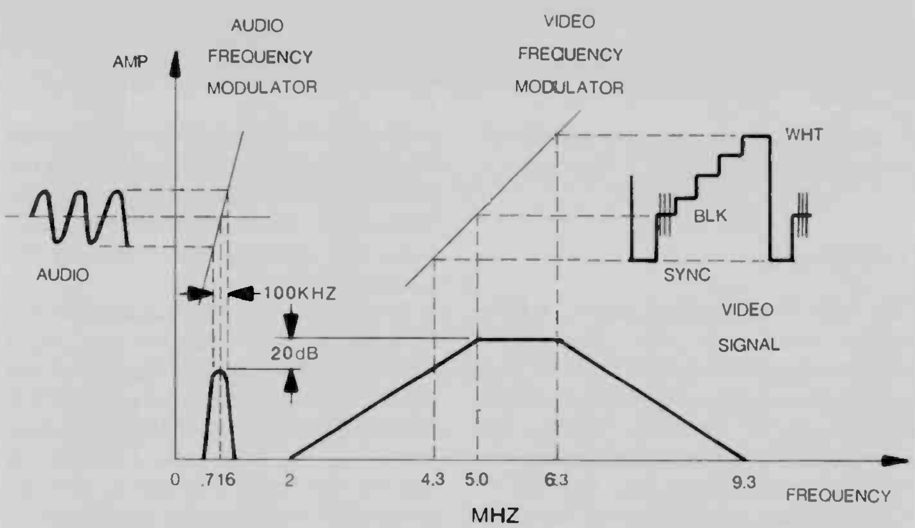

Fig. 6. Frequency spectrum. In recording, the audio and video signals drive separate frequency modulation circuits. The frequency modulated signals are added together to provide a single voltage waveform to drive the cutterhead. The spectrum of this signal is shown above. Note that the audio-carrier amplitude is 20 dB below the video-carrier amplitude.

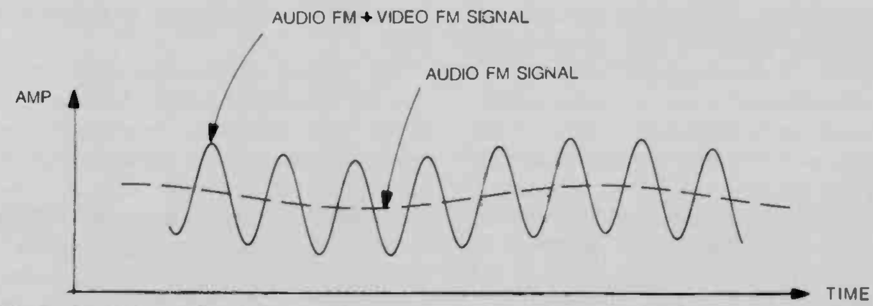

Fig. 7. Cutterhead signal. The audio and video FM signals are added together to provide a waveform of the type shown here to drive the cutterhead. The amplitude of the audio FM wave is exaggerated so that it can be seen easily.

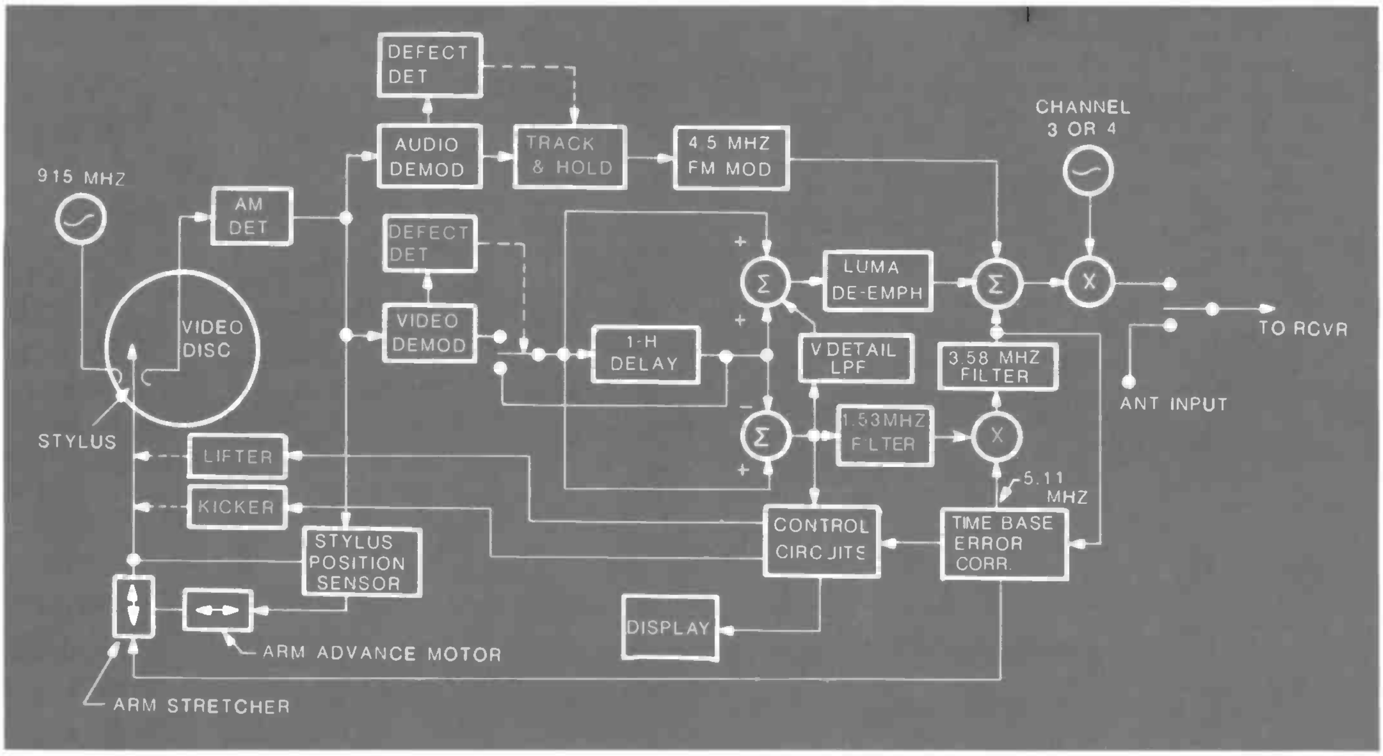

Fig. 8. Player block diagram. The principal parts of the player electronics are shown in this diagram. The circuitry includes six custom-integrated circuits, including a microprocessor in the control circuit.

7, which is used to drive the cutterhead during mastering.

The player

The VideoDisc player consists of a turntable driven — at 450 rpm — synchronously with the 60-Hz power line; a mechanism for inserting and retrieving a disc; a stylus cartridge mount and associated circuitry; signal processing circuitry; and control elements. A simplified block diagram of the player is shown in Fig. 8. At the left is the 915-MHz oscillator, the output of which is modulated by the stylus-disc capacity and then rectified to provide the FM signal that emulates the rise and fall of the disc surface. This signal is fed to both video and audio demodulators. When either the audio or video FM carrier is lost, measures are taken to prevent a noticeable disturbance in the resultant audio or video output. When no audio disturbance is detected, the audio feeds through the track-and-hold circuit to the 4.5-MHz frequency modulator to generate the audio portion of the NTSC signal. When a defect is recognized, the audio level is held at its last valid value until the defect is corrected.

When no defect is recognized in the video signal, it is passed directly to a 1-H delay line, the principal component in the comb filter. The input of the delay line and the output are added together to realize the luminance comb filter. After appropriate de-emphasis, the luminance signal is combined with other signals to make up the composite NTSC signal.

The output of the delay line is subtracted from the input to realize the color comb filter. The output of this filter, containing the 1.53-MHz color subcarrier, is mixed with a 5.11-MHz oscillator signal to convert the color subcarrier to 3.58 MHz as required for the NTSC signal. The upconverted 3.58-MHz color signal is added to the luminance and audio to provide the composite NTSC signal, which is then put on a carrier for either channel 3 or 4, as chosen by the operator, and delivered to the output jack on the rear of the player. When the player is turned off, the antenna input signal is fed directly to the output jack.

The passage of the luminance signal through its comb filter will remove vertical detail from this signal. For example, the luminance video signal required to write alternate black-and-white lines is completely obliterated when the input and output of the delay line are added together. To regenerate the complete low-frequency signal required for vertical detail in the picture, the low-frequency portion of the combed chroma signal, which is truly luminance information rather than chrominance information, is added to the combed luminance signal to provide an uncombed signal below 500 kHz.

When a disturbance to the video is noted, the automatically controlled switch at the delay line input causes the output of the delay line to be fed back to the input so that the signal is recirculated. Thus, when a defect is detected on any one horizontal line in the picture, the throwing of the recirculation switch causes signal from the previous line to be substituted for the bad video. In most cases such substitution is nearly invisible. As a result, defects on the disc that would otherwise be objectionable are made unobtrusive.

As a result of tolerance buildup during the manufacture of the disc and player and the placement of the disc on the turntable, the disc can be slightly off-center for playback. A non-centered condition results in surface speed variation along a groove which, if not corrected, may cause serious horizontal picture jitter at a once-around rate. Off-centering causes groove speed to be too high on half of each rotation and too slow on the other half of each rotation.

The arm-stretcher shown in the lower left corner of the diagram has been included in the player to correct for the effects of off-centering. This device is similar to a moving-coil loudspeaker mechanism which is fastened by a flexible coupling to the rear end of the stylus arm

and moves the stylus arm tangentially along the groove. When the groove speed is too low, the stylus arm is moved opposite to the groove velocity to increase the relative speed. When the groove speed is too high, the stylus arm is moved in the direction of the groove velocity to reduce the relative speed. The signal for driving the arm stretcher is obtained by comparing the 3.58-MHz color burst from the disc with a fixed oscillator at the same frequency. The net result is that off-centered conditions as great as 10 mils do not produce detectable jitter in playback.

During the play of a disc, the carriage for the stylus cartridge is moved in such a way as to keep the stylus arm and flylead centered in the cartridge housing. This is accomplished by sensing the lateral position of the stylus relative to the cartridge housing by capacitive coupling of the stylus flylead to varactor diodes driven out-of-phase by a 260-kHz oscillator. As the capacitance of one diode increases, the other decreases and vice-versa. These diodes are located, one on each side of the stylus flylead, so that a fraction of their capacitance is added to the stylus capacitance as a function of how close the diodes are to the flylead. When the stylus is centered, the capacitance variations of the two varactor diodes, being out-of-phase, cancel one another. However, in off-centered conditions the effect of one diode is greater than that of the other. The resultant capacitive variations cause a change in the tuning of the stylus resonant circuit giving rise to 260-kHz components in the output of the 915-MHz amplitude detector, indicating an off-center condition. The amplitude and phase of the 260-kHz signal indicate the amount and direction of the stylus off-centering. A dc arm-advance motor is driven in response to the 260-kHz error signal to center the stylus arm and return the error signal to zero.

The stylus kicker shown in the lower left of the block diagram is included in the player to provide small, rapid lateral movements of the stylus during play. A small permanent magnet mounted on the stylus arm near the stylus is forced sideways by magnetic fields from small coils mounted in the stylus cartridge housing. When movement of the stylus is desired, an appropriate pulse of current through the coils causes the stylus to jump sideways one or more grooves in either the forward or reverse direction. This operation is activated during the visual search mode. When the visual search button is depressed, a pulse is applied to the kicker coils just prior to each vertical blanking interval with an appropriate magnitude to move the stylus two grooves. Since there are 8 fields per rotation, the program moves at 16 times normal speed. However, since stylus movement takes place just ahead of the blanking interval, the TV synchronizing pulses are continuous and no picture breakup occurs.

The stylus kicker is also used to correct for locked-groove defects on discs. To facilitate this operation, a unique number is recorded with each TV field on the disc. The numbers increase monotonically from the beginning to the end of the disc. Circuits built into the player decode and keep track of the field numbers. During normal play, these numbers progress regularly. When locked-groove situations arise and the numbers jump backwards instead of progressing normally, player recognition of this fact causes the application of pulses to the kicker coils to move the stylus ahead by two grooves. These pulses continue until field numbers read from the disc equal or exceed the numbers predicted by the player circuits. In most cases, locked-groove defects are corrected before an observer is aware of the problem. No corrective action is taken when forward groove skips occur. In general, these forward skips cause little disturbance to the viewer.

Another use made of the field numbers recorded on the disc is to convert them to time of play in minutes from the beginning of the disc and to show them on the LED displays on the front of the player.

The stylus lifter is activated to raise and lower the stylus as required for proper player operation. The stylus is lowered during normal play and visual search, and it is lowered momentarily onto a stylus cleaner each time a disc is removed from the player. In all other conditions, including power off, the stylus is lifted off the disc.

Player operation

Figure 9 is a photograph of the SFT100W player introduced in March 1981. It measures 17-inches wide by 15.5-inches deep by 5.75-inches high. It weighs 20 pounds and consumes 35 watts of power. Jacks for antenna input and RF output, a channel selection switch, and power-line cord are on the back. As shown in the figure, a function lever switch on the right side of the front panel has positions for LOAD/UNLOAD, PLAY and OFF. In the LOAD/UNLOAD position, a caddy-entry door is opened to permit the loading or retrieving of a disc by means of caddy insertion. In the PLAY position, the caddy-entry door is closed, the turntable is energized and the disc is played.

During the play of a disc, player operation is controlled by five push buttons. The PAUSE push button causes the stylus to lift from the disc and the arm advance to stop. A second push of this button causes play to resume. The PAUSE button allows one to interrupt the program for as long as desired without missing any of the program content and without harm to the disc. The two VISUAL SEARCH push buttons cause the stylus to be kicked two grooves either forward or reverse during each vertical blanking interval so that the program action proceeds at 16 times normal rate without picture breakup. These VISUAL SEARCH buttons are used for locating a precise section of the program. The two RAPID ACCESS push buttons lift the stylus and move the stylus carriage at about 150 times the normal speed in either the forward or reverse direction. During this operation both video and audio signals are muted.

The PLAY TIME indicators (LED) give an indication of the stylus position measured in minutes of play from the beginning of the disc. These indicators also show an "L" for the LOAD/UNLOAD position of the function lever, "P" for PAUSE, and an "E" to indicate that the program has ended.

After a disc has been inserted into the player, the SIDE indicator shows which side of the disc, 1 or 2, is uppermost in the player and is being played or ready to be played.

The removable door on the top of the player provides access to the stylus cartridge so that it can be changed when required.

The stylus is designed to operate for years in a normal home environment. Discs can be played many hundreds of times without deterioration. All other parts of the system are designed for extended life.

Programs

At least 100 program selections are available. Additional selections will be added each month to provide an extensive catalog to satisfy every taste.

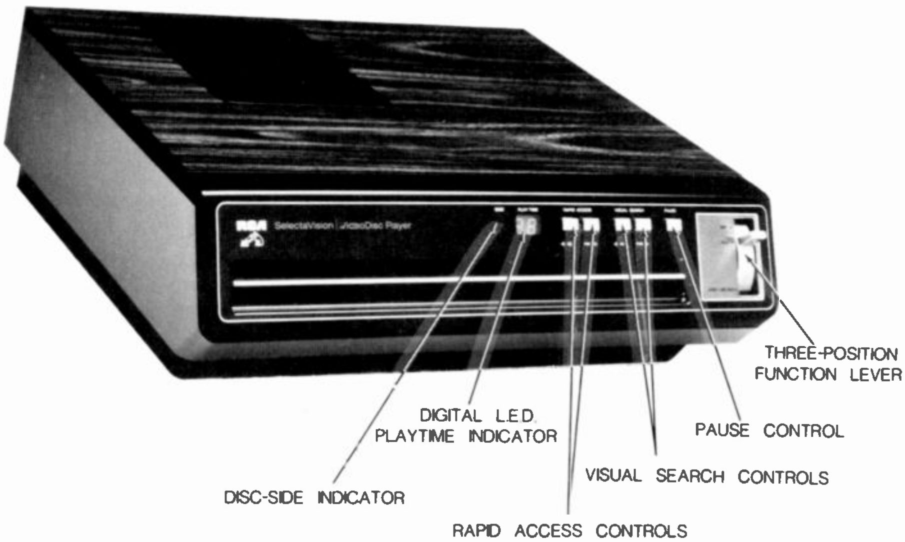

Fig. 9. VideoDisc Player — Model SFT100. The player measures 17 x 15½ x 5¾ inches, weighs 20 lbs. and draws 35 watts from the power line. The disc-caddy is inserted in the slot in the front of the player with the function lever in the "LOAD-UNLOAD" position. Withdrawal of the caddy leaves the disc in the player. The disc is played by moving the function lever to the "PLAY" position after which the play is controlled by pushbuttons. Reinsertion of the caddy after the play puts the disc back into the caddy.

System specifications

Playing Time:	2 hours (1 hour per side)	Signal-Sensing Technique:	Capacitance
Player Weight:	20 pounds	Disc Material:	Conductive PVC
Power Input:	35 watts	Disc Handling:	Protective sleeve
Size:	17" x 15½" x 5¾"	Disc Diameter:	12 inches
Stylus Material:	Diamond	Rotation Rate:	450 rpm
		Revolutions Per Side:	27,000 (one hour)

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Program planning for a commercially oriented division

At Picture Tube Division managers are using a desk-top computer in a new program-planning system called MUSCLE that helps them efficiently deploy resources, meet critical dates, resolve interprogram priorities and improve communications.

Abstract: *The Picture Tube Division (PTD) has developed a unique product-planning system that operates well within a dynamic commercial business environment. After surveying available planning and control systems, PTD chose to adapt a version of CPM (Critical Path Method), coupled with a desk-top computer, to improve Engineering planning. Adaptation and implementation of the system took five months. It now encompasses all aspects of PTD's new product projects, from conception through to production. The system requires minimal staffing, and could be readily adapted to other RCA divisions.*

Program planning for a large commercially oriented business requires unique planning tools. A customized, computer-aided version of the Critical Path Method (CPM) is being well-received within RCA's Picture Tube Division (PTD). The system that has evolved may have applications in other RCA divisions.

RCA's PTD is a dynamic, high-technology, multinational operation. Domestically, PTD provides primary support for the RCA Consumer Electronics Division (CE). In addition, many other U.S. television-set manufacturers consistently use RCA color-picture tubes, and a large portion of the tubes exported from the U.S. are from PTD plants. Through subsidiaries, joint ventures, and technical equipment contracts, PTD technology and products have a major presence in Latin America and throughout Europe.

The color-picture-tube market has become very competitive. As the cost-price squeeze intensified, TV-set manufacturers tended to eliminate circuits designed to compensate for picture-tube variations. Today, tube sales depend on improving uniformity, performance, and reliability with on-time delivery. As PTD's sales base expanded to many customers with diversified requirements, and color-tube technology matured, the nature of PTD's engineering programs underwent change. Over the past ten years there has been a shift from running several large concurrent programs to having as many as 25 smaller programs at one time. A typical new-product-engineering program now lasts less than a year and encompasses product and process innovation. It usually involves six or more functional organizations in several locations, under continual pressure to meet dates dictated by production plans for customer-TV sets. But these programs are simpler (from a planning viewpoint) than those encountered in large military or aerospace projects.

The program-planning system

A new PTD program-planning system (dubbed "MUSCLE") is aimed at meeting the information needs of management at all levels. Use of MUSCLE aids in the efficient deployment of resources, improves confidence in meeting critical dates, helps resolve interprogram priorities, and improves communications between operational organizations.

Of prime interest to PTD management was the efficient application of resources with confidence that critical program dates will be met. The need for improved program planning became apparent as the size and complexity of the PTD business increased. The key objectives for a new program-planning system included:

- To direct attention to critical areas.
- To recognize logical relationships between tasks.
- To operate with minimal planning staff.
- To update easily.
- To give results readily understood by operating personnel.

The alternative systems

After a careful review of available project planning systems, PTD developed a customized version of the Critical Path Method (CPM). Among the alternatives considered were:

PERT (Program Evaluation & Review Technique) The sophistication of three durations per task and the resulting probability assessments was not needed. It was also felt that the somewhat complex output would not be readily understood by many program personnel.

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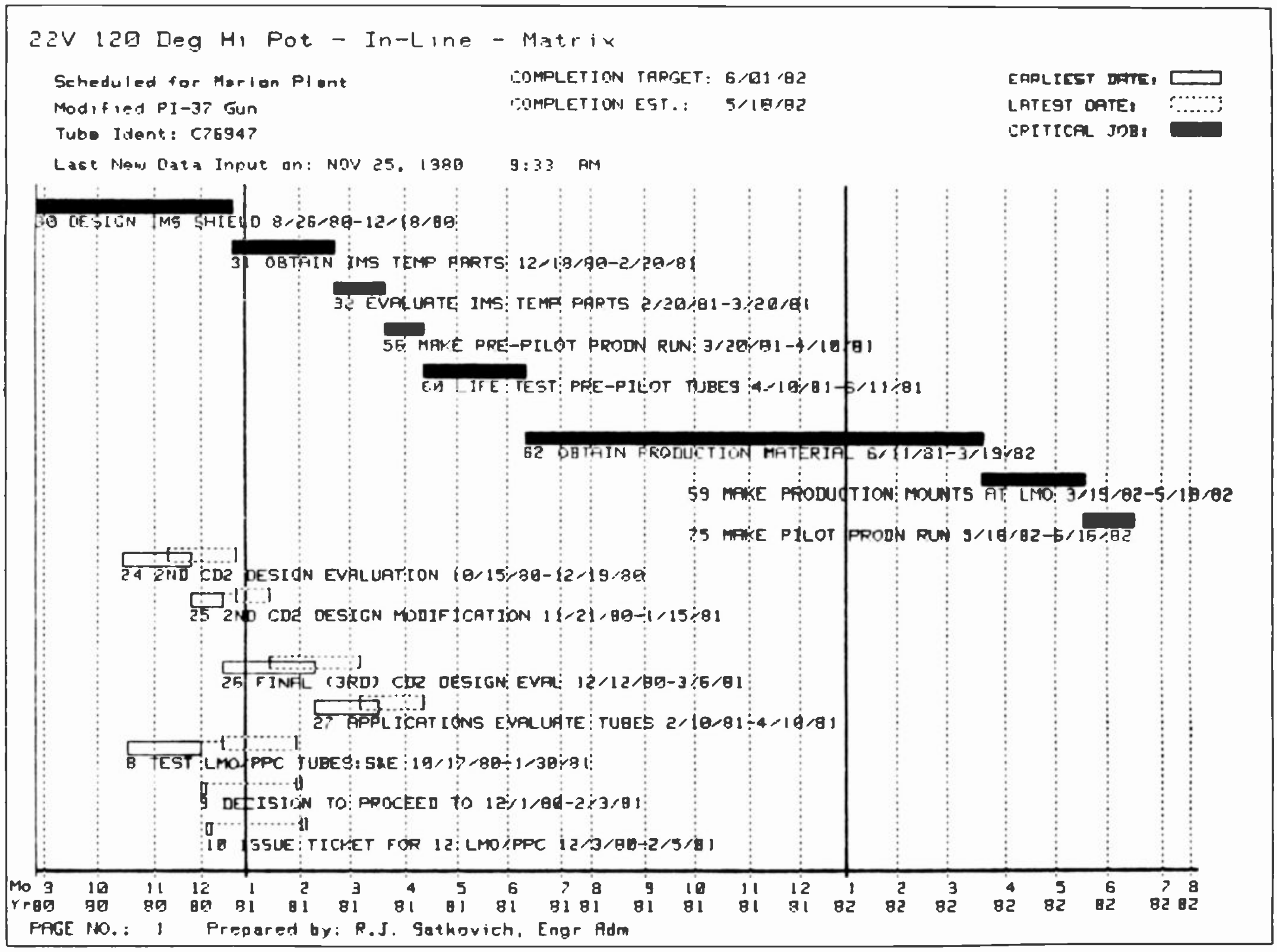

Fig. 1. Graphic presentation of program plan. Tasks are arranged by criticality and starting date. Blackened bars show "critical tasks." Dotted bars indicate allowable task-completion dates that would not jeopardize a program completion date. Calendar across the bottom considers PTD holidays.

Gantt Charts (time-phased bar charts) Relationships and constraints between program tasks are not apparent. Manually prepared Gantt charts are difficult to keep updated.

CPM (Critical Path Method) The CPM system of documenting a program's inter-task relationships and determining areas of criticality was readily adapted to the PTD new product environment. Through use of a small desk-top computer, information storage, analysis, and presentation can be updated quickly and easily.

Initially, the PTD CPM system was set up to use McDonnell Douglas/McAuto's "MSCS" (Management Scheduling and Control System) package via the IBM-370 large mainframe computer in Cherry Hill, New Jersey. It was accessed on time-sharing, with batch output. It immediately became apparent that 24-hour turnaround was a severe limitation to iterative planning. Also, the graphics output was only marginally acceptable and difficult to adapt. In addition, since PTD programs were typically depicted as small networks (several hundred tasks each), the costs and power of a large computer system as well as the complexities of more comprehensive project-planning software packages were not necessary or desired. Sporadic inability to access the Cherry Hill system became a critical problem when prompt decisions were required.

MUSCLE

After review of available small-computer program-planning systems, PTD selected Hewlett-Packard's "System 45" desk-top unit and their "Program Management" software package. The software, written in an enhanced BASIC language, was extensively modified and adapted to unique PTD requirements. The resulting system makes it easy to run back-to-back program changes to optimize results. The excellent graphic output immediately highlights critical program areas. A sample is shown in Fig. 1. The allowable "float" (work days that a job can be shifted without impacting a program end date) can be readily seen by comparing solid and dotted boxes for any one job. Desk-top computer use has the added benefit of essentially no on-going machine-use costs after initial purchase of the unit. Table I summarizes and compares the HP System 45/Program Management software and the McAuto package as evaluated in the PTD environment.

During adaptation of the Hewlett-Packard software, extreme care was taken to humanize the output reports. The content of the reports was limited to the information wanted, and only terminology readily understood by the users was in-

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cluded. The graphics capabilities of the HP system were fully exploited to present program-status information in a clear fashion. Users require no knowledge of the computer. A small administrative staff services the computer and provides coordination and follow-up on all items in the system. This allows line managers to best use their time and expertise, focusing on the logic of the plan and its implementation.

As expected, successive program plans followed a very similar task-logic pattern. After six months of experimentation, a basic model for new-product programs was established that fits most cases. Note that the program plan logic model was created and optimized by technical management personnel working on the new-product programs (not by computer personnel). It, therefore, became "their" plan, a critical aspect of the success of MUSCLE.

A feature recently added to the MUSCLE system facilitates critical skill-center analysis across many programs. By "lifting" all data (including dates and job "float") associated with a specific similar job from a group of programs, bottle-neck areas can be examined by management. Work schedules can be adjusted for optimal use of available resources with known impact on program end dates. Tailored graphic reports eliminate the need to review lengthy comprehensive listings.

Table I. Comparison of the Hewlett-Packard and the McAuto computer-aided program management systems. When evaluated in the PTD environment, note that the HP system is judged best for "small" networks, while McAuto appears suited for "large" projects.

Feature	*Hewlett-Packard "System 45 Program Mgmt"*	*McDonnell Douglas McAuto "MSCS" (with "CompuNet")*
Computer running costs	None	CMS charges plus share of MSCS lease
Graphics		
Gantt	Excellent	Marginal
Logic diagram	None	Good/Costly (with "CompuNet")
Turnaround time	5 min (100 jobs) 15 min (750 jobs)	24 hour (batch)
Adaptability	Good	Fair
Resource allocation	None	Good/complex
Operator training	1 week	2 months
Maximum jobs/project	1,800	42,800
Software system support	Good	Good
Inter-project analysis	Good	Difficult

Why it works

The key factors in acceptance and use of MUSCLE have been its simplicity and accuracy as well as the emphasis placed upon the human and pyschological aspects of the system. PTD management recognized the value of the system at an early stage of its development. The temptation to use MUSCLE as a whip was meticulously avoided, so as not to foster padded job-time estimates. Although the computer reduced much of the drudgery of operating the system, it has been kept at a low profile with a minimum of computer jargon. The rapidity of the system allows many iterations of a plan in a single day, each with a meaningful graphic output. This allows managers to make changes freely and gauge their impact immediately. The importance of this cannot be overemphasized.

The MUSCLE system has found widest acceptance within PTD as a tool for managing new-product designs, but the system is applicable to a broad class of project planning areas. The simplicity of the system makes it easy to introduce to new users and applications. It is interesting to note that the use of MUSCLE grew from grass-roots support, not from management edict. The management results noted from the use of the MUSCLE system include timely execution of programs, fewer slippages, better communications, and clearer control of priorities.

J.B. Tindall

The New Renaissance Man: Can we find a "super-manager" for C² systems?

Command and Control (C²) software has been rife with alarming failures and cost overruns. What's needed is a New Renaissance Man skilled in project management, software management, and hardware management.

Even 20 years ago when computer technology was in its infancy, it was clear that computers would play an important role in Command and Control (C^2). This initial optimism has been largely fulfilled, and the recent advances stimulated by microelectronic circuitry have prompted speculation on the additional wonders we can expect because of computer technology. The computer, after all, not only amplifies the power of the human mind, but extends that power into realms unthinkable a generation ago. These tremendous achievements have become reality because of advances both in computer design and in software engineering.

Unfortunately, the record for software development has not been as sanguine as the record for computer hardware development. The discussion below explores the evolution of software engineering in an attempt to discover why its failures have had such a traumatic effect on the development of military systems, particularly C^2 systems. This discussion traces the commonly suggested reasons for past difficulties down to the probable root causes, examines trends in software development, and explores recommended modern programming practices and some new technologies that impact software design. More important, the qualifications of the "super-manager" capable of directing this complex and interrelated effort are examined. The development of such managers, skilled in the many technological and management disciplines required by C^2, challenges the resources of government and industry. Is it possible for anyone to achieve all the skills required of this New Renaissance Man?[1, 2]

Abstract: *The long, complicated development cycle for command and control systems is particularly susceptible to problems. Improvements in four key areas will minimize the problems: (1) an integrated systems approach must be taken from the start; (2) modern software engineering discipline (including top-down design, structured programming, and higher order languages) must be applied fully; (3) proper judgment, keeping in mind the realities of evolving requirements, must be exercised in sizing the hardware; and (4) the development effort must be managed by someone who understands all the technological and managerial disciplines involved. This paper provides an overview of the many complex trade-offs that must be assessed if command and control software development is to be improved, and suggests that a New Renaissance Man is required as "super-manager" of software design's transition from an art into the world of system engineering.*

Traditional system development problems

During the development of a system with an embedded computer, the user and developer seem to be forever at each other's throats.[3, 4, 5] The user complains that the software is late and doesn't satisfy his requirements; the machine is too small for the job; changes cost too much and take too long, and so on. The developer, on the other hand, complains that the user really doesn't know what he wants; the Statement of Work may require premature selection of hardware; requirements are constantly changed; and, finally, the user imposes constraints incompatible with usual management procedures.

These complaints evoke the following facts:

- User is unsure of requirements; requirements will constantly change.

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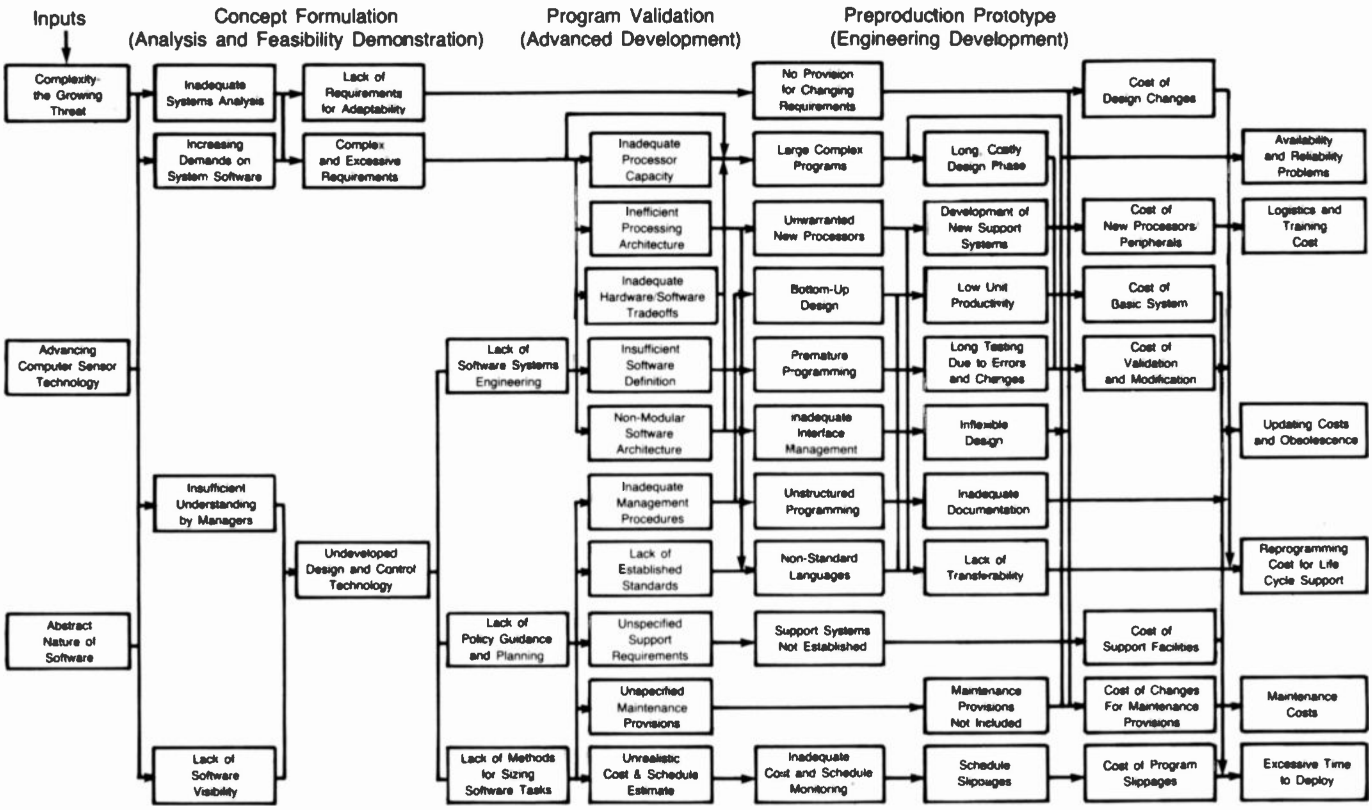


Fig. 1. Historically, the complex relationships inherent in the software development cycle for C² systems have contributed to late deliveries and major cost overruns.

- Few managers understand hardware and software and management.
- Programming is still treated as an art.
- Early hardware selection forces premature functional partitioning.
- Parkinson's Law leads to strained memory and costly programming.
- Hardware constraints motivate use of low-level languages.
- Support software development fails to maintain the pace of hardware development.
- Excessive standards, rigid programming location proscriptions, and security clearance requirements hamper effective software development.
- Need for advanced operating systems pushes the state of the art.
- User requires automation of highly complex processes.
- Cost estimating has been by rule of thumb.

Figure 1 shows one author's view of the many interrelated software problems.[6]

Four factors cause most software problems. First, it is nearly impossible to find a manager who is available, trained, and capable of handling all aspects of software design.

Second, failure to use modern software engineering discipline often results in costly development cycles and lack of program maintainability. Top-down design, structured programming, and the use of higher-order languages (HOLs) are the major ingredients of the new discipline.[7, 8]

Third, failure to anticipate exotic demands, complex executive programs, and evolving requirements results in selection of a computer too small to satisfy system requirements. The costs of this misjudgment are prohibitive.[9]

Finally, the separate acquisition of hardware and software with the hope of integration later is almost certainly doomed to failure. Experience has shown that an integrated system approach must be taken from the start.

Other problems, largely unresolved, plague the military software development manager:

- Multilevel security[10]
- Operating systems for distributed processors[11, 12]
- Data base management for distributed data[13, 14, 15, 16]
- Verification and validation[17, 18, 19]
- Possible over-regulation[20]

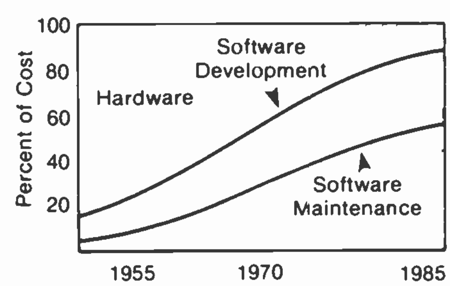


Fig. 2. Mushrooming life-cycle software costs necessitate more attention to cost reduction during the development cycle.

Future trends

Elements of the Air Force Systems Command have estimated that in the next 15 years there will be eight times as much military software produced as in the past 15 years. The demand will grow at a rate in excess of 20 percent per year. Considerable efficiencies are expected to accrue through the use of program design languages and modern software discipline; but even if programmer productivity rises an expected 300 percent, there will still not be enough programmers to meet the projected demand. Furthermore, the trend to do more with software continues.[21] Figure 2 shows the hardware/software cost trend with approximately 90 percent of the system cost being the development and maintenance of computer software. As

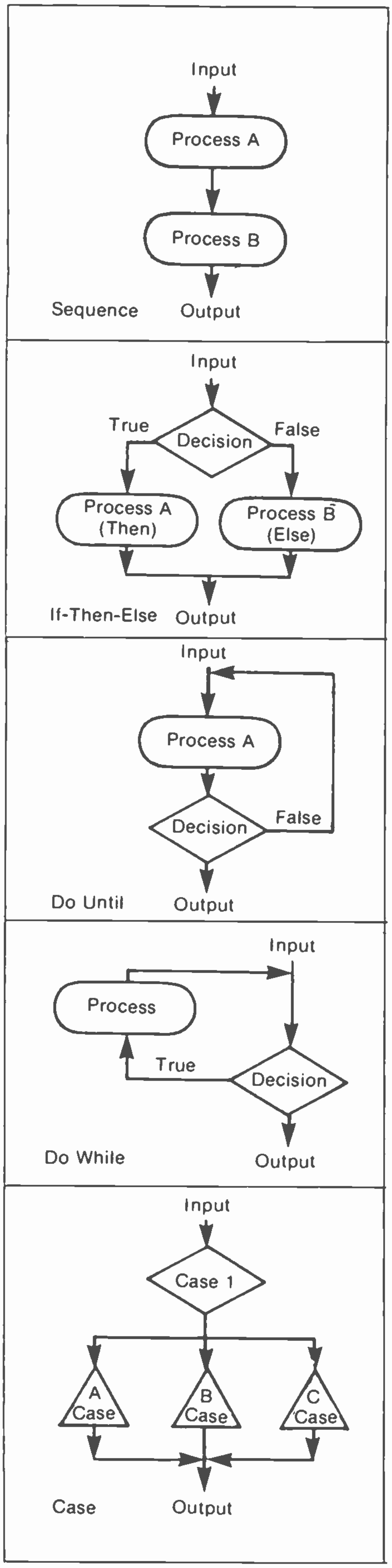


Fig. 3. Efforts to improve software production and to increase its maintainability have resulted in the use of structured programming with limited logical constructs, such as those shown above.

both the amount of work to be done and the cost of doing the work mount, all indicators point to a need for concentrated efforts for improving software development.

A disciplined design

There are four distinct elements in any C^2 system: people, procedures, software, and hardware. From a system designer's point of view, this list provides a spectrum of system flexibility with the greatest flexibility residing in people and the least flexibility in hardware. Of course, the greatest computational power resides in hardware and the challenge to the designer is to utilize this capability to its fullest. (The modern notion of firmware fits consistently into the spectrum as an extension of capability generally performed by hardware.)[19, 20, 21] Other design trade-offs are mentioned later.

Total system management seems to be the central and overriding need. The system designer must view the four elements on the flexibility spectrum as an integrated package. He must achieve a total system design early in the conceptual stage after rigorous assessment of system requirements and careful allocation of tasks. He must view software as an integral system attribute rather than as an isolated tool, while weighing carefully the trade-offs among flexibility and power. In summary, the system designer must design the system from the top down to achieve proper functional partitioning among tasks allocated to people, procedures, software, and hardware. Then and only then can he make a judicious choice of hardware.

Finally, once it is determined which functions software should address, the software must be further partitioned into modules. The benefits of this approach are manifold, but testability and adaptability are among the most prominent. This type of partitioning can lead to much simpler operating systems and to compatibility with distributed hardware. Indeed, the new Department of Defense (DOD) standard language, Ada, stresses modularity and may be implemented without an operating system.

A disciplined development environment

The Rome Air Development Center efforts to improve software production have resulted in several significant study programs including compiler implementors, error analysis, and quality assurance procedures. Work on a disciplined environment has led to specifications on structured programming and program support libraries.[22]

Structured programming usually recognizes that top-down software design is needed before detailed coding can be

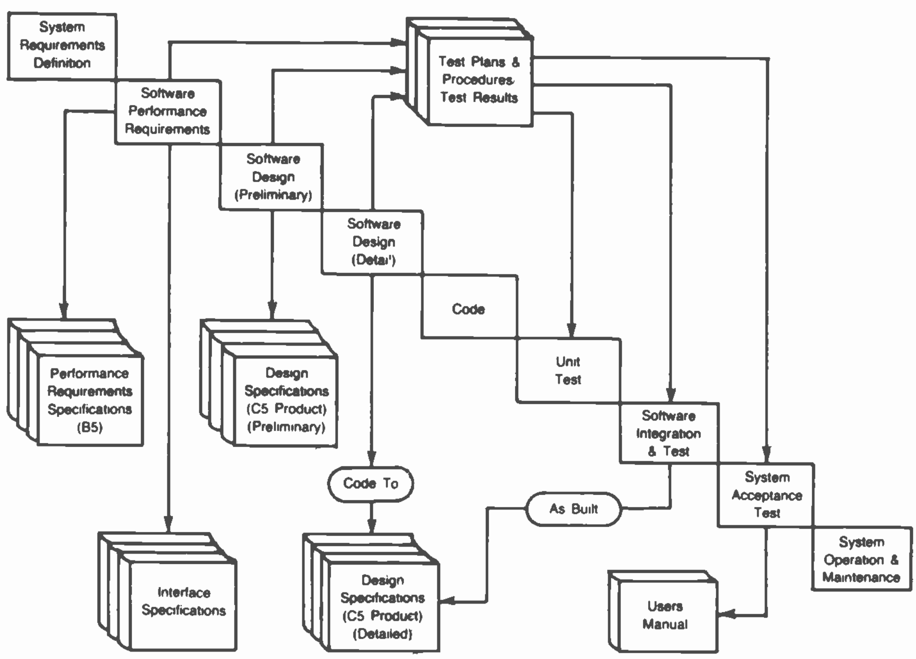


Fig. 4. A top-down approach to system definition and resolution, coupled with well-structured documentation developed to support program milestones, is essential to orderly computer program development.

started. This automatically leads to partitioning, although there are methods for improving the partitioning. Structured programming also includes adherence to a specific set of rules that allows only limited logical constructs such as simple precedence (sequencing), comparison tests and branching, and repetition (loops). One operation is sometimes banned — the GO TO instruction — since it leads to overly complex feedback loops and interdependencies. Figure 3 shows a commonly accepted set of constructs.[5]

The use of HOLs (higher-order languages), such as Pascal and Jovial, is another facet of the drive toward discipline. Transferability is one possible payoff from the use of HOLs; that is, software can be moved (more easily) between computers and sometimes even adapted to new applications. Program maintainability has been firmly established as a real payoff.[23]

A disciplined environment also includes control over the host computer and its development tools, together with maintenance of a program support library in which a librarian records and controls all code and documentation. Figure 4 shows some typical product documentation necessary for a maintainable system.[18]

Other development tools have been used successfully to reduce rising costs. Notable among these is the program design language, which "provides for natural expression of procedural definitions (programs) at a level of completeness and detail appropriate to the designer's current knowledge of requirements."[24] It is estimated that use of a program design language can reduce production costs by 20 percent.

Still another technique, not yet tested, is the software architecture design work of Andreu and Madnick of MIT's Center for Information Systems Research.[25] The principle here is the structured refinement of requirements to determine dependencies and the application of algorithms to group requirements so that intergroup dependencies are minimized. This leads to a rational partitioning of software into modules; unexpected interdependencies have historically led to trouble late in program development (after the design is rigid). Figure 5 illustrates the major steps in the process.

In addition to work being done to discipline the people who perform programming, effort is being made to standardize the entire software acquisition cycle. Agencies, such as the Electronics Systems Division of the Air Force Systems Command, have provided guidebooks for use by program managers. These cover topics such as contracting, documentation, configuration management, quality assurance, estimating, and other related topics as a means to standardize the software acquisition cycle as much as possible.

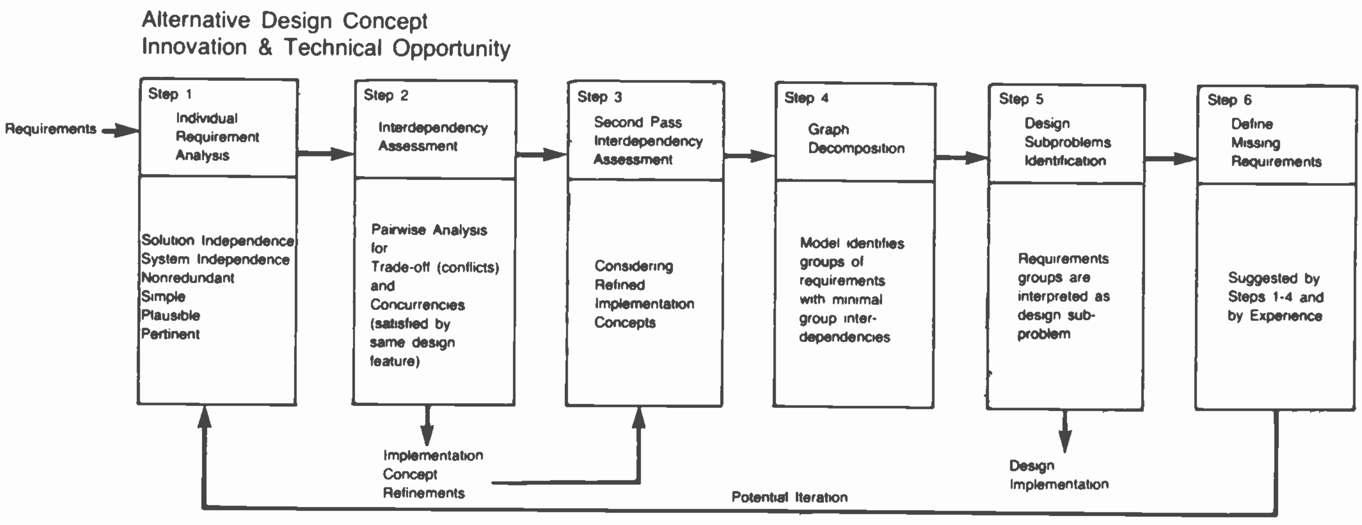
Modern discipline should also include a vastly improved method for estimating software costs. RCA PRICE S parametric cost estimating does precisely this; it uses information such as the number of lines of executable object code (or code in any language), the mix of code type (operating systems and real-time command control systems cost twice as much as data base retrieval systems and twelve times as much as mathematical operations), and schedules. Figure 6 shows a typical PRICE S output sheet for a mobile radar. Figure 7 shows the effect of too long a schedule.[9]

For additional information on PRICE S systems, read the article by M.H. Burmeister on page 21.

New approaches to military systems

Perhaps no other technology has had as big an impact on software as the revolutionary development of microelectronics. Reductions in the cost, size and weight of circuitry are staggering; lower processing speed, the unfortunate side effect of these improvements, is rapidly being eliminated. Other effects are also important to the new software architect. The reliability of LSI, VLSI, and VHSI circuitry is significantly higher than that of the older hardware this new technology replaces. In addition, there are collateral gains in radiation hardening in certain cases (CMOS/SOS).

Microprocessors have had the most obvious impact on software since their advent permits emulation of many large computers. This capability permits reuse of



Benefits
- Provides Disciplined Structure for Front-End Software Architectural Design
- Avoids Pre-Determined Design Implementation
- Avoids Surprise Interdependencies Late in Implementation
- Provides Partitioned Software Modules

Fig. 5. Rigorous attention to the identification and minimization of module interdependencies decreases downstream problems in the test phase.

```
SAMPLE CASE                                                              MOBILE RADAR
                                      INPUT DATA
FILENAME: SAMPLE                                                      DATED: 07/22/77

DESCRIPTORS
  INSTRUCTIONS    36000         APPLICATION    0.0           RESOURCE        3.500
  FUNCTIONS           0         STRUCTURE      0.0           LEVEL           2.600
                                                             INTEGRATION     0.500

APPLICATION CATEGORIES           NEW DEVELOPMENT             SYSTEM CONFIGURATION
                    MIX         DESIGN         CODE          TYPES         QUANTITY
  DATA S/R          0.0         1.00           1.00          0                 0
  ONLINE COMM       0.08        1.00           1.00          1                 1
  REALTIME C&C      0.08        1.00           1.00          2                 2
  INTERACTIVE       0.23        1.00           1.00          1                 2
  MATHEMATICAL      0.28        0.50           0.70          ***             ***
  STRING MANIP      0.26        1.00           1.00          ***             ***
  OPR SYSTEMS       0.07        1.00           1.00          ***             ***

SCHEDULE
  COMPLEXITY        1.250
  DESIGN START      OCT 77      IMPL START     JUL 78        T&I START      DEC 78
  DESIGN END        DEC 78      IMPL END       AUG 79        T&I END        JUL 80

SUPPLEMENTAL INFORMATION
  YEAR              1977        ESCALATION     0.0           TECH IMP        1.00
  MULTIPLIER        1.000       PLATFORM       1.4           UTILIZATION     0.80

                                 PROGRAM COSTS

COST ELEMENTS                    DESIGN         IMPL          T & I          TOTAL
  SYSTEMS ENGINEERING             392.           16.          290.           698.
  PROGRAMMING                      51.           76.          119.           246.
  CONFIGURATION CONTROL            90.           23.          179.           292.
  DOCUMENTATION                    66.            7.           72.           145.
  PROGRAM MANAGEMENT               37.            7.           36.            80.
     TOTAL                        636.          129.          695.          1461.

                                 ADDITIONAL DATA
DESCRIPTORS
  INSTRUCTIONS    36000         APPLICATION    5.299         RESOURCE        3.500
  FUNCTIONS         400         STRUCTURE      4.961         LEVEL           2.600

SCHEDULE
  COMPLEXITY        1.250
  DESIGN START      OCT 77      IMPL START     JUL 78        T&I START      DEC 78
  DESIGN END        DEC 78      IMPL END       AUG 79        T&I END        JUL 80

                                 SCHEDULE GRAPH
OCT 77                                                                      JUL 80
************ DESIGN *************
                          ********** IMPLEMENT **********
                                      ************* TEST & INTEGRATE **************
```

Fig. 6. Typical PRICE S output lists the inputs (number and type of instructions, application, resources available, amount of new design, etc.) along with the proposed schedule at top. Bottom half of output gives the program cost and graphs the program schedule for the three development phases — design, implementation, and test and integration.

time-tested software, with potential savings in cost and time. In addition, a new look at software architecture from the total system point of view will show that many functions previously accomplished with software can now be lodged in firmware or even hardware. In the latter case, it may be possible to exploit low-cost general-purpose microprocessors.[26, 27] Reprogramming could then be accomplished by substituting one microprocessor for another. It is again clear that the necessary and interrelated trade-offs and decisions cannot be made by using old techniques that cleanly separated hardware and software development. The decision requires knowledge of both worlds.

Distributed data processing is a term so broad in its interpretation that considerable discussion is needed to determine whether two speakers are talking about the same concept. For the operational military environment, the term means any multiple-processor configuration that achieves redundancy and physical distribution of processing so that the supported system has no critical nodes.[28, 29, 30, 31] Thus, system capability may gracefully degrade when nodes or links are attacked, and a lucky hit or two cannot eliminate the system's effectiveness. Figure 8 shows a structured taxonomy.[31]

The military market's unique requirements for system survivability from both physical and electromagnetic threats is driving a major effort to distribute the data processing for many systems dependent on computers. Significant cost savings can be accomplished through distribution, although this result is frequently not fully exploited because of other system requirements. The Ada language is designed to permit multiprocessor operation.

The Military Computer Family is a manifestation of the drive within the Department of Defense to improve the battlefield survivability and interoperability of data processing systems. Its design objectives are aimed at providing compatible hardware, software, and support systems. The concept involves modularity via form, fit, and function specifications; the development of the common DOD language called Ada; and standards for interfaces, computers, and instruction set architectures.

Some difficult questions remain. At which level should modularization be accomplished? What will be the effect on major defense contractors if modular (off-the-shelf) configurations are used by the services? Can the Government procurement system and program management system accommodate this modular approach?

Man's ability to accumulate information has proved to be limited only by his budget. Unfortunately, the ability to access, move, analyze, present, and purge this information is relatively archaic, especially in the military environment where information is widely dispersed and highly dynamic.

The abstruse world of artificial intelligence has produced a handful of experts who, in trying to emulate the human

ACTIVITY LENGTH IN MONTHS

COMPLEXITY = 1.250	DESIGN	IMPL	T & I	TOTAL
SPECIFIED SCHEDULE	14.0	13.0	19.0	33.0
(OVERLAP)		(5.0)	(8.0)	
TYPICAL SCHEDULE	9.6	10.0	13.9	21.9
(OVERLAP)		(5.7)	(5.9)	

DEVELOPMENT COSTS

COMPLEXITY = 1.250	DESIGN	IMPL	T & I	TOTAL
SPECIFIED SCHEDULE	636.	129.	695.	1461.
TYPICAL SCHEDULE	500.	110.	611.	1222.
ESTIMATED PENALTY	136.	19.	84.	239.

Fig. 7. Schedule effect summary compares user-specified schedule and schedule generated by PRICE S, and also lists cost penalties associated with the user-specified schedule.

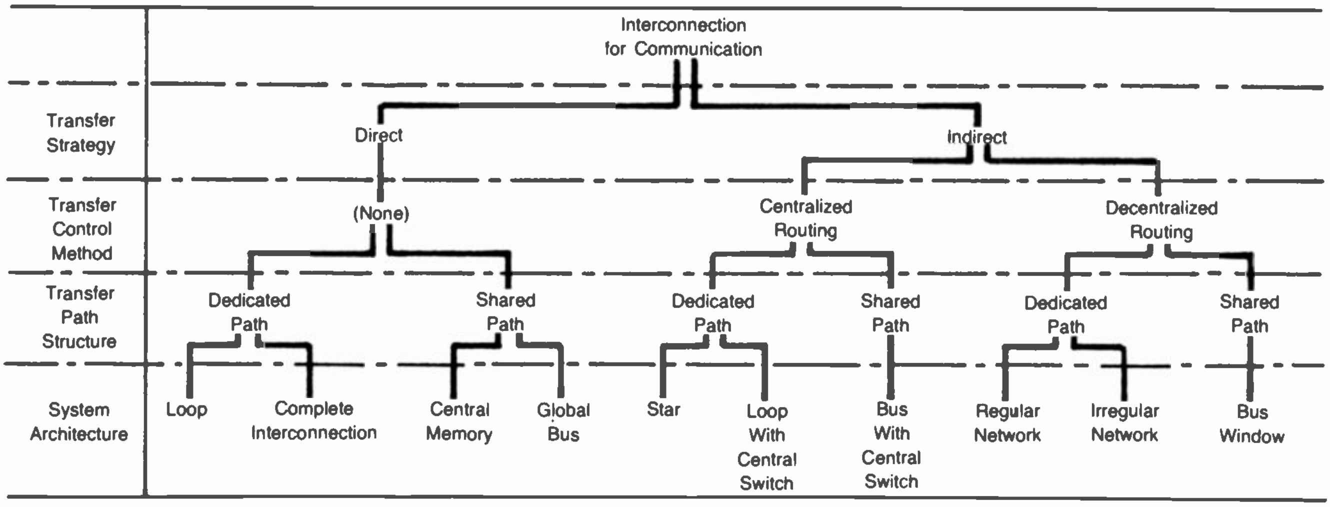


Fig. 8. Selection of the proper distributed data processing architecture can contribute significantly to system survivability.

thought process, have developed several techniques for improving the utility of stored data. One of these is knowledge-based data bases. The concept is an enhancement of "associative" data bases. Special languages, such as LISP, have been devised to treat facts as data and to enable a non-quantitative mathematics on lists of semantically related data. This, in turn, permits pattern-directed information retrieval. Furthermore, LISP objects can simultaneously be data and programs (functions), and an inherent recursive function capability[32,33] leads to a powerful descriptive technique. The new DOD language Ada will also possess many of these qualities.

An extension of knowledge-based data base theory leads to virtual machines, where the user accesses not only data but also programs and tools of widely diverse natures through a virtual machine monitor (VMM). This approach makes one machine "function as though it were multiple, physically isolated systems."[34] This occurs through control over interconnections between an array of modeling machines and data base machines. All the interfacing is transparent to the user.

A manager of many disciplines: the New Renaissance Man

The significant point here is that a new breed of manager is required, a New Renaissance Man, one who understands and appropriately applies all the technological and managerial disciplines involved in developing tomorrow's sophisticated C^2 systems. With one hand, this super-manager must ensure the design of a totally integrated C^2 system with all the complex technological tradeoffs that such a design implies and with optimum allocation of tasks to people, procedures, hardware, and software. With his other hand, this super-manager must plan and direct a disciplined system development effort to meet not only the system requirements existing today but also those that will evolve over the long system life cycle.

An individual so erudite is difficult to imagine, but his emergence is critical if government and industry are to continue the present thrust in C^2 systems.

Conclusion

We have briefly discussed the most basic problems in C^2 development. These problems include the utilization of modern software development discipline; tradeoffs in allocating tasks among people, procedures, software, and hardware; tradeoffs between micro- and minicomputers; trade-offs between centralized and distributed processing; and the skills and knowledge of the managers charged with directing this complex effort.

Many questions remain:

- Is software development already overmanaged/overspecified?
- Do the dynamics of microelectronics make commitments to specific technologies pointless?
- What are the payoffs in distributed data processing?
- How can a manager be trained to be a New Renaissance Man? Is it even feasible to be so widely capable?

We have no alternative but to answer these challenging questions. We have no alternative but to produce better management through training over the full spectrum — program management, software management, and hardware management. Industry and government alike must provide incentives to attract top quality people.

The New Renaissance Man must be versed in the disciplines listed above. Equally important, he must be able to accept changing and evolving requirements as a way of life. Finally, he must be able to employ new tools in the task of system design. In particular, early functional partitioning will require improved scientific analysis.

The bottom line is that software design is moving out of the realm of occult art and into the world of system engineering.

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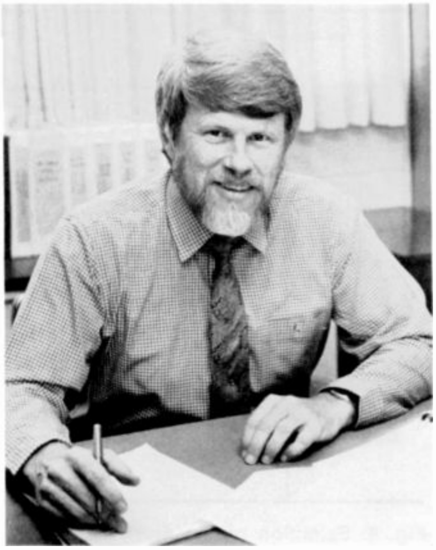

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New Publication from the *RCA Engineer*

According to the RCA Engineering Information Survey conducted in 1977, the *RCA Engineer* is the second most important source of technical information about RCA (the most important information source being the engineer's associates). The back issues of the *Engineer* (150 of them) provide a record of RCA's progress in invention, development, and manufacturing. To make this wealth of technical information accessible to the engineers, the *Twenty-five Year Index to the RCA Engineer* has been published.

The index can help you find specific information that is needed in your work. Or the index might provide a vital contact in another RCA business who has related experience and who would be willing to consult with you. The index gives you the opportunity to profit from RCA's technical heritage, to reuse knowledge, and to build on past accomplishments.

The *Twenty-five Year Index to the RCA Engineer* is available, in limited quantities, at all RCA technical libraries. Recipients of the *RCA Engineer* can obtain their personal copies by writing to:
RCA Engineer
Building 204-2
Cherry Hill, NJ 08358

M.H. Burmeister

RCA PRICE System — the engineer's flexible tool

Programmed Review of Information for Costing and Evaluation (PRICE) means more cost-effective engineering.

Abstract: *The PRICE System, four parametric cost-estimating models offered by RCA, provide the cost estimation essential to the successful development of a new product.*

What is PRICE?

PRICE is an acronym for Programmed Review of Information for Costing and Evaluation. The PRICE System is a universal family of four parametric cost-estimating models for use in the military and commercial environment.

PRICE was first developed in 1962 as an RCA in-house model. It is used in estimating engineering and manufacturing costs for electronic, mechanical and electro-mechanical items or entire systems while they are still in the conceptual stage, and also as the program progresses through the development and production stages. PRICE L is a Life-Cycle model that takes data from the basic PRICE Hardware model and computes support costs. PRICE S uses the PRICE parametric modeling methods to estimate software costs through design, coding and integration and testing. A new Software-Life-Cycle model, PRICE SL, has just been developed to provide cost estimates through the life of a program.

Cost estimation, especially in the conceptual stage, is essential to the successful development of a new product. Based on accurate cost estimation, management can make decisions on whether to proceed, alter or cancel a product or program. Accurate front-end cost analysis, based on the proposed design, allows changes in parameters prior to finishing the system design criteria, and it can be done in far less time than conventional methods. Table I shows an example of man-hours that can be saved by estimating the cost of a project with PRICE.

Who uses PRICE?

Since August 1975, PRICE has been available to outside corporations on a contractual basis. All of the models are accessed through commercial time-sharing computer networks. Twenty-seven of the top 50 defense contractors subscribe to the PRICE models. The Army, Navy, Air Force, NASA, other government agencies, and some European governmental and industrial organizations are also users. As the Department of Defense and the General Accounting Office adopt a multi-year contracting principle, the ability to correctly price a product and determine the optimal production schedules becomes a significant part of a proposal. Trade-offs and their economic ramifications can be identified early, and cost-effective changes

Table I. Typical resources needed to estimate the costs of an avionics system containing 20 subsystems.

	With conventional methods	*With parametric models*
A. Secure descriptive information (scope of work)	160 man-hours	24 man-hours
B. Select and analyze comparative cost experiences. (for estimating purposes)	40 man-hours	8 man-hours
C. Adjust historic cost data for differences in scope of work, technology, economics, resources, scheduling, tooling, etc.	80 man-hours	Included in B by automated models
D. Develop the estimate including potential engineering changes, schedule factors, etc., through assembly and test	400 man-hours	8 man-hours
Total for basic estimate	680 man-hours	40 man-hours
Perform Sensitivity Analyses and Technology Trade-offs.	200-400 man-hours if done, but time seldom permits	1-8 man-hours

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Table II. Applications of PRICE.

- Evaluations of bids and proposals
- Design-to-Unit-Production-Cost analysis
- Estimates of cost to complete
- Bid preparation and submittal
- Estimates of cost to modify
- "Should" cost analysis
- Bid, no-bid decisions
- Long-range planning
- Procurement planning
- Cross-checking of design concepts
- Microelectronic cost estimating
- Application to life-cycle cost analysis
- Design cost trade-offs analysis

determined. PRICE is a proven system for meeting those requirements. Table II outlines those and other PRICE applications.

PRICE methodology

Many parametric cost models exist throughout industry and government agencies. Each is designed to cover a specific range of products or systems, and requires its sets of unique inputs (including performance features, technologies, and quantities). Many models are required because different systems have different cost-significant characteristics that require unique mathematical regressions to quantify the costs.

PRICE was formulated as a universal system to generate appropriate products or systems, and is the only system widely accepted in the marketplace.

The method used in PRICE to model the estimating procedure is parametric. Therefore, when the model calculates a cost for manufacturing, it does not use a parts list and labor resource chart, but rather a parametric representation of the effects of parts, labor, and maintenance costs. Parametric methods are common in many businesses. Real-estate and tax assessments are regularly derived from parametric estimates of property values. The number of rooms, type of construction and even the zip code of a home are parameters used to estimate real value.

The fundamental characteristic of the parametric inputs is that of direct and indirect interrelationship with other inputs and outputs. A change in any one parameter is usually not localized in one cost element, but rather, may have a direct effect on some cost elements, and an indirect effect on many more. For example, consider the impact of a change in quantity. Certainly this would cause a change in manufacturing cost. But, it might also affect the fabrication process and, hence, the cost of tooling. In addition, a change in quantity would probably have a schedule effect and so the cost due to escalation would differ. A filtered impact on integration and testing, sustaining engineering and project management, would almost certainly result from a change in quantity. This dynamic effect is characteristic of most input variables.

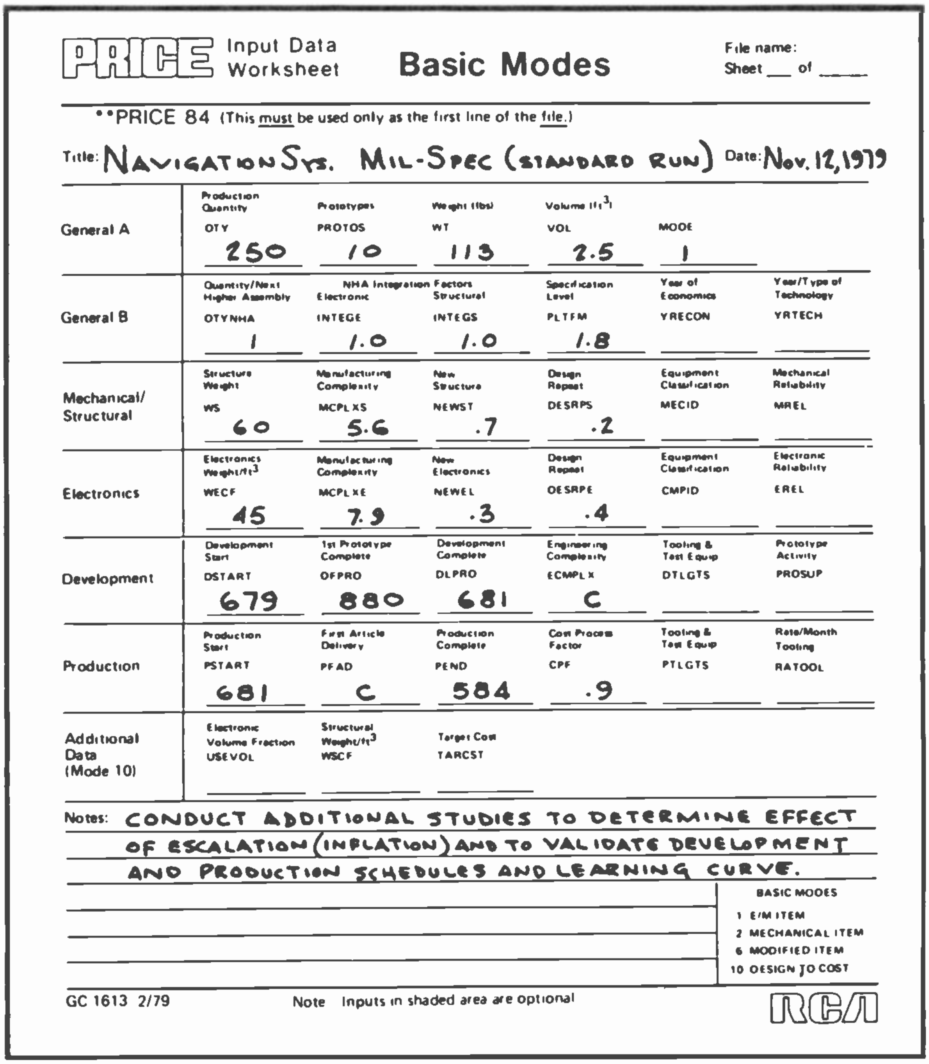
The PRICE model contains thousands of mathematical equations relating the input variables to cost. Each specific set of input parameters uniquely defines the hardware for cost modeling. The resultant cost output is determined from the mathematical equations alone. PRICE, therefore, does not perform the function of a table look-up model.

PRICE has been designed to estimate costs with a minimal amount of hardware information. This feature makes it a useful tool for cost estimation of programs in the conceptual stage of development, since the model uses its internally generated values for any missing input variables.

Of course, it is always preferable for the PRICE user to supply the inputs, when their values are known, to reduce the statistical uncertainty of the parametric model. A description of the generic parametric inputs used in PRICE is given in Table III. A sample PRICE input sheet is shown in Fig. 1.

PRICE System description

The PRICE System consists of four models. The basic PRICE Model reliably estimates system acquisition costs based upon: physical parameters such as quanti-



PRICE Input Data Worksheet — Basic Modes

File name:
Sheet ___ of ___

**PRICE 84 (This must be used only as the first line of the file.)

Title: NAVIGATION SYS. MIL-SPEC (STANDARD RUN) Date: Nov. 12, 1979

General A	Production Quantity QTY: 250	Prototypes PROTOS: 10	Weight (lbs) WT: 113	Volume (ft³) VOL: 2.5	MODE: 1	
General B	Quantity/Next Higher Assembly QTYNHA: 1	NHA Integration Factors Electronic INTEGE: 1.0	Structural INTEGS: 1.0	Specification Level PLTFM: 1.8	Year of Economics YRECON	Year/Type of Technology YRTECH
Mechanical/Structural	Structure Weight WS: 60	Manufacturing Complexity MCPLXS: 5.6	New Structure NEWST: .7	Design Repeat DESRPS: .2	Equipment Classification MECID	Mechanical Reliability MREL
Electronics	Electronics Weight/ft³ WECF: 45	Manufacturing Complexity MCPLXE: 7.9	New Electronics NEWEL: .3	Design Repeat DESRPE: .4	Equipment Classification CMPID	Electronic Reliability EREL
Development	Development Start DSTART: 679	1st Prototype Complete DFPRO: 880	Development Complete DLPRO: 681	Engineering Complexity ECMPLX: C	Tooling & Test Equip DTLGTS	Prototype Activity PROSUP
Production	Production Start PSTART: 681	First Article Delivery PFAD: C	Production Complete PEND: 584	Cost Process Factor CPF: .9	Tooling & Test Equip PTLGTS	Rate/Month Tooling RATOOL
Additional Data (Mode 10)	Electronic Volume Fraction USEVOL	Structural Weight/ft³ WSCF	Target Cost TARCST			

Notes: CONDUCT ADDITIONAL STUDIES TO DETERMINE EFFECT OF ESCALATION (INFLATION) AND TO VALIDATE DEVELOPMENT AND PRODUCTION SCHEDULES AND LEARNING CURVE.

BASIC MODES
1 E/M ITEM
2 MECHANICAL ITEM
6 MODIFIED ITEM
10 DESIGN TO COST

GC 1613 2/79 Note Inputs in shaded area are optional RCA

Fig. 1. A sample PRICE input sheet for an electronic assembly developed over a two-year period with production of 250 units during the three years after the development program.

Table III. Fundamental parameters in the PRICE model.

- Quantities of equipment to be developed, produced, modified, purchased, furnished and/or integrated and tested.
- Schedules for development, production, procurement, modification, integration and testing, including lead time for set-up, parts procurement, and redesign.
- Hardware geometry consisting of size, weight of electronic and structural elements, and electronic packaging density.
- Amount of new design required and complexity of the development engineering task.
- Hardware structural and electronic design repeat.
- Operational environment and specification requirements of the hardware.
- Type and manufacturing complexity of the structural/mechanical and electronics portions of the hardware.
- Fabrication process to be used for production.
- Pertinent escalation rates and mark-ups for General and Administrative charges, profit, IR&D, cost of money, and purchase item handling.
- Technological improvement.
- Yield considerations for hardware development.

ty, size, weight, environmental specification, type of technology, and level of integration; and schedule parameters such as months to first prototype, manufacturing rate, and amount of new design (Table III).

PRICE can predict costs for many alternatives before designs and bills of material are finalized. It is also used extensively for independent assessment of conventionally prepared cost estimates.

When properly applied to an organization, PRICE can accurately reflect the past dollar-to-product relationships of that organization, and, thus, can provide an unbiased baseline for comparison to conventionally prepared cost estimates. When PRICE and the conventional estimates do not coincide, the rationalization process should pinpoint the area of disagreement and, therefore, the area of departure from past-established patterns. This may represent risk from a schedule, technical or cost standpoint, and should be clearly identified to management.

Inputs to PRICE cover a wide range of systems. Since all products must have weight and size, these are used by PRICE as the principal descriptors. Electronic areas are characterized by technology, application and packaging. Mechanical structures can be described in terms of types of material, construction and densities. Procedures have been developed to PRICE-process situations in which weights and sizes are not known. In these cases, the physical characteristics are generated by the model. The PRICE model can use other inputs to estimate weight and size if these are not known. The model will check for input appropriateness and warn the user if an input value is "out of line."

PRICE outputs

PRICE generates costs for the development and production phases. Outputs are categorized by such elements as Drafting, Design, Project Management, Prototype, and Special Tools and Test Equipment. PRICE can also develop an engineering schedule or measure the reasonableness of an input schedule. Variations of parameters such as physical features, components, percentage of new design, and reliability (MTBF), can be quickly assessed. Integration and test costs for both engineering and production can be developed by PRICE at any level of the work breakdown structure.

PRICE has provisions to include the costs for GFE and purchased items. It evaluates the cost of testing, modification (if necessary), and integration and test with other equipments.

Figure 2 shows a PRICE output for a cost study on a hypothetical military airborne radar. The top-third of the output lists the program inputs. The rest of the sheet includes the derived estimates, schedules, supplemental information and cost ranges.

```
                              - - - PRICE 84 - - -
                               ELECTRONIC  ITEM

       DATE 31-MAR-80                 TIME 16:45          FILENAME:  ABRDR
                                      (800087)

NAVIGATION SYSTEM    MIL-SPEC   (STANDARD RUN)     MAR 31,1980

 PRODUCTION QUANTITY      250      UNIT WEIGHT     113.00    MODE              1
 PROTOTYPE QUANTITY      10.0      UNIT VOLUME       2.50    QUANTITY/NHA      1

UNIT PROD COST    33.61    COST PROCESS FACTOR     0   MONTHLY PROD RATE  11.49

PROGRAM COST($ 1000)        DEVELOPMENT        PRODUCTION        TOTAL COST
   ENGINEERING
      DRAFTING                  159.               32.              191.
      DESIGN                    587.               96.              683.
      SYSTEMS                    98.               -                 98.
      PROJECT MGMT              165.              562.              727.
      DATA                       47.              119.              166.
        SUBTOTAL(ENG)          1056.              809.             1865.

   MANUFACTURING
      PRODUCTION                 -               8403.             8403.
      PROTOTYPE                 973.               -                973.
      TOOL-TEST EQ               98.              125.              223.
        SUBTOTAL(MFG)          1071.             8528.             9598.

        TOTAL COST             2127.             9337.            11464.

DESIGN FACTORS       ELECTRONIC MECHANICAL    PRODUCT DESCRIPTORS
  WEIGHT               53.000*    60.000        ENGINEERING COMPLEXITY  1.221*
  DENSITY              45.000     24.000*       PROTOTYPE SUPPORT       1.0
  MFG. COMPLEXITY       7.900      5.600        PROTO SCHEDULE FACTOR   0.250*
  NEW DESIGN            0.300      0.700        ELECT VOL FRACTION      0.471*
  DESIGN REPEAT         0.400      0.200        PLATFORM                1.8
  EQUIPMENT CLASS     *****      *****          YEAR OF TECHNOLOGY      1979
  ENGINEERING CHANGES 0.045*     0.014*         RELIABILITY FACTOR      1.0
  INTEGRATION LEVEL     1.0        1.0          MTBF(FIELD)               121*

SCHEDULE             START               FIRST ITEM            FINISH
    DEVELOPMENT      JUN 79    ( 15)     AUG 80     ( 10)      JUN 81     ( 25)
    PRODUCTION       JUN 81    ( 14)     JUL 82*    ( 22)      MAY 84     ( 36)

SUPPLEMENTAL INFORMATION
  YEAR OF ECONOMICS           1979             TOOLING & PROCESS FACTORS
  ESCALATION                  0.0                DEVELOPMENT TOOLING          1.0*
  T-1 COST                   74.11*              PRODUCTION TOOLING           1.0*
  AMORTIZED UNIT COST        37.35*              RATE TOOLING                   0
  DEV COST MULTIPLIER         1.00*              PRICE IMPROVEMENT FACTOR 0.900
  PROD COST MULTIPLIER        1.00*              UNIT LEARNING CURVE      0.884*

COST RANGES                 DEVELOPMENT        PRODUCTION        TOTAL COST
     FROM                      1874.              8123.             9997.
     CENTER                    2127.              9337.            11464.
     TO                        2489.             10999.            13488.
```

Fig. 2. The actual PRICE output resulting from the sample input previously shown.

Design-to-cost

There is a mode of PRICE which is a design-to-cost procedure. The target cost, quantities, product class, and level of technology are entered as inputs. Outputs include design limits. If the design is held to the PRICE-derived limits, there is a good chance that the cost target will be met.

Product calibration

Successful use of PRICE is predicated on each user's calibration of the model and the resulting adaptation to his particular line of equipment. With the continued increase in the use of PRICE on varied products throughout the world, one fact becomes evident: PRICE is applicable to a diverse range of equipment and situations.

Calibration can be accomplished by using an organization's past projects to provide a technical and cost-historical basis as inputs to PRICE. From this historical information, PRICE can derive empirical scalar values which relate an organization's past performance to its products and costs. Several past projects in each product line can accurately characterize an organization and its products, and the derived scalar values, with new product descriptors, can then be used to estimate "should-cost" values for new projects.

Considering the variety of situations presented by the different electro-mechanical hardware in the world, it is really no surprise that a cost-estimating model should need "fine tuning." In fact, one would have to be suspicious of a model that could not be calibrated. Consider the differences between methods used to fabricate microprocessors and laser optics. The technology used for design and production of some microprocessors is to the point where they are practically stamped out on an assembly line. Scientific calculators, initially selling for $250 now retail for as little as $25. On the other hand, high-grade laser optics are still being made one at a time with considerable amounts of manual labor to grind the optics to precise specifications. These two products represent different situations requiring different adaptations of PRICE.

The PRICE L model

The PRICE Life-Cycle-Cost Model (PRICE L) is a method for rapidly computing-support costs for many varieties of systems. PRICE L operates in conjunction with the basic PRICE model, and offers many advantages not available from other life-cycle-cost models.

The PRICE L model was designed to significantly reduce the effort required in preparing life-cycle-cost estimates. PRICE L's user inputs can be limited to factors for the equipment's employment, deployment, and levels of support capability, equipment and maintenance locations, and total number of years to be considered. All hardware inputs are developed by the PRICE model. PRICE L is exercised in conjunction with the PRICE model through an on-line interactive computer terminal. Response is within minutes, permitting rapid evaluation and sensitivity analysis. PRICE L cost ouputs, depicted in Fig. 3, have been human-engineered so that they can be read and understood without technical interpretations. These outputs are, as shown in Fig. 3, grouped under Program Cost, Development, Production, Support, and then totalled. Additionally, the Operational Availability and Readiness are outputs leading to a cost-effectiveness list. As a run is completed, it is easy to check it, and changing parameters to test for desired variations is easy because the input parameters are shown at the top of the sheet.

Many life-cycle-cost models require an inordinate amount of time to develop or prepare their inputs. Typically, "batch" computer methods are used, which are time-consuming, and serve to inhibit sensitivity analysis. The typical life-cycle-cost model computer outputs are also complex. In many cases, trained technicians must interpret the outputs before they can be analyzed by the program managers.

Automatic input provided by PRICE

During the use of the PRICE model, the user may request the system to generate a

```
PRICE LIFE CYCLE COST                                              PRICE L2  03/20/80

 POWER AMP

                                                              GLOBAL FILENAME:
INPUT FILENAME:       CRADR                                  CONCEPT FILENAME:
DEPLOYMENT FILENAME:  AMPLD                                  CHANGES FILENAME:

MTBF            554    MTTR-LRU  1.5   MOD TYPES/LRU     31   LRUS/EQUIP        2
RATIO (1)       1.00    -MODULE  3.0   PART TYPES/LRU   141   LRU FAIL ALLOW    0

MAINTENANCE CONCEPT 10
REPLACE PARTS AT ORGANIZATION.

    PROGRAM COST             DEVELOPMENT   PRODUCTION      SUPPORT        TOTAL
       EQUIPMENT                     779        12317          ***        13096
       SUPPORT EQUIPMENT             ***         2047         3071         5118
       SUPPLY                        ***         1130         1252         2382
       SUPPLY ADMIN.                 ***            7          106          113
       MANPOWER                      ***          ***          816          816
       CONTRACTOR SUPPORT            ***          ***            0            0
       OTHER                           0          ***            1            1

          TOTAL COST                 779        15501         5246        21526

    OPERATIONAL AVAILABILITY   0.9893       OPERATIONAL READINESS  0.9893

    SUPPORT EQUIPMENT          ORG               INT               DEPOT
       NUMBER OF SETS          15                0                 0
       UTILIZATION             8.273             0.0               0.0
       LOAD FACTOR             0.414             0.0               0.0

    SUPPLY                     UNITS             MODULES/TYPE      PARTS/TYPE
       INITIAL                 0                 0                 41
       BALANCE CONSUMED        0.0               0.0               39.363

COST EFFECTIVENESS LIST (X)

      10=  100     23=  108     7=  110     6=  111     25=  114     24=  115
       8=  117      5=  125     9=  127    17=  137     27=  141     18=  142
      14=  146     11=  151    12=  156    13=  160     16=  172      2=  186
      21=  194      3=  196    28=  197    22=  202     19=  217      4=  218
      26=  256     15=  278    20= 1105     1= 1333

COST AND READINESS TABLE
  MC     TOTAL      OPNL.      MC     TOTAL     OPNL.      MC     TOTAL      OPNL.
  NO.    COST       READI.     NO.    COST      READI.     NO.    COST       READI.

   1    228248     0.7868      11     32831     0.9996     20    202545     0.8424
   2     39929     0.9893      12     33997     0.9996     21     41680     0.9885
   3     41634     0.9763      13     34843     0.9996     22     42510     0.9652
   4     42581     0.8973      14     31761     0.9996     23     23258     0.9885
   5     26863     0.9893      15     56695     0.9386     24     24691     0.9885
   6     23855     0.9893      16     37353     0.9996     25     24009     0.9651
   7     23325     0.9763      17     29401     0.9893     26     54103     0.9719
   8     24757     0.9763      18     30260     0.9763     27     30236     0.9885
   9     24743     0.8970      19     44366     0.9383     28     41560     0.9718
  10     21526     0.9893
```

Fig. 3. PRICE L has selected the most cost-effective maintenance concept for one theater of operation in this example.

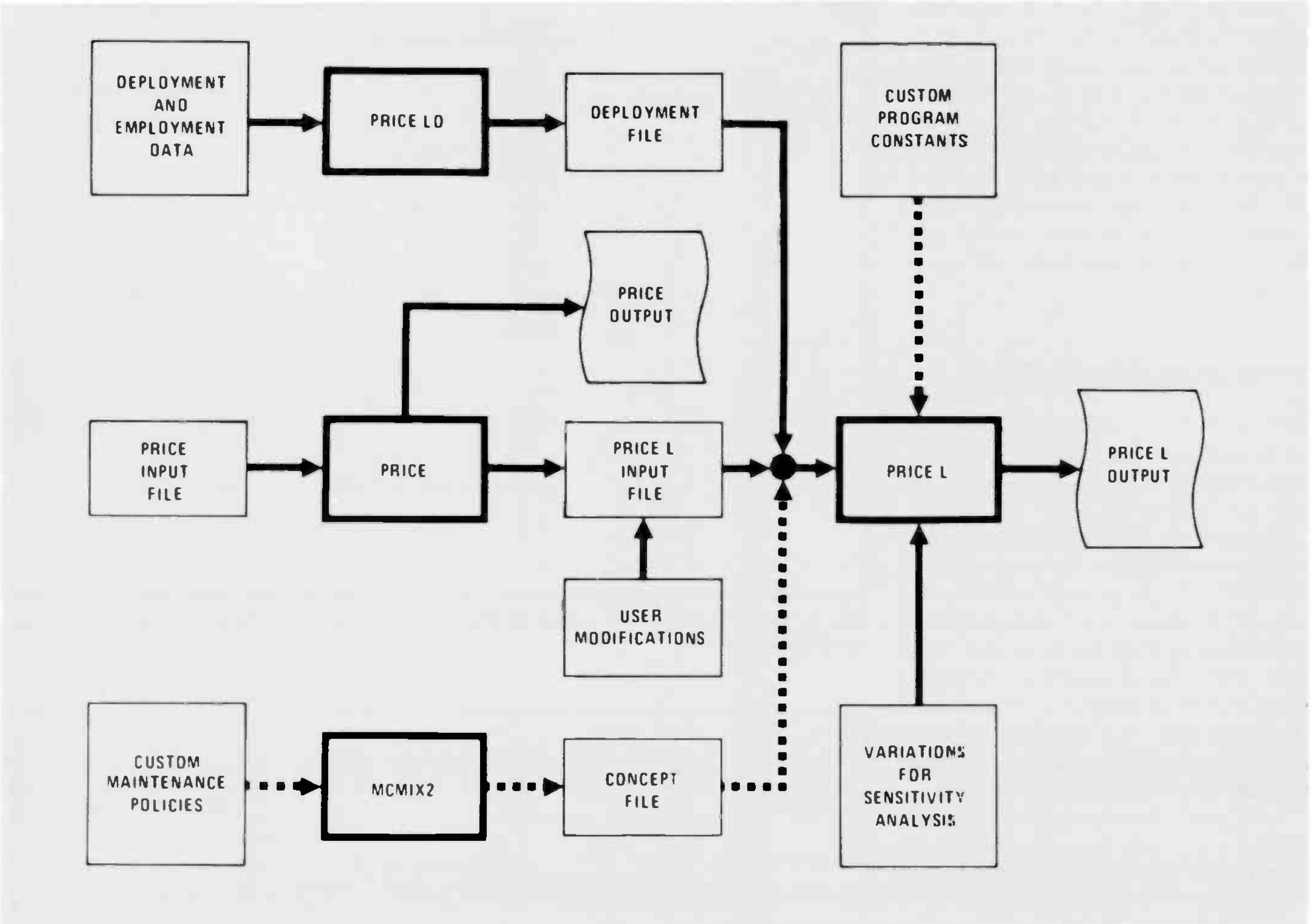


Fig. 4. This block diagram illustrates the relationship of PRICE to PRICE L, and depicts the general category of input and output data in both models.

life-cycle-cost (LC) data file consisting of virtually all the required life-cycle-cost variable inputs. Alternatively, a user can create a PRICE L data file directly, if he wishes to input the governing parameters. He may also modify the PRICE-generated data before or during the life-cycle-cost exercise. Figure 4 illustrates the data flow.

Values developed by PRICE for input to PRICE L include:

- Number of module types and part types and the weight, volume, and cost of modules and parts;
- Development and production costs and schedules;
- MTBF and MTTR for all repairable assemblies; and
- Costs of test equipment.

In addition, PRICE L incorporates many Global values that, although seldom varying between projects, can be readily changed to represent various service maintenance and supply organizations.

Three theaters of operation

In the Vietnam era, the Air Force had B-52s deployed in the U.S. and Europe, as well as southeast Asia. Each of these theaters of operation required that a different scenario be drawn to model the life-cycle-cost factors involved. For example, MTBF is undoubtedly different for the same equipment in each theater. Equipment operating time, number of units deployed, required operational readiness, supply-line times, repair turnaround time and countless other factors could be different in each heater. PRICE L is unique in its capability to handle up to three scenarios simultaneously.

Three theaters of deployment and specification of equipment deployment and employment capability permit more accurate modeling of Navy deployments on carriers and naval air stations; Army and Air Force overseas depots sending work back to CONUS depots; and force levels for each year, and planned levels of operation for each year. This also applies to civilian firms, say oil companies with drilling rigs deployed all over the world.

Design to LCC

One major advantage of the PRICE/PRICE L method is its ability to rapidly assess the life-cycle-cost effects of design changes, while the hardware is still in the concept development stages.

When known, costs for training, field installation and test-site preparation and operations, software, and energy can be "thru-putted" to be included in the LCC totals.

Twenty-eight standard maintenance concepts

A unique feature of the PRICE L model is the use of 28 built-in standard maintenance concepts that can be examined by the user during a single run. The model will determine and print out the most cost-effective support configuration, accompanied by an assessment of the relative cost-effectiveness of the other candidate configurations. Specific maintenance concepts may be dictated by the user as well. In addition to the 28 standard maintenance concepts, users can specify hybrid concepts as combinations of the 28 standard ones. The PRICE L model can therefore be used to determine cost-effective support configurations, when such trade-offs are appropriate.

What does PRICE S do?

PRICE S derives and displays projected costs of software for each of three development phases: Design, Implementation, and Test and Integration.

In addition to costs, the model computes typical schedules for the size, type and difficulty of the project described. If desired, manpower and scheduling constraints that apply to the software development effort can be specified. The consequences of these constraints are examined internally, and costs are adjusted to account for apparent accelerations, stretch-outs and phase-transition inefficiencies.

Four modes of operation are available: Normal Operation, Resource Calibration, Application Calibration and Design-to-Cost.

The Normal mode is the one used to develop estimates for new software projects. In this mode, project descriptors and calibrated parametric values are combined with economic and technological growth factors to produce cost and schedule estimates. The Normal mode is supported by two optional sensitivity analyses. Figures 5 and 6 illustrate these analyses.

Two Calibration modes instruct PRICE S to run "in reverse" to calculate empirical factors from historical costs. The Calibration modes are tools enabling an estimator to quantitatively organize and describe real-world experience in a systematic way that permits extrapolation to new software development projects.

The Design-to-Cost mode uses specified target costs to compute typical program sizes and schedules consistent with given cost constraints. This mode permits PRICE S to be applied to investigate feasibilities and to set scope-of-work goals when faced with limits on total resources and allowable expenditures.

All four modes are supported by optional reports that summarize the projected monthly status and the cost consequences of inefficiencies induced by resource and schedule constraints.

--- PRICE SOFTWARE MODEL ---

SAMPLE CASE
COSTS IN INFLATED DOLLARS/1000

COMMAND & CONTROL

SENSITIVITY DATA
(RESOURCE - COMPLEXITY)

COMPLEXITY

RESOURCE		1.150		1.250		1.350	
3.400	COST	1495.	COST	1695.	COST	1974.
	MONTHS	18.0	MONTHS	18.0	MONTHS	18.0
3.500	COST	1563.	COST	1775.	COST	2076.
	MONTHS	18.0	MONTHS	18.0	MONTHS	18.0
3.600	COST	1632.	COST	1864.	COST	2173.
	MONTHS	18.0	MONTHS	18.0	MONTHS	18.0

Fig. 5. This is an optional output of PRICE S which shows a sensitivity analysis of two important variables.

--- PRICE SOFTWARE MODEL ---

SAMPLE CASE
COSTS IN INFLATED DOLLARS/1000

COMMAND & CONTROL

SENSITIVITY DATA
(APPLICATION - INSTRUCTIONS)

INSTRUCTIONS

APPLICATION		32400		36000		39600
5.199	COST	1523.	COST	1734.	COST	1985.
	MONTHS	18.0	MONTHS	18.0	MONTHS	18.0
5.299	COST	1557.	COST	1775.	COST	2035.
	MONTHS	18.0	MONTHS	18.0	MONTHS	18.0
5.399	COST	1591.	COST	1817.	COST	2084.
	MONTHS	18.0	MONTHS	18.0	MONTHS	18.0

Fig. 6. Another optional output of PRICE S. The standard output format of PRICE S is similar to PRICE and PRICE L.

Because the interactive procedures of PRICE S permit rapid analyses, many alternative conditions can be quickly assessed.

PRICE SL

PRICE SL is the most recent addition to the PRICE family of parametric cost-estimating models. The new model is designed to provide life-cycle-cost estimates for customers using the PRICE S software model.

Life-cycle costs occur after a software package has been developed, tested and put to use. These costs include:

- Repairing defects missed in testing;
- Making changes needed to improve operating efficiency;
- Adding capabilities and features that were not included in the original specifications.

The ISPA News

This professional journal is published by the International Society of Parametric Analysts. ISPA is a professional organization originally started by a group of PRICE users and now consists of approximately 600 parametric analysts. The majority of the ISPA members are RCA PRICE users.

Limited quantities of this quarterly publication are available to readers of the *RCA Engineer*.

PRICE SL receives most of its inputs from a computer run of the basic PRICE S model, with some additional inputs to define the support activity. As with other PRICE models, SL can be made to match a particular customer's needs by varying its growth, enhancement and maintenance levels. The only other inputs needed are the years of support required and the number of systems installations.

RCA engineer PRICE use

PRICE is available to all PRICE-trained engineers researching and developing any new product. Using PRICE, you can determine the most cost-efficient way to proceed and still meet the specification requirements. You can quickly and easily try out alternative designs, materials, and complexities to determine what is best.

You can plan the production runs to include start-to-end timing based on quantities desired. This also allows you to determine the most economical technology. The average cost to RCA per PRICE run is minimal compared to conventional cost estimation.

PRICE training

Over 100 RCA personnel have been trained in the PRICE System. Engineers desiring to be PRICE-trained must attend courses given at Cherry Hill, New Jersey. PRICE offers a two-week Hardware class, a one-week Life-Cycle class and a one-week Software class. Each attendee receives a complete set of reference material. Trainees learn how to develop the parametric data, and how to correct erratic inputs. Requests to be trained and to use the PRICE System should be cleared through your supervisor. Then call Ms. Geri Devlin, (609) 338-5215, PRICE Marketing, for enrollment details.

PRICE—an engineer's flexible tool

PRICE's flexibility, speed and economical use are available to RCA engineers who need it. Its accuracy can be determined by running the appropriate model, getting the estimated data and then comparing it to the actual results. Since so much of industry, especially our competitors, are PRICE users, it behooves all of us to use it for pricing our proposals.

PRICE is a viable, growing system. Give PRICE a call.

Mark Burmeister is the Director of RCA PRICE Systems. As Manager of operations, Mr. Burmeister was one of the founders of the PRICE organization in 1975. He later became Manager of PRICE Operations and Marketing, the position he held until his June 1980 appointment as Director. Prior to the formal organization of PRICE Systems as a separate business unit, he worked with the inventor of PRICE, Mr. Frank R. Freiman, in the first practical applications of the PRICE model. These applications served NASA and the U.S. Air Force in the Space Shuttle and B-1 programs.

From 1961 to 1971, Mr. Burmeister served in the Program Management Office on several major programs at RCA in Burlington, Massachusetts. From 1955 to 1961, he had various assignments throughout the United States with the RCA Service Company.

He was recipient of the 1970 David Sarnoff Medal for APOLLO Lunar Module efforts.

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R.E. Steinmeyer

Software from CISS for the engineering community

An extensive, varied software menu, fast efficient and economical service at two locations, and customer service facilities ensure that Corporate Information Systems and Services (CISS) aids the RCA business and scientific community.

Abstract: *The author lists CISS software programs and programming languages for telecommunications and computer services; engineering; math libraries; plotting utilities; data management and management. CISS training is also available.*

As today's pressures on the engineer become increasingly severe, the challenge is usually to make the product — satellite, radar, TV camera, LSI circuit — stronger, lighter and more efficient. At the same time, the engineer's productivity comes under even closer scrutiny.

At Corporate Information Systems and Services (CISS), we are aware of these problems. We offer to help you to a better solution — in a shorter time — at a more effective price, with data processing capabilities (or facilities) to enhance the productivity of the engineer.

The forerunner of CISS was formed in 1975 to service the major operating units of RCA in the area of information processing. The organization was a result of the Corporate Computer Study, which recommended that RCA take advantage of the economy of scale resulting from the pooling of computer equipment and related resources. As a result of that recommendation, a shared-computer facility was created in Cherry Hill to provide cost-effective computer service to the RCA business and scientific communities.

The Corporate Computer Center presently operates two sites — one in Cherry Hill, New Jersey, and the other in Somerville, New Jersey. The present hardware configuration includes three IBM 370/168s, one IBM 3033, an IBM 3032 and two Univac 90/80 processors. The two centers operate around the clock, seven days a week and can pass data to either site through the communication network (see Fig. 1). The IBM computers make use of both the Virtual Machine Facility/370 (VM 370) and the Multiple Virtual Storage (MVS) operating systems. The VM operating system is primarily used for time-sharing using the Conversational Monitor System (CMS). The MVS systems are used for batch, Time-Sharing Option (TSO) and Customer Information Control System (CICS) processing.

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Engineering

CSDP, the COSMAC Software Development Package, consists of a cross-assembler, a COSMAC simulator, and symbolic debugging facilities which provide an augmented means for developing and proving out programs to be used on COSMAC-based systems. A prime advantage of this system is that is saves considerable program development time because of the support provided by the time-sharing system in file management, storage, editing, and the like, and the support provided by the CSDP, its quick cross-assembler, its error-checking simulation, and its powerful debugging facilities. In addition, CSDP permits the use of extended mnemonics and D-sequences, and the rapid incorporation of changes in system specifications.

Programs developed with the aid of CSDP can be transferred to a hardware system such as CDS or the COSMAC Evaluation Kit for final system checkout.

CSDP was developed at RCA Solid StateDivision in Somerville, New Jersey.

CSMP III, the Continuous System Modeling Program, allows a digital simulation of continuous processes from models prepared directly from block diagrams or ordinary differential equations.

DYNA3 is a large finite-element structural analysis program developed by RCA Missile and Surface Radar. It incorporates much of the experience gained in 10 years of work with finite-element programs from various sources. The program has all of the basic capabilities of comparable commercial programs and also fulfills the specific needs of MSR static and dynamic structural analysis tasks. Its advantages over commercial programs are its convenient format and its adaptability to the requirements of a specific job. DYNAQ is the interactive version of this program.

DYNA3 is maintained and improved by its principal users, and in the course of performing special tasks, they incorporated many labor-saving routines not found elsewhere. It has a very powerful dynamics section that includes steady state, 3-D shock and random inputs. Its static section permits the analysis of various loads: line, area, spin, sway and *g* loads. A wind and ice load routine and a procedure for thermal analysis have been incorporated to greatly simplify the input effort

MIMIC is an interactive logic simulation program used for logic-design verification and test-pattern generation of large logic nets. The user specifies run options via an interactive command language. Network description is also used to generate artwork for LSI chips. MIMIC is available on CMS.

MOTHA, a general program written in FORTRAN IV developed by RCA Missile and Surface Radar, solves flow or thermal networks consisting of up to

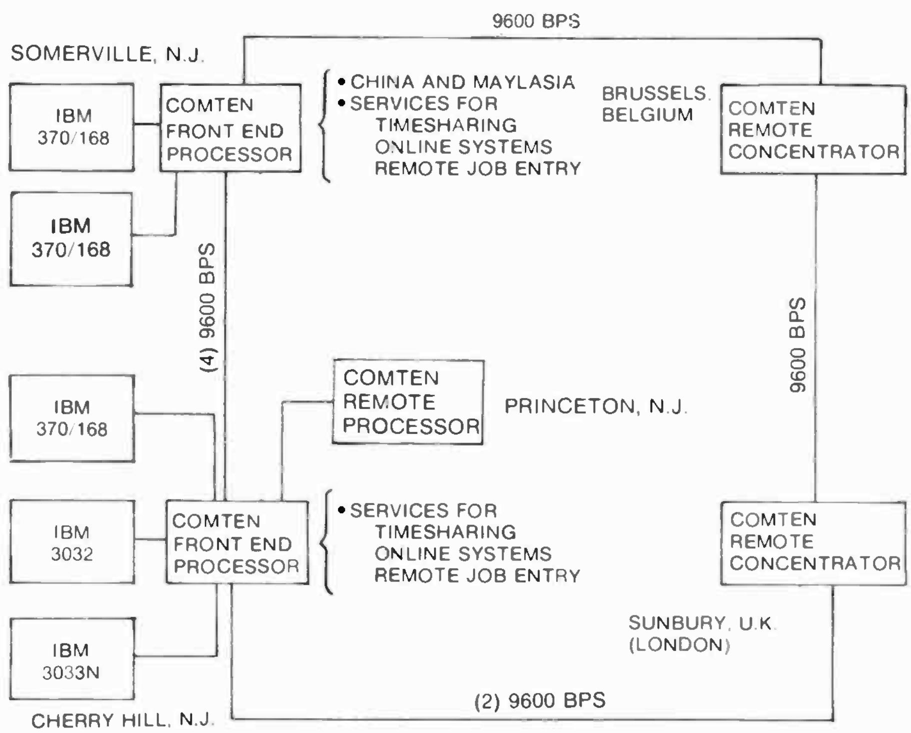


Fig. 1. Geographically dispersed customers can gain access to the IBM Computer Network through the COMTEN nodes.

Backup is provided in the case of any machine malfunctions or in the case of a disaster at either site.

The three IBM computers in Cherry Hill share five drum units and 150 disk drives. They also share 32 tape units and make use of three impact printers and two 3800 laser printing systems. The 3800 printing systems are each capable of printing 215 pages per minute.

The two IBM computers in Somerville share three drums, 78 disk drives and 24 tape units. There are three impact printers, one 3800 printing system and a microfiche unit.

The Univac computers in Cherry Hill share a drum, 22 disk drives, 12 tape drives and three line printers. The Univac computers can also access the 3800 printing systems in Cherry Hill.

The combined sites have well over 65-billion bytes of on-line storage available. They process over 6000 batch jobs per day, print more than 400-million lines of output each month and support approximately 2700 time-sharing users.

In addition to its extensive computing

400 nodes and 1200 resistors. For thermal analysis the resistors can be of the conductive, convective or radiative type, and may include one-way flow resistors.

The program has a number of input and output options, the latter including punched-card output, a plotting tape, and a map of final temperatures. Multiple runs may be made.

R-CAP is a circuit-simulation program that can analyze either the dc operating points, or the transient or small signal responses of bipolar and MOS transistor circuits. R-CAP uses highly efficient non-linear modeling techniques for bipolar transistors (extended Ebers-Moll) and COS/MOS transistors (including bulk charge, channel-length modulation and bias-dependent mobility effects).

R-CAP handles networks which contain any of the following components: linear resistors, capacitors and inductors, junction diodes, MOS and bipolar transistors.

R-CAP runs either batch or interactively on the computer. Its features are user-oriented and include pre-built models for bipolar and MOS transistors, and a free-format description and component command language. R-CAP was developed at RCA Solid State Technology Center in Somerville, New Jersey, and is supported by that organization.

SPICE2 is a general-purpose circuit-simulation program for non-linear dc, nonlinear transient, and linear ac analyses. Circuits may contain resistors, capacitors, inductors, mutual inductors, independent voltage and current sources, four types of dependent sources, transmission lines, and the four common semiconductor devices: diodes, BJTs, JFETs, and MOSFETs.

SPICE has built-in models for the semiconductor devices, and the user need specify only the pertinent model-parameter values. The model for the BJT is based on the integral charge model of Gummel and Poon; however, if the Gummel and Poon parameters are not specified, the model reduces to the simpler Ebers-Moll model. In either case, charge storage conductance may be included. The diode model can be used for either junction diodes or Schottky-barrier diodes. The JFET and MOSFET models are both based on the FET model of Shichman and Hodges.

Programming Languages

APL is an advanced interactive general-purpose language which facilitates development of concise programs in a short time using well-known mathematical symbols. It is

capacity. CISS provides numerous software packages designed to increase productivity. A text-processing capability, SCRIPT, has been used to significantly reduce proposal preparation time. The COSMAC Software Development Package has provided substantial reductions in development time for COSMAC-based systems. A user-friendly statistical package, SAS, has been used by both design and marketing groups for data management and statistical reporting. A versatile graphics package, DISSPLA, is presently providing displays of user data and, using the world mapping feature, provides maps of the continental coastline and political boundaries in any of 15 projections. Data-base management systems, such as FOCUS and RAMIS, have been used in areas such as quality control and research to provide rapid analysis of data. And MEMO, used to send and forward messages to one or more users of the VM/370 system, is providing immediate communication with London, Anchorage and Brussels, as well as numerous domestic locations. These, and other products discussed in this article, can substantially contribute to the productivity of the user.

Telecommunications and computer services

Corporate facility users are supported by the Telecommunications and Computer Services group (TACS). Through this organization a multitude of analytical and technical skills and services are available.

Within TACS, the Computer Customer Services organization is the focal point for all customer liaison. It is set up to be responsive to customer needs as well as to provide support to ensure customer saisfaction. The Customer Services organization provides a "hot-line" telephone number to ensure immediate response to customer requirements.

The Business Development organization seeks new and prospective users throughout the United States, Canada, and Europe. Business analysis and special studies provide prospective users with meaningful financial information and analysis of potential savings through use of the Corporate Computer Center.

TACS is responsible for providing the following services:

- *Education*. Education is available for the potential user, the current user, and management. During 1980, over 1100 student days of education were provided.
- *Publications*. Manuals and monthly newsletters keep the user technically current.
- *Conversions*. Conversion of major operating units to the CISS Center includes evaluation, planning, development of conversion tools, program conversion, and project management. Also, application development and programming manpower contracts are available to customers.

particularly strong in matrix operations. APL has a library of programs to aid in a very large number of applications.

ASSEMBLER is a low-level language with a one-to-one correspondence of assembler-language commands to machine-language commands, thereby making it more efficient than high-level languages.

BASIC, an interactive programming language, is designed for use in preparation, testing, execution, and debugging from a terminal. Data can be supplied from the program, the terminal, or external files. The CISS version, WATERLOO BASIC, features variable length names, the ability to store programs in compiled form, "structured programming" statement-types, and a substantial number of built-in functions.

COBOL is a high-level language particularly applicable to business applications.

FLECS is an extension of the FORTRAN language for use as a programming tool. It allows easier and more natural code as well as structured programming techniques, such as "do while."

FORTRAN is a high-level language especially useful in scientific and high-level mathematical applications. Both G1- and H-level compilers are available.

PASCAL is a general-purpose structured programming language designed for ease of learning and diverse machine compatibility.

PL/1 is a high-level language that combines the features of FORTRAN and COBOL. It is highly suited to either business or scientific applications, and in addition affords the advantages of "structured programming."

SPITBOL, a programming language with extremely powerful string manipulation capabilities, is a fast-compiler implementation of the SNOBOL-4 computer language. SPITBOL is very useful in the parsing of lines of information (strings) into their basic components, creating complex patterns and original data types. An example of this is the use of SPITBOL in compiler design.

TESTFORT is a FORTRAN interactive debug that permits the user to debug FORTRAN G1 programs using CMS (Conversational Monitor System) in a conversational manner. It consists of a set of subcommands that allow you to stop and start a program as it executes, to examine values of variables, change them, trace transfers, maintain frequencies, and control action for errors.

WATFIV is a programming language and fast FORTRAN compiler that has a one-pass load-and-go processor. WATFIV has string manipulation capabilities and is adaptable to structured programming techniques. WATFIV also provides extensive error diagnostics to help in debugging programs.

- *Technical Services*. Technical Services resolves customer questions, coordinates, and evaluates new software releases. Over 50 software products are available to aid in the application of computers to scientific, engineering, and business problems.
- *Business Teleprocessing Applications Services*. This function supports the user in an on-line transaction-oriented environment providing timely data access at user terminals.
- *Telecommunications Customer Services*. This group coordinates the resources of CISS and its vendors in providing telecommunication services to all RCA activities.

Even though it is impossible to list all the software available to the engineers within RCA, some of the more frequently used software is described in this article. There are many software programs available to the engineer which have been developed or obtained at various MOUs throughout RCA. The Technical Services organization is currently initiating a catalog of shared software. Contributions to the library that are of general use to the CISS-user community should be forwarded to your CISS representative. Technical Services will maintain this on-line catalog for access by all users. Your CISS representative, who may be reached through the Customer Services hot line (TACNET 222-6666), is a good place to start when trying to locate a particular software package or a general type of software.

On these pages we present a partial list of the software currently running on the computers in Cherry Hill and/or Somerville.

Training

To assist new users CISS offers training in the use of their computer systems and selected software products. For a schedule of current offerings contact your CISS Customer Representative at TACNET 222-6666. To register for class call TACNET 222-6400.

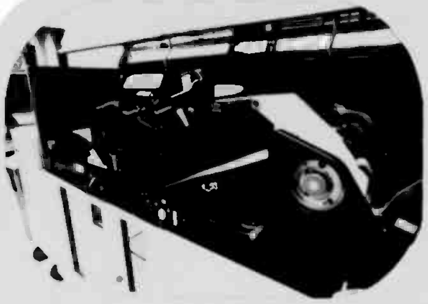
Classes are currently scheduled for the following products:

• VM/CMS	• APL
• EXEC	• CICS
• JCL	• IDMS
• SAS	• MVS Utilities
• FOCUS	• RAMIS
• BASIC	• SCRIPT

Other classes will be scheduled as necessary. Suggestions are gladly accepted.

In addition to our regular training, an overview of our hardware and software capabilities is available to be given at your location. If you are interested, call your CISS customer representative at TACNET 222-6666.

Through appropriate use of the computer facilities offered at RCA, an engineer or scientist can improve his productivity and expand his results.



Math Libraries

BMDP/BMD is a package of statistical and mathematical programs developed by UCLA.

IMSL, a library of subroutines that are applicable to engineering computations and statistics, is used by passing parameters from a calling routine.

NAG (Numerical Algorithmic Group), a package of scientific subroutines available on CMS, is written in FORTRAN and must be used by a calling routine that reads the input and prints the results. The NAG library covers such topics as quadrature, operations research, simultaneous linear equations, and matrix manipulations.

PRSL, a library for scientific and engineering computations developed at the RCA Laboratories, Princeton, New Jersey, provides FORTRAN subroutines and functions.

SAS, the Statistical Analysis System, is an easy to use statistical and data management package with report writing and graphing. It can handle a range of analyses from simple data reduction to nonparametrics and complex multivariate techniques. The econometrics routines give the extended capability of time series and smoothing techniques. SAS can be run in an interactive mode.

SLMATH is a collection of subroutines developed by IBM dealing with matrix algebra and numerical mathematics. These routines are input-output free and can be accessed by passing parameters from a calling routine.

TWODEPEP is a small, easy-to-use, finite-element program that solves a large class of elliptic, parabolic, and eigenvalue partial differential equation problems in general multidimensional regions.

Plotting Utilities

APL*PLUS PLOT is an APL-based system containing functions for obtaining graphic output at the terminal. Without the need for special graphics equipment, the user may control the scale, axes, limits, display size, plot-characters scale and annotation. The user may also choose histogram output.

CALCOMP is a series of callable routines which produce plots on any CALCOMP plotter using a 900-series controller.

DISSPLA, a versatile software system composed of FORTRAN subroutines, is called by the user's program. These routines are used to produce data displays for both business (bar charts, line charts, etc.) and scientific (maps, scatter diagrams, etc.) applications. DISSPLA is device-independent. It supports, among others, the Tektronix 4006, 4010, 4013, 4014, 4025, 4027 graphics terminals, the Tektronix 4662 and 4663 graphics plotters, the Hewlett Packard 7220 and 7221 graphics plotters, and various CALCOMP plotters. This is not an exhaustive list, but shows devices that have been used on our version of DISSPLA.

HP PLOT/21, a series of callable FORTRAN subroutines used to control plotting on the Hewlett-Packard model-7221 plotter, is designed to support a wide variety of applications, to provide a means of writing applications without extensive knowledge of the fundamental disciplines of the hardware and to provide flexibility to scale, orient and draw data.

PLOT-10, the name given to a series of graphics products produced by Tektronix, includes routines to generate software characters and symbols on a display screen, to preview routines for CALCOMP plotters and to do advanced graphing.

SAS/GRAPH is an interactive computer-graphics system for producing color plots, bar charts, graphs and other displays on screens and plotters. SAS/GRAPH programs are actually SAS procedures. All SAS retrieval, data management, analysis and other capabilities may be used with SAS/GRAPH. Data values are put into SAS data sets before SAS/GRAPH procedures use them.

TELL-A-GRAF is an interpretive "front-end" to DISSPLA. TELL-A-GRAF may be used by both programmers and non-programmers. It provides flexibility and ease-of-use through a system of overrides and options, to produce intricately tailored plots.

ZETA PLOT is a series of callable FORTRAN subroutines to control plotting on ZETA plotter models 30, 230, 1240, and 3640. This plotting capability is added by connecting a ZETA plotter to a terminal and coupler.

Data Managers

FOCUS is a comprehensive information-management system incorporating the facilities of a data-base-management system with

For information regarding RCA's computer systems, call:

Computer Customer Services
Cherry Hill, N.J.
TACNET 222-6666
(609) 338-6666

the retrieval and reporting facilities of a file-management system. Among its features are natural language query, pie-chart and bar graphs, interface to IDMS and APL, file encryption, and screen formatting.

IDMS is a data-base-management system based on current CODASYL specifications. It comes with a data dictionary capability, a full set of utilities, an on-line query language, a report writer and audit software. It interfaces with CICS, as well as with most high-level languages.

MARK-IV is a data-file-manipulation system that can facilitate the programming of almost any business data processing problem. It provides effective facilities for file and data-base creation, maintenance, information retrieval system implementation and report writing.

RAMIS is a comprehensive information management system that incorporates the facilities of a data-base-management system with the retrieval and reporting facilities of a file-management system.

Management Tools

ADRS II, A Departmental Reporting System, is an APL-based system containing functions for setting up, modifying, and printing column-oriented management reports. It provides a single comprehensive system to assist in applications involving data analysis, inquiry, and report generation.

GPSS-V is a simulation tool for modeling and examining the behavior of systems that are difficult to describe mathematically. Many applications have complex logical or procedure-oriented natures.

MEMO is a system which allows users of RCA's VM/370 system to exchange messages in a format similar to standard business memoranda. Features of the MEMO system include the ability to:

- Send messages to one or more users of the VM/370 system;
- Send "carbon copies" to users who would normally get them;
- Take the message input from the terminal or from a CMS file;
- Forward messages which you have received to other users; and
- Manage the contents of your private "mailbox."

The user's end of the MEMO system is the MEMO command, which is entered in CMS. It is designed to be logical and easy to use, and to assist the user by:

- Enabling the user to use MEMO effectively knowing only a small subset of the commands;
- Prompting for arguments which the user does not enter;
- Providing assistance whenever the user enters a question mark in response to a prompt;
- Allowing the user to "quit" at any time if he feels uncomfortable; and
- Having no effect on your virtual machine's global environment.

MIMS (Mitrol Industrial Management System) is a system to maximize manufacturing profit by providing accurate and timely information for decision making and control.

MSCS is a critical path program designed to handle planning, scheduling, and monitoring of complex projects. MSCS uses either PDM or ADM networks and produces a variety of calendar and scheduling reports.

SCRIPT/370 provides a text-processing capability that formats input files created by the CMS editor. SCRIPT can be used to produce letters, documents, manuals, proposals, and distribution lists. SCRIPT is very good for producing any document that is subject to revisions.

Ron Steinmeyer has been a member of the CISS TACS organization since 1977. He has served as an Account Representative for the GSD community and is presently the Manager of Technical Services in CISS. His responsibilities include the support of all user-related software and the service desk (hot-line) function for Customer Services.

Contact him at:

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W. Chu|R.E. Honig

On-line computerized literature search at RCA

Information is only as valuable as it is accessible. That's why RCA librarians are helping engineers and scientists throughout the company, using computer searching.

Abstract: *Today's information explosion makes it increasingly difficult to have access to and search the technical literature covering even a single topic. Such a task can no longer be achieved by manual means, but requires the assistance of a computer. The present article outlines the approach taken at RCA Laboratories to use on-line computerized literature searching in a cost- and manpower-effective mode. The authors present an example to illustrate how an appropriate strategy will produce ultimate success.*

Before embarking on a new project, or writing an article, you would do well to carry out a thorough literature search—Nobel Prizes are not handed out for reinventing the wheel. In the "old days" prior to 1976, following standard practice, you went to the library and consulted the appropriate abstracts, say Chemical Abstracts. You first looked up the desired subject matter in the most recent annual and five-year cumulative indexes, then listed all applicable entries by number, checked out each abstract one at a time, and finally copied out the pertinent information by hand (or else lugged the 10-pound tomes to the nearest Xerox machine). This procedure was painful and time-consuming even in 1950 when the total number of entries amounted to a mere 75,000. Compare this with a present annual harvest of about 450,000 entries, a sixfold increase during the past 30 years.

It is obvious that in today's world, an on-line computerized literature search is not only desirable, but is a must. A few test runs we made recently showed convincingly that the system is cost- and manpower-effective, but that success or failure depends on the initial choice of the keywords or descriptors and any subsequent modifications as needed. A typical computer search, such as the one shown in the "Results" section of this paper, produced 24 references printed on-line and 115 references, including abstracts, ordered off-line. It took about 10 minutes to run and cost under $40, which at first sight may appear high. But contrast this to a manual search made by a typical staff member at a cost, including overhead, of $40/hour—the staffer may end up with perhaps half a dozen pertinent entries in one hour, which is at least one order of magnitude below the computerized output rate.

Furthermore, a manual search depends on the availability of the abstracting journals, yet few libraries today can afford the considerable expense involved—the present annual subscription cost for Chemical Abstracts alone amounts to $5500, and its five-year cumulative index sells for a cool $9,000.

Background information

Computerized literature searching has been done for a number of years in the so-called "batch" mode, which especially interests those who wish to keep abreast of current technical developments. Several organizations offer this service on a subscription basis—for example, the Institute for Scientific Information (ISI) and the Aerospace Research Applications Center (ARAC). The subscriber selects appropriate descriptors and receives a periodic readout. The batch-mode system is basically non-interactive since changes can be made at most four times per year, and is no substitute for a fully interactive on-line search that exhaustively covers a given topic over a specific time period. The fully interactive search is the subject of this article.

We have already mentioned some of the advantages of the fully interactive on-line computerized search service. Technical staff members can save time. But the system also allows any library to function effectively without having to subscribe to a full complement of technical and abstracting journals.

On-line computerized literature-searching services are now available at 11 RCA locations. These are listed in Table I, together with the names and phone numbers of the librarians who are involved in carrying out the search. If your location does not yet have this facility, call Doris Hutchison, Manager, Technical Information Systems, Cherry Hill, New Jersey, (TACNET: 222-5412) for assistance.

Although interactive on-line computerized literature-searching systems existed in the 1960s, the first computerized search at RCA Laboratories was carried out in late 1976. Of the many systems available, two were selected in Princeton as the most suitable for our technical needs—Lockheed's "DIALOG", and Systems Development Corporation's (SDC) "ORBIT." In addition, Camden and Moorestown have Defense Technical Information Center's (DTIC) "DROLS" (Defense Research and Development Test and Evaluation On-Line System).

Well over 100 data bases or files covering all subjects are available. Some of these have been generated for on-line searching.

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Table I. RCA libraries providing computerized literature searching services.

Major operating unit	*Location*	*Librarian(s)*	*Phone*
Astro-Electronics	Princeton	Mary Pfann	229-2247
Automated Systems	Burlington	Veronica Hsu	326-3322
Consumer Electronics	Indianapolis-Sherman	Susan Tamer	422-5925
David Sarnoff Research Center	Princeton	Wendy Chu Larry Eubank	226-2608 226-2609
Government Communications Systems	Camden	Olive Whitehead Virginia Mattice	222-3488 222-4046
Missile and Surface Radar	Moorestown	Natalie Mamchur	224-3394
Research Laboratories	Tokyo	S. Mogi	
SelectaVision VideoDisc® Operations	Indianapolis-Rockville	Pennie Lumley	426-3397
Solid State Division	Findlay	John Platt	425-1502
Solid State Division	Lancaster	Mary Kathryn Noll	227-2220
Solid State Division	Somerville	Barbara McCoy	325-6017

Those of interest to technology and business researchers are listed by name in Table II, together with starting years and brief descriptions. Of the top five most important entries, four are available in hard-copy at Princeton, while the Engineering Index exists at Camden, Moorestown, and Burlington. But, many of the RCA libraries do not have access to any of the indexes except through computer searching, which again points out its usefulness. To date, the Princeton librarians have done a total of some 700 computerized searches for 187 individuals.

Procedure

The first step in starting a computerized search is to go to the library and talk to the librarian. The librarian may suggest you supply a charge number and fill out a form (Fig. 1) which elicits from you the information required to formulate the appropriate "strategy." This includes the choice of appropriate keywords, truncations, data bases, and the time period to be covered.

The success or failure of any search hinges on the proper selection and truncation of keywords.

What is the most effective approach? First, identify the technical subject the search is to cover. Then break up this subject into separate terms or groups of keywords with Boolean operators "and," "or," and "not."

Proper truncation of each keyword is

Table II. Data bases or files used in computerized searching.

Code or name	*Starting year*	*Description*
CA SEARCH	1967	Chemical Abstracts
INSPEC	1969	Science Abstracts
SCISEARCH	1974	Science Citation Index
NTIS	1964	Government Reports, Announcements and Index
COMPENDEX	1970	Engineering Index
CHEMNAME		Dictionary of Chemical Substances
CLAIMS/U.S. PATENTS	1971	U.S. Science and Engineering Patents
COMPREHENSIVE DISSERTATION ABSTRACTS	1861	U.S. Ph.D. dissertations, and some Canadian and foreign entries
ENERGYLINE	1971	Energy Information Abstracts
ISMEC	1973	Information Service in Mechanical Engineering
METADEX	1966	Metal Abstracts/Alloys Index (American Society for Metals)
NON-FERROUS METALS ABSTRACTS	1961	(British Non-Ferrous Metals Technology Centre)
RAPRA ABSTRACTS	1972	Rubber and Plastics Research Association Abstracts
SPIN	1975	Searchable Physics Information Notices (AIP)
SSIE CURRENT RESEARCH	1978	Smithsonian Science Information Exchange
SURFACE COATINGS ABSTRACTS	1976	(Paint Research Association of Great Britain)
WELDASEARCH	1967	(Welding Institute, England)
WORLD ALUMINUM ABSTRACTS	1968	(Aluminum Industry)
ABI/INFORM	1971	Business management and administration
DISCLOSURE	1977	Reports filed with U.S. Securities & Exchange Commission
EIS INDUSTRIES PLANTS	current	Current information on U.S. industrial plants
FROST & SULLIVAN DM^2	1975	Announcements of U.S. Government contract activities
PREDICASTS	1971	All phases of business and marketing

David Sarnoff Research Center, Library

On-Line Literature Search

Subject: Computer aided design of large scale integration

Keywords: (Include synonyms and acronyms; indicate truncations with "?" where necessary)

1. Computer aided design"?" or CAD
2. Large scale integrat"?" or LSI
3. Very large scale integrat"?" or VLSI
4. ______
5. ______
6. ______

Combine: 1 and 2 ; 1 and 3

Databases:

____ INSPEC (Science Abstracts)

____ CA Search (Chemical Abstracts)

_X_ COMPENDEX (Engineering Index)

____ SCISEARCH (Science Citation Index)

____ NTIS (Government Reports Announcements and Index)

Others: ______

Time Period Covered:

All __X__ Most Recent ______ (Specify Years)

Search Requested by: ______ Date: ______

Approved by: ______

Charge to Section: ______, S.O. # ______

Fig. 1. A typical form, to be filled out after discussion with the librarian, is simple to follow.

Boolean Operators

The Boolean operators AND, OR, and NOT are like intersection, union and negation in elementary set theory. These logical operators act on, or connect, two concepts or sets.

The OR operator enlarges the number of citations included in a search. By combining concept $_1$ OR concept $_2$ we get a set with all, and only, those citations relating to concept $_1$ or concept $_2$ or both. This new union set generally contains more citations than either concept holds alone.

By combining concept $_1$ AND concept $_2$ we get a set with only those citations relating to both concept $_1$ and concept $_2$. The resultant intersection set will contain less than the number of citations for either concept alone.

The NOT operator also tends to diminish the number of citations selected. Combining concept $_1$ and NOT concept $_2$, we get a set that contains those citations relating to concept $_1$ but not to concept $_2$. This is a partial negative intersection.

Combinations of the elementary Boolean operators can reach any level of complexity desired.

Numbered callouts are explained on page 38, column 3.

```
     BEGIN 8
              19JAN81 16:23:06 USER2635
     $0.41    0.006 HRS FILE8
     $0.03    TELENET
     $0.44    ESTIMATED TOTAL COST                                  (1)
   FILE8:COMPENDEX - 70-80/DEC                                      (2)
   (COPR. ENGINEERING INDEX INC.)
              SET ITEMS DESCRIPTION (+=OR;*=AND;-=NOT)
              --- ----- ------------------------------
   ? SELECT COMPUTER(W)AIDED(W)DESIGN? ? OR CAD                     (3)
                       4137 COMPUTER(W)AIDED(W)DESIGN? ?
                        507 CAD
                  1   4273  COMPUTER(W)AIDED(W)DESIGN? ? OR CAD
   ? SELECT LARGE(W)SCALE(W)INTEGRAT? OR LSI                        (4)
                       1467 LARGE(W)SCALE(W)INTEGRAT?
                       1717 LSI
                  2   2391  LARGE(W)SCALE(W)INTEGRAT? OR LSI
   ? COMBINE 1 AND 2
                  3    134  1 AND 2                                 (5)
   ? SELECT VERY(W)LARGE(W)SCALE(W)INTEGRAT? OR VLSI                (6)
                         76 VERY(W)LARGE(W)SCALE(W)INTEGRAT?
                        255 VLSI
                  4    292  VERY(W)LARGE(W)SCALE(W)INTEGRAT? OR VLSI
   ? COMBINE 1 AND 4
                  5     24  1 AND 4                                 (7)
   ? COMBINE 3 NOT 5
                  6    115  3 NOT 5
   ? PRINT 6/5/1-115                                                (9)
   PRINTED6/5/1-115
   ? TYPE 5/3/1-24                                                  (8)
   5/3/1
     1091201    ID NO.- EI801291201
     HIERARCHICAL APPROACH TO VLSI LAYOUT.
     FREAS, S. T.; SLUTZ, E. A.; VAN CLEEMPUT, W. M.
     SANDIA LAB, ALBUQUERQUE, NM
     DIG PAP IEEE COMPUT SOC INT CONF 20TH, COMPCON SPRING 80, VLSI: NEW
   ARCHIT HORIZ, SAN FRANCISCO, CALIF, FEB 25-28 1980.  PUBL BY IEEE (CAT N
   80CH1491-0 C), PISCATAWAY, NJ, 1980 P 156-159   CODEN: DCSIDU
   ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   ? LOGOFF
              19JAN81 16:33:15 USER2635
    $11.63    0.171 HRS FILE8 12 DESCRIPTORS                        (10)
     $0.86    TELENET
     $1.20    24 TYPES
    $23.00    115 PRINTS
    $36.69    ESTIMATED TOTAL COST                                  (11)
```

Fig. 2. Typical output from an on-line search shows how an appropriate strategy will produce successful results.

important because it enables you to retrieve all possible variants based on a given root system. For example, "librar?" will include "library," "libraries," "librarian," etc. Remember to also include all applicable synonyms and acronyms. Remember, your librarian is not a specialist in your own field and will need your assistance in developing the most effective strategy.

Once the strategy has been defined, the appropriate information is entered via a terminal into the computer. The most effective approach is for the requester to be present at the search to take full advantage of the interactive capability of the on-line system. A printout of the number of entries (on which cost estimates can be based) and the first few references help determine the validity of the keyword choice. If the references retrieved are not fully relevant, keywords may be added, deleted, or modified at any stage of the run by trying different words and/or combinations. Also, depending on the data base used, different limits may be imposed, such as: searching by title only; by subject heading only; over a specific time period; in a given language; and including or excluding patents. The volume of entries will determine whether the remainder of the run is done on-line (fast, but expensive) or off-line. In the latter mode, results are available within a few days and, for some data bases, can be supplied with full abstracts. The full output should be examined to establish whether further keyword changes are desirable.

So far, we have discussed only searches based on keywords. In addition, the following alternative access points are available: authors; corporate sources; journal titles; and report or contract numbers. Finally, we should mention the Selective Dissemination of Information (SDI) system which stores the search profile and updates the file automatically.

Results

In this section, we present a typical on-line search (Fig. 2) with numbered callouts covering the topic "Computer-Aided Design of Large-Scale Integrated Circuits," using the COMPENDEX (1) data base for the period 1970 to the present (2).

When the keyword groups "Computer-Aided Design?" (3) and "Large Scale Integrat?" (4), together with their acronyms,

User Comments

On several occasions I have used our library's computerized literature search and I found it very efficient in producing the information I needed. Knowing the author's name, I could find not only the one paper I was looking for, but also the related work that I was not aware of. Asking for papers on a specific topic, I had quick access to far more references than I could have found in bound indexes. The computerized literature search is a great time saver and a powerful helper.

J. Pankove
Fellow Technical Staff
RCA Laboratories
Princeton, N.J.

I have used the RCA Library computerized literature search in my research on crystal growth and semiconductor lasers and have found it to be an extremely efficient and time-saving system. Over the past years, I have written two review chapters on this work and have used the search to help insure that I did not overlook any major paper in the field. I also have periodic searches performed on "Indium Gallium Arsenic Phosphorus" alloys (the material employed in our newest lasers, LEDs and photodectors) to keep up-to-date with the literature. So many articles are published on this topic that it is almost impossible to stay current by scanning individual journals.

G.H. Olsen
Member Technical Staff
RCA Laboratories
Princeton, N.J.

The computerized search you performed for publications relating to (pocket) pagers turned up some fifty abstracts of recent articles. Although some were not of interest to me, as was to be expected, a few were exactly what I had hoped to find. Your search saved me several hours of manual searching and covered many sources that would not have been available to me.

H. Christoffersen
Director
Patent Analysis
Patent Operations
Princeton, N.J.

Computer retrieval is a boon to a small library, such as ours here in Japan, which does not have the large number of readily accessible journals found in large centralized libraries.

E.O. Johnson
Director
Research Laboratories, Inc.
Tokyo, Japan

During a long stay at RCA Laboratories in Princeton, New Jersey, I had the opportunity to use the DIALOG system for searching literature. At that time I was entering a new field in research. Using DIALOG with a minimum effort, I could access all the basic literature to get me started. Now as I am back at the RCA Laboratories in Zurich, Switzerland, I can only hope that we will have access to the system one day not too far in the future.

Karl Knop
Member Technical Staff
Laboratories RCA Ltd.
Zurich, Switzerland

were entered, the computer produced 134 entries (5). At this point, we decided to narrow the search by modifying the second group to "Very Large Scale Integrat?" (6) which netted 24 entries (7). These were typed on-line (8), while off-line prints were ordered for the remainder. The on-line run took 10 minutes and 16 seconds (10), and the total charge amounted to $36.69 (11), which includes the off-line prints. The on-line computer output, including the first reference printout, is reproduced in Fig. 2. One of the off-line entries, complete with abstract, is reproduced in Fig. 3.

```
  1085815    ID NO.- EI801185819
  COMPUTER-AIDED  CCD/LSI  PHOTOMASK  LAYOUT AND DOCUMENTATION
TECHNIQUE USING NESTED CELLS.
  Geer, Ronald G.
  R&D Gear Inc  Lawndale, Calif
  Solid State Technol  v 23 n 5  May  1980  p  86-90   CODEN:
SSTEAP
  ISSN 0038-111X
  A comprehensive computer-aided mask layout and documentation
technique  has  been developed which simplifies the conversion
of  Charge-Coupled  Device  (CCD)/LSI  circuits  into  working
photomasks. This flexible approach facilitates the creation of
high-density  cell  layouts  through the use of a standardized
nested cell building  block  library.   It  is  an  efficient
solution  to  the  unique problem of interconnecting pipelined
CCD circuitry.  The nested cell concept permits the  designer
to   quickly   generate   complex   layouts   and   associated
documentation using easily drawn symbols which can be directly
digitized into computer memory.   Demonstrations  have  shown
that  this  technique reduces the overall die design time by a
factor of three,  permitting additional time to be devoted  to
the circuit design and check effort.  2 refs.
  DESCRIPTORS:    (*SEMICONDUCTOR  DEVICES,   CHARGE   COUPLED,
   *Computer Aided Design).
  CARD ALERT: 714, 723
```

Fig. 3. Typical off-line entry, complete with abstract.

Conclusions

On-line computerized literature searching is a professional tool of great intrinsic value. Quite a few staff members do agree, as brought out by their volunteered comments (see sidebar). The computerized search is cost- and manpower-effective and will, when properly executed, produce literature surveys far more complete than those produced by manual means. But, the success of a computerized search does depend critically on the instructions the thinking staff member gives to the computer which has a fabulous memory, but no brain.

Rick Honig is Group Head, Materials Characterization and Research, RCA Laboratories. Since 1950 when he joined RCA Laboratories, he has been engaged in solid state research, including the analysis of solids by mass spectrometry, vaporization studies of Group 4B elements and the sputtering of surfaces by low-energy positive ions. He has published over 50 papers in the fields of mass spectrometry, ion physics, and ultrahigh vacuum. He has been in charge of the Materials Characterization Group at RCA Laboratories since 1966.

Contact him at:
RCA Laboratories
Princeton, N.J.
TACNET: 226-3241

Wendy Chu is Manager, Library Services, RCA David Sarnoff Research Center. She joined RCA in 1974 after holding several positions in local, state and industrial libraries. She is a member of the American Library Association, the Chinese American Librarians Association, and the American Society for Information Science and she is on the program committee of the Special Libraries Association. She was chairperson of the Positive Action Program for Minority Groups, Princeton/Trenton chapter.

Contact her at:
RCA Laboratories
Princeton, N.J.
TACNET: 226-2608

H.K. Jenny

Personal computers pervading RCA's engineering population

And within ten years, every engineer may have one to replace his calculator.

Abstract: *There is a substantial ownership of personal computers among RCA's engineering population. Many different uses are being pursued, but overriding all applications appears to be the educational aspects of familiarization with operating computer hardware and software. This report shows the types of systems owned, their uses and some characteristics of the user population. It also covers participation in users groups and recommendations for support. The growing computer literacy and its potential effects on RCA are touched on.*

At the 1979 Advisory Board meeting of the *RCA Engineer,* several of the Chief Engineers, who are also Advisory Board members, recommended that a determination be made as to how many RCA engineers were involved in off-the-job personal computer usage. A questionnaire was inserted in the May 1980 issue of TREND and, to date, 223 replies have been received. It is not known how many owners of personal computers have not replied. From comments received, it appears that the number of personal computer owners will be growing substantially.

This report reviews the survey returns and, hopefully, will serve to "cross communicate," to help establish connections to user groups, and to stimulate added support, recognition and use of the specific skills of personal computer users.

What kind of personal computers are owned?

The answers ranged from programmable calculators and microtutors to complete systems containing disks and printers. Also, some respondents own several systems. In percentage of total, arranged in frequency of ownership, we find:

36%	RCA Cosmac VIP	5%	Commodore PET
20%	Radio Shack TRS-80	3%	Motorola 6800
9%	Apple II	3%	Ohio Scientific C4PMF
7%	Kim - I	3%	Heath H89
5%	"Home Brew"	2%	Digital Group, Inc.

Also, we find one or two of: T199/4, Bally, Explorer 85, Vytec 1400, Southwest Tech. Products, 6502, AIM65, Intelligent Systems Corp., Sorcerer, North Star Horizon, CDP 18S711, Cromenco Z80, DATAC 1000, SOL, Altair 8800, Imsai 8080, SDK 85. Table I shows the distribution of personal computers reported by respondents' business unit and location.

What is the major use made of these computers?

The following responses were received in the categories offered (most respondents checked more than one):

- 85% for educational purposes (50% self; 35% family)
- 70% to learn about computers
- 64% for entertainment
- 53% to learn about computer languages
- 38% for scientific/technical projects
- 26% for home management projects
- 17% for home controls/security
- 12% for small business use

This provides a fairly clear indication that learning represents a prime incentive for acquiring a personal computer.

Engineering personnel are usually rather frugal in the use of their time and money, and when they get involved in projects, they are very result-oriented. There are numerous indications that the results of the cited learning have found direct application to the respondent's job. For instance, hardware engineers have indicated that personal computer activity has provided them some needed software education.

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What has been achieved with personal computers?

It appears that much of the personal computer effort is directed at answering the following questions:

- How does the computer work and how do I operate it?
- What constitutes a system and how do I get the pieces to work together?
- How can I latch computers to other subsystems and systems?
- What languages, from assembly to high-level languages (and there are many), can I learn?

What this means is that much learning has been achieved in assembly, interfacing, debugging of equipment and working knowledge of languages. Many respondents are proud of their "home brew" achievements, others of their early programming successes, and yet others are into rather sophisticated systems and applications. Here are some of the specific applications that have been pursued:

VIP *(SSD-14; GCS-13; Labs-8; AS, Broadcast, PTD, CE-6 each; MSR-4; Service Co., Staff-2 each; Americom, AE, Globcom, VideoDisc-1 each)*

Music synthesis; teaching aid; Morse code keyer; interfacing with home heating system; Morse code teaching device; burglar alarm, remote TV control; math problems; automotive cruise control; water sprinkler timer and zone control; home environment monitor; word processing; use as terminal; automatic phone dialer for security system; time clock/stop watch for event/time logging.

A display at Moorestown advertised the activities of the Microcomputer Club of RCA, Moorestown.

TRS-80 *(MSR-8; GCS-6; AS-5; Labs, SSD-3; CE, Service Company, PTD, VideoDisc-2 each; Globcom, Americom, AE, NBC, Patents, Staff-1 each)*

Stock analysis program; regression programs; ham radio; access to micronet time sharing system; develop software for small

Table I. Types of respondents' systems by location.

Location	VIP	TRS 80	APPLE II	Comm. PET	Ohio Sci.	Motor. 6800	Heath H98	SOL	IMSAI 8080	DATAC 1000	Altair	Digital Group	KIM	Other	Total
Bloom.	2													2	4
Burl.	6	4					1						2	2	15
Calif.		1													1
Camden	19	8	4	5			2			2			2	6	48
Cherry Hill	3		1			1									5
Findlay	1														1
Indianap.	5	4	3	1	2	1								1	17
Lancaster	11	3	1			1								2	18
Marion	1		1				1						1		4
Mrstown.	4	8		1	1				1		1	2	4		22
Mountain.	2														2
N.Y.	1	1							1						3
Princeton	8	5	3	1	1	1	1		1					1	22
Scranton	1		1												2
Somerville	5	1			1								1	1	9
Staff and Others	8	5	5	1	1	4	1	2				2	4		33
															206

Sampling of Popular Microsystems

Note that all the following products are 8-bit (single-character) machines unless otherwise indicated.

Model	*Standard features*	*Price (basic configuration)*	*Options*	*Vendor*
ACI-90	16-bit Pascal computer, 64K main memory, 2 floppy disks	$5,695-$6,550 dep. on configuration		**Associated Computer** 17751 Sky Park E Irvine, CA 92714 (714) 557-0560
Alpha Micro/ AM-1010 Business System	16-bit computer, 64K main memory, 2 floppy disks	$12-15,000, dep. on configuration	Hard disks, line printers, communications	**Alpha Micro Systems** 17881 Sky Park N. Irvine, CA 92714 (714) 957-1404
APF Imagination Machine	9K main memory, 8-color crt, cassette tape deck	$599	Add'l 8K main memory, mini-floppy-disk modem	**APF Electronics, Inc.** 1501 Broadway New York, NY (800) 223-1264
Apple III'	96K main memory mini-floppy 12" crt, Keyboard, interface	$4,240	128K main memory, printer, 3 add'l. mini-floppies	**Apple Computer, Inc.** 10260 Bandley Dr. Cupertino, CA 95014 (408) 996-1010
Atari 800	Main memory expandableto 48K integral keyboard	Without peripherals, $1,080; with peripherals, to $5,000	Crt, minifloppy	**Atari, Inc.** 1346 Bordeaux Dr. Sunnyvale, CA 94086 (800) 672-1404
Commodore PET CBM 8032	32K main memory, 2 minifloppy disk drives, 9" crt, keyboard	$1,795	Printers, communications	**Commodore International** 950 Rittenhouse Rd. Norristown, PA 19403 (215) 666-7950
Computer Devices Model 1206	An intelligent portable terminal can be used as a desk-top	$5,386 in basic configuration	Up to 4 diskettes	**Computer Devices, Inc.** 25 North Ave. Burlington, MA 01803 (800) 225-1229
Cromemco Z2H	64K main memory expandable to 512K; minifloppies 11M-byte disk	$9,995	Crt, printer, additional hard-disk capacity	**Cromemco, Inc.** 280 Bernardo Ave. Mountain View, CA 94043 (415) 964-7400
DEC Datasystem 208	65K main memory, crt, 2 minifloppies printer, keyboard	Under $5,000	Terminals, hard disk, added floppy disks, communications	**Digital Equipment Corp.** Continental Blvd. Merrimack NH 03054 (603) 884-5111
Digi-Log System 1000	32K main memory 2 minifloppies, 12" crt, keyboard	$5,495	64K main memory, add'l. communications	**Digi-Log Systems, Inc.** Babylon Rd. Horsham, PA 19044 (215) 672-0800
Durango F-85	64K main memory, 2 floppy disks, printer	$11,975 complete	Hard disk	**Durango Systems** 3003 N. 1st St. San Jose, CA 95134 (408) 946-5000
Gnat-10	64K main memory 2 floppy disks, compl. business system	$5,950	Floating-point processor	**Gnat Computers** 7895 Convoy Ct., Bldg. 6 San Diego, CA 92111 (714) 560-0433
Heath H-89 All-in-One	Up to 48K main memory, crt, keyboard, single minifloppy	In kit form, $1,695; wired (from Zenith), $2,895	2 more mini-floppy disks, printers, communications	**Heath Co.** Benton Harbor, MI 49022 (616) 982-3285
Hewlett-Packard HP-85	16K main memory, 5" crt, keyboard, printer	$3,250	Floppy disks, 32K main memory	**Hewlett-Packard Co.** 1000 N.E. Circle Blvd. Corvallis, OR 97330 (503) 757-2000
IBM Model 5120	64K main memory, 2 floppies 12" crt	From $9,340 to $23,990, dep. on memory, peripherals	Printers, built-in sorting for files	**IBM GSD** 4111 Northside Pkway. Atlanta, GA 30301 (404) 238-3000

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Model	Standard features	Price (basic configuration)	Options	Vendor
Intelligent Systems Model 3650	16K, main memory, crt with 8-colors, minidisk with 92K memory, keyboard	$2,495 complete		**Intelligent Systems Corp.** 225 Technology Park Norcross, GA 30092 (404) 449-5961
Micromation Z+	65K main memory, 2 floppy disks	$5,500	Multi-user syst., multi-processors, hard disks	**Micromation** 1620 Montgomery St. San Francisco, CA 94111 (415) 398-0289
Minimax	108K main memory, 2 floppy disks	$7,700		**Computhink,** 965 W. Maude Sunnyvale, CA 94086 (408) 245-4033
North Star/ Horizon computers	64K main memory	$2,700 to $4,400 for basic cpu	Minifloppy disks hard disks, crts, printers	**North Star Computers** 1440 Fourth St. Berkeley, CA 94710 (415) 527-6950
Ohio Scientific/ Challenger C3-OEM	48K main memory, 2 floppy disks, integral	$3,995 stripped	Hard disks, printers, terminals	**Ohio Scientific, Inc.** 1333 S. Chillicothe Rd. Aurora, OH 44202 (800) 321-6850
Onyx C8001	64K main memory, 10- or 20M-byte disk, cartridge	About $11,000		**Onyx Systems, Inc.** 73 E. Trimble Rd. San Jose, CA 95131 (408) 946-6330
Quay 500	64K main memory, diskettes	$3,000	Hard-disk multi-user system	**Quay Corp.,** P.O. Box 386 Freehold, NJ 07728 (201) 681-8700
Radio Shack/ TRS-80 Model II	64K main memory, 1 floppy disk, crt	$3,899		**Radio Shack** 900 2 Tandy Ctr. Fort Worth, TX 76102 (800) 433-1679
Sharp Micromini	64K main memory, 2 floppies, printer, crt, keyboard	Under $6,000 complete	128K main memory, addi-	**Sharp Electronics Corp.** 10 Keystone Pl. Paramus, NJ 07652 (201) 265-5600
Smoke Signal/ Chieftan 9822	32K main memory double-sided, 2 floppy disks	$4,675 complete	32M-byte hard disk	**Smoke Signal** 31336 Via Colinas Westlake Village, CA 91362 (213) 889-9340
SWT	56K main memory, 2 floppy disks, crt	$5,100	128K main memory, hard disk	**Southwest Technical** 219 W. Rhapsody San Antonio, TX 78216 (512) 344-0241
Tektronix 4052	32K main memory, 11" crt, key-board	About $9,800, dep. on memory and peripherals	Data-comm inter-faces, up to 64K main memory, plotters, printers, storage devices	**Tektronix, Inc.** P.O. Box 500 Beaverton, OR 97077 (800) 547-1512
Vector Graphics/ VIP (Vector Intelligent Partner)	Crt, single disk drive, integral	$3,995 complete	Qume Sprint III printer	**Vector Graphics, Inc.** 31364 Via Colinas Westlake Village, CA 91361 (213) 991-2302
Xerox-Diablo 3000	48K main memory, 2 floppy disks, 12" crt	$14,000-$30,000, dep. on memory, peripherals	Printers, added terminals, com-munications	**Shasta General Systems** 1329 Moffett Park Dr. Sunnyvale CA 94086 (800) 538-8718
Wang 2200 SVP	32K main memory expand-able to 64K; diskette, crt, printer	About $6,000	4M-byte disk, printer graphics ter-minal, add'l disk	**Wang Laboratories, Inc.** 3 Industrial Ave. Lowell, MA 01851 (617) 459-5000
Zilog Model 249	64K main memory, 2 floppy disks, 11" crt	$9,500 complete	2 additional disk drives, capa-bility for hard disk	**Zilog, Inc.** 10411 Bubb Rd. Cupertino, CA 95014 (408) 446-4666

An interest group called the VIPers. Technical support and a newsletter are advantages of membership.

business (records and payroll); data handling and analysis; sales analysis; amateur TTY + CW; auto satellite tracking; personal schedules; reading and language learning; word processing; computation; computer language translation; personal finance management; learning for kids; log drawings; work schedule of groups; design aid; home management control; security; energy saving; games; home record management; word processing for letters and reports; stock market (performance of covered options); text editing (advanced); business modelling for long range planning; color graphics and animation; income tax; school grading; stock forecasting.

Commodore PET *(Broadcast-2; Labs, MSR, Service Co.-1 each)*

Teach, test and grade students; use in college masters program; payroll; inventory control; membership/mailing lists; accounts receivable; stock market data; small scientific programs.

Attention: TRS-80 Users

The results of a survey in TREND showed a large number of TRS-80 owners among RCA's personal computer users. These owners voiced a strong interest in exchanging programs. As a result, a Corporate TRS-80 Users Group has been formed with the purpose of, initially, providing a means for program exchange and, later, offering other services.

If you are interested in this activity, contact the organizer:

George E. Haas
TRS-80 Users Group
RCA Laboratories, W-238B
P.O. Box 432
Princeton, NJ 08540
TACNET: 226-2491

He will mail you membership and software information.

Apple II *(Service Company-4; GCS, CE-3; Labs, PTD-2; AS-1)*

Graphics games; cross assembler; investment decisions; Morse code translator; text editor; precision math (π to 7,000 digits); analyze communication theory problems; personal finance management; word processing; more efficient data manipulation (200-fold improvement in time over manual); handle quality data; plot numerical data; analyze data; games; spacecraft attitude motion simulation; color graphics and animation.

Motorola 6800 *(Service Co.-2; Labs, PTD, VideoDisc-1 each)*

Interconnect several systems; play music; Morse code keyer; home CMS terminal.

Kim - 1 *(Labs, AS, PTD, Broadcast-1 each)*

Chess programming; ham radio; robotics; music.

Digital Group, Inc. *(MSR, Service Co.-2 each)*

Home finance control; astrology and planetary programs.

Ohio Scientific *(CE-2; AS, MSR, Service Co., SSD-1 each)*

Statistics; home management; voltmeter; video graphics for automotive interface.

Altair *(MSR, SSD-1)*

Stock analysis; recoup acquisition cost through various small software jobs.

Imsai 8080 *(AE, MSR-1 each)*

Text processing; home accounting; color graphics; games.

Intelligent Systems Corp. *(SSD-1)*

Word processing; games; finance; elaborate graphics.

Southwest Tech. Products Corp. *(Service Co.-1)*

Home heating air conditioning control; checkbook; text editing; use as terminal to access computer networks.

What are the characteristics of the RCA personal computer user?

Following is a cross-sectional view of some respondent characteristics. We can compare the various distributions of this survey with that of the 3000 engineers who responded to our Engineering Information Survey conducted in 1977. All figures represent percentage of total respondents.

Age Distribution (years)	*Personal Computer Survey*	*Engrg. Info. Survey*
Under 21	1%	1%
21 - 30	16%	11%
31 - 40	24%	24%
41 - 0	30%	36%
51 - 60	26%	25%
Over 60	3%	3%

The age distribution of personal computer users approximates the total engineering population.

Educational Level	*Personal Computer Survey*	*Engrg. Info. Survey*
Non Degree	27%	13%
B.S.	44%	49%
M.S.	25%	31%
Ph.D.	4%	6%

More than twice the percentage of non-degree respondents are involved with personal computers. This is because technicians (and several other non-engineering occupations) are involved with personal computers but did not participate in the Engineering Information Survey.

Major Field of Highest Degree	*Personal Computer Survey*	*Engrg. Info. Survey*
Electrical Engineering	50%	56%
Computer Science	8%	2%
Physics	8%	11%
Mechanical Engineering	4%	13%
Mathematics	4%	4%
Chemistry	1%	5%
Others	25%	9%

Computer scientists are higher, mechanical engineers and chemists are lower users than their representation in the engineering population.

Job Classification	*Personal Computer Survey*	*Engrg. Info. Survey*
Engineer	71%	75%
Leader or first level supervisor	12%	15%
Manager above first level	17%	10%

It is interesting to note the much greater involvement of managers above first level. Some of the more mature managers who have not had computer-related educational experience are using the personal computer as a vehicle to get oriented and acquire a computer-working capability, particularly in software.

About one-fifth of the personal computer survey respondents are in job classifications other than engineers and engineering supervisors.

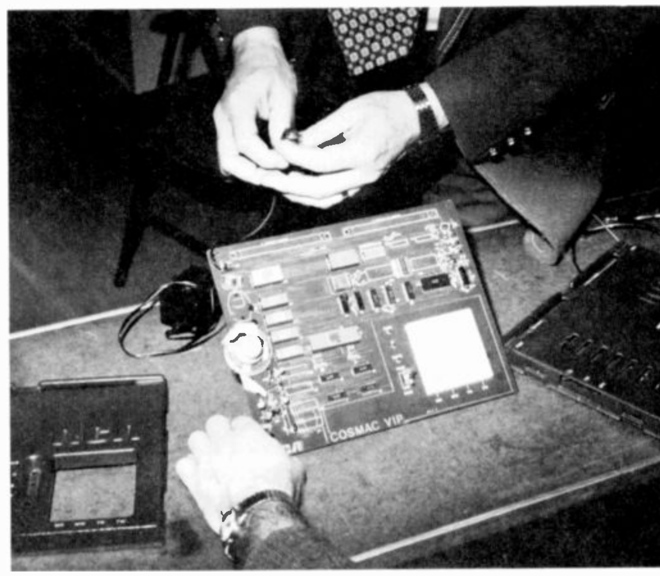
How do the respondents cross communicate?

Thirty percent of the respondents are members of established user groups and fifty percent feel a need for a local user group.

User Groups Attended by Respondents

Plant user groups are active at:

Moorestown — MSR Computer Club
For information: George Poletti, ext. 3802
Camden — Informal Users Group
Meets Mondays 12:00 in 10-2 conference room
For information: A.B. Kaiser, ext. 3495



Checking out a COSMAC.

System Dedicated Groups:

1802 Users Group
TRS-80 Users Group (local chapters — Cherry Hill/Eastern Massachusetts)
6502 Users Group
Heath Users Group
PET Users Group
PPC (HP personal programmable users group — local chapters)
Apple Puget Sound Program Library Exchange, Seattle, Washington
Melbourne Apple Core (FL)
Cromenco Users Group
North Star Software Exchange

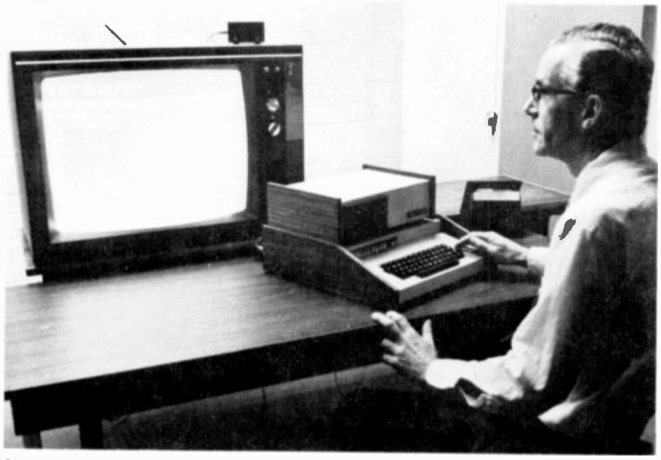
Language Users Groups:

PUG Pascal Users Group
FIG Forth Interest Group

Microcomputer education soars

Nearly 60 percent of the 1,614 participants in RCA Corporate Engineering Education (CEE) classes in 1980 chose the following courses in microcomputers and in programming techniques "C51: Microcomputer Fundamentals" was the most popular CEE course, with 294 enrollees, followed closely by "CL51: Microcomputer Fundamental Laboratory Exercises" at 179 and "C70/CL70: Programming Techniques" at 102.

The demand clearly shows that interest in microcomputers and their applications runs high among RCA's technical staff. Of the 68 course-packages available during 1980, eight accounted for 66 percent of the enrollment. And six of these most popular courses offer microcomputer or software training.



A personal computer with color graphics capability is used for educational, financial and home accounting applications.

Geographical User Groups:

- New England Computer Society
- ACG N.J. Amateur Computer Group of N.J.
- Computer Club of N.J.
- Valley Computer Club
- NE Penna. Computer Club
- University Pioneer Computer Club (Scranton, Pa.)
- Space Coast Microcomputer Club (FL)
- PACS (Phila. Area Computer Society)

According to the survey, local user groups are not too well publicized and there is additional potential membership of: 20 at Camden; and 10 each at Moorestown, Princeton, Indianapolis, Somerville, Lancaster, and Burlington.

Respondent recommendations

Following are direct respondent quotations regarding desired support of personal computer effort:

"An RCA-sponsored software library, in HP or Level II Radio Shack BASIC, on paper and cassette, would generate additional interest and spread the usefulness of personal systems throughout the Company."

New interactive terminal from RCA

RCA MicroComputer Products' new VP-3303 interactive data terminal handles a wide variety of industrial, educational, business, and individual applications requiring interactive communication between computer and user. At $389, the microprocessor-controlled terminal, with color graphics, reverse video, programmable and resident character sets, selectable baud rates and data formats, a built-in RF modulator and a light-touch, flexible-membrane keyboard with finger-positioning overlay and aural feedback, will be a welcome addition to the microcomputing population. The terminal can interconnect via standard RS-232 modems for communication across telephone lines. The VP-3303 is compatible with most time-sharing and database computer networks such as those provided by CompuServe Information Services and Source Telecomputing Corporation.

For more information, call or write:

MicroComputer Products
Electro-optics and Devices
New Holland Avenue
Lancaster, PA 17604
TACNET: 227-7661

"I feel a need for much more software support from RCA. The non-availability of educational software for the VIP is particularly frustrating."

"I would like to see software and other computer equipment available through RCA family stores at discount. While it may not be feasible to stock such items, a catalog could be available for ordering items via family store manager."

"Since RCA has computers, chips, books, why not offer them at a discount through the family stores?"

"I would like RCA library subscriptions to popular computer and do-it-yourself publications, and especially magazines for up-to-date information."

"Recognize extracurricula computer activities in employee performance evaluation and job offers into computer programming for RCA."

"All RCA engineers (and technical personnel) should be encouraged and supported as much as possible in the use of personal computers."

"I feel it would be beneficial to RCA and to employees to provide small computers similar to personal computers, with the engineering groups for problem solving."

"There is a large field of use for small minicomputers in the manufacturing field which could provide much data, and at a reduced labor cost. This type of application would be to the benefit of RCA."

"I work as an Equipment Services electrician and am exposed to various microprocessor-controlled devices as part of my job. Any type of formal education that could be provided in the field of microprocessors and microcomputers at this location, I'm sure would be greatly desired."

Learning languages

Typical respondent comments provide a good flavor for the efforts in planning, acquiring, scrounging, interfacing, debugging and getting systems working.

"I used the VIP for CEE courses. I have programmed some extra games, but like controlling external devices. I've built a simple burglar alarm and interfaced an ADC0816 data acquisition chip to the VIP."

"Data manipulation capability has permitted faster analysis of product sales and has allowed us to try different changes on paper before they are implemented."

"The computer logs tool-design drawings. It aids in scheduling."

"The computer is giving my family (especially children) familiarity with computer technology, and establishing an interest in my children for both computer and electronics career fields."

"It reduced about 30 years of manual manipulation of data to roughly two months."

"I'm building on a program library. Programs developed include a graphics program for plotting numerical data, several numerical analysis programs, and several game programs. My next project is to develop a simulation of spacecraft attitude motion."

"I had the computer for four weeks. I wrote one program and used it in RCA to calculate quality data. This program has decreased the calculation time by 65 percent, in addition to being more accurate. This system was demonstrated to the Quality Manager."

"I learned logic and computer basics (aided by after-hours courses). I'm conversant in BASIC, FORTRAN and FORTH languages; learning PASCAL, LISP, and COBOL. I'm producing assembly language, BASIC and FORTH programs for home management, controls, security, energy savings, games; application programs in record management (home) and computations (business); letter and report writing using word processing programs. I'm active in advising local government and schools in use of computers for teaching, record management and security."

"A personal computer network accessing other personal computers or mainframes seems to have much potential. I'm using the 6800 microprocessor chip. It seems very easy to work with and can be used for both control and arithmetic operations."

Conclusions

This survey indicates that personal computers have found substantial entry into the ranks of RCA's engineering population. The use is fairly independent of age and educational level, but surprisingly high for managers above first level.

The survey conveys a fairly vivid picture of the many off-the-job hours spent in acquiring computer (hardware and software) familiarity by choosing, buying, setting up, interfacing, debugging, and other activities. A great deal of the effort is educational—learning to do something new and to do it better and then to apply it to a variety of uses. Here, too, it is probably more from the learning and practicing point of view than for pure utility.

This growing computer literacy may have a profound and positive impact on future engineering job assignments and conduct. Encouragement and support of personal computer use appears to be very supportive of professional growth of the individual as well as the competitiveness of the Corporation.

Hans Jenny has experience as a design engineer, engineering leader and manager, and Chief Engineer and Operations Manager of RCA's solid-state microwave product line. In his present position as Manager, Engineering Information, he uses this background to assist RCA engineers in their and the Corporation's efforts to remain viable and competitive.

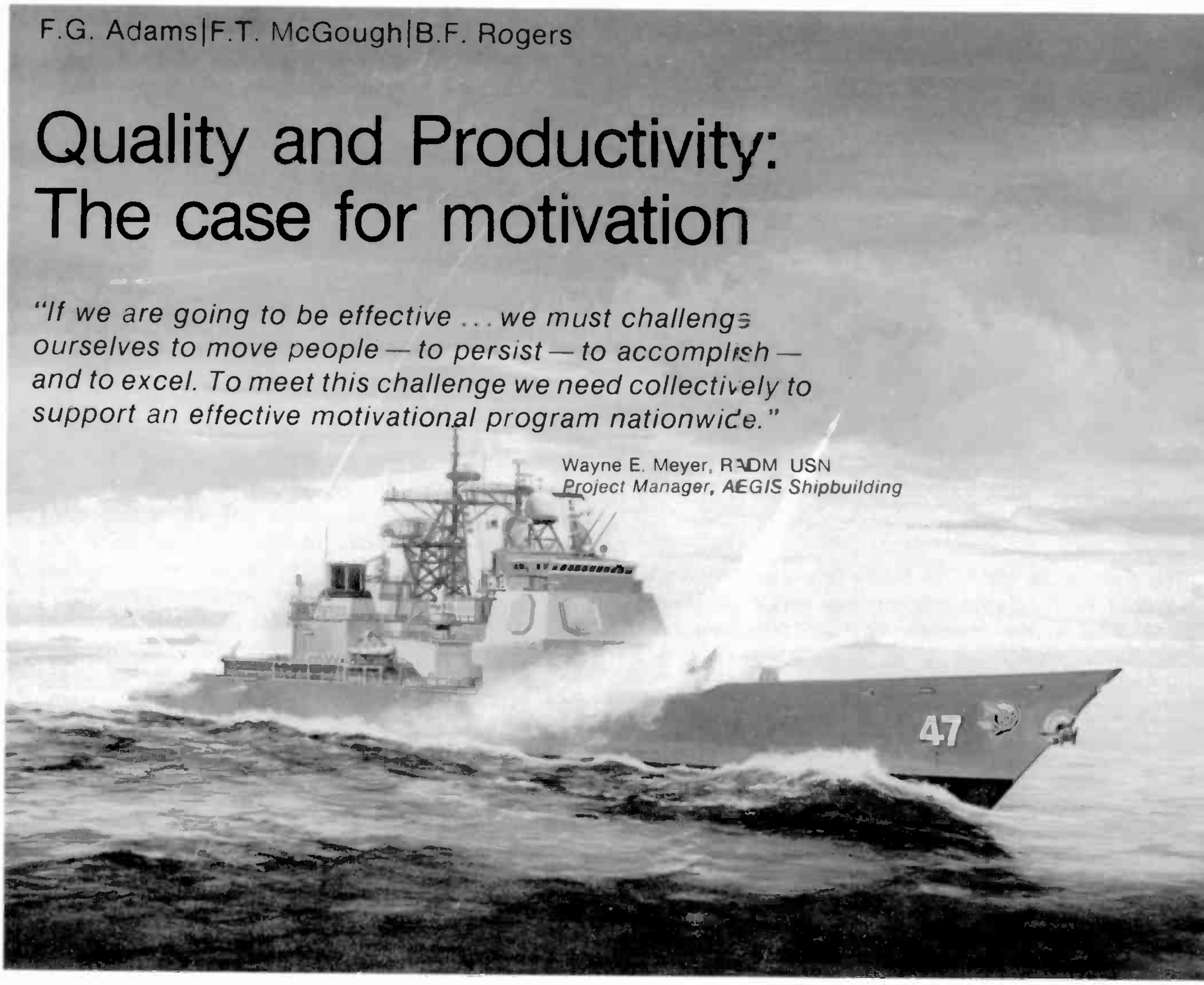
Contact him at:
Engineering Information
Corporate Engineering
Cherry Hill, N.J.
TACNET: 222-4251

F.G. Adams|F.T. McGough|B.F. Rogers

Quality and Productivity: The case for motivation

"If we are going to be effective ... we must challenge ourselves to move people — to persist — to accomplish — and to excel. To meet this challenge we need collectively to support an effective motivational program nationwide."

Wayne E. Meyer, RADM USN
Project Manager, AEGIS Shipbuilding



Quality and Productivity: Two words that reflect the basic ideals of industrial progress. Everyone uses them and recognizes the need for them. But getting there is difficult unless *people* want those ideals. And once this attitude is achieved, sustaining it over the long haul is just as, if not more, difficult. The effort involved is frustrating and demanding; the results tend to be illusory, with little that is concrete showing on the bottom line. Yet the potential benefit is more than worth the effort.

Today's systems invoke levels of sophistication and complexity unthought of just a few years ago, representing hundreds and even thousands of man years of the best scientific and engineering talent directed to the synthesis and design of operationally effective, highly reliable systems. All of this effort can go down the drain if everyone involved in the manufacturing process isn't totally committed to the excellence of the end product.

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Published by U.S. Naval Material Command.

On AEGIS, the entire team — Navy and industry — is committed to excellence. The nurturing and maintenance of motivation over a ten-year engineering development period have been made possible only as a direct result of continuous management support and attention.

Today AEGIS Excellence stands as the unifier for everyone involved with AEGIS, from the sailors preparing to take the system to sea to the engineering and manufacturing staffs of every contractor, subcontractor, and vendor associated with the program. And with the shift in emphasis from development to production, RCA is using the AEGIS Excellence Program as a springboard for an intensified "Involvement in Quality" campaign emphasizing procurement and the equipment manufacturing process.

The AEGIS Excellence Program

The principal objectives of the AEGIS Excellence Program are to build and maintain a sense of involvement and team spirit among the hundreds of participating companies and their thousands of employees. The mechanism is public recognition — for firms and individual employees whose performance demonstrates a special awareness of the need for quality and productivity on AEGIS.

Begun in early 1971, the program has grown and achieved national prominence, in large part by continuous, *overt* management support and direction. The Navy Project Manager has provided personal leadership in this area from the outset. One sure-fire measurement of success is the fact that the AEGIS Excellence Program is being used as a model by other DoD-industry teams involved in major development programs. Here are some program mechanics:

- **Individual Awards** Everyone involved in AEGIS is eligible. To date more than 200 individuals have been cited for outstanding performance, representing Navy personnel and Navy civilians as well as RCA and subcontractor people.
- **Contractor Awards** Top AEGIS Program managers make special public presentations to firms (often small businesses) showing special awareness of quality and productivity — 31 contractors nationwide through mid-1980.
- **Newsletters** Five thousand copies of AEGIS Excellence *Newsletters* circulate worldwide to ships and shore installations, Navy Department and other DoD organizations, and all involved contractors. This communication vehicle publicizes award winners and program progress, and provides the context for individual understanding of the size, scope, and importance of AEGIS.
- **Posters** Very widespread distribution and frequent updates provide a continuous visual reminder of the need for excellence in AEGIS.

The AEGIS Excellence Program remains a solid motivational force on AEGIS, and in addition serves as a foundation on which smaller, specifically directed programs can be built. With the change in program approach from engineering development to production, RCA has launched a derivative program, "Involvement in Quality," to build increased awareness of the need for quality and productivity.

The IQ Program

The Involvement in Quality (IQ) Program specifically targets material suppliers and internal manufacturing operations for achievement recognition. In fact, IQ is a way of life, not merely a program. It has been comfortably merged into, and will remain a part of, the regular RCA factory work pattern. IQ accommodates the basic feelings of pride in accomplishment that all workers have to varying degrees by providing channels of communication for improvement ideas and visibility of the results they produce. *Two-way* communication is a key element: given a voice and visibility, the individual worker gains both recognition and increased pride of accomplishment.

The IQ structure

The IQ structure involves awareness, information feedback, leadership, involvement, teamwork, pride, recognition, achievement, and commitment. The initial effort, begun early in 1980, concentrated on procurement operations (suppliers) and moved gradually into manufacturing operations as the factory workload increased for AEGIS production.

Project and engineering managers hold information exchanges with suppliers and with factory work teams. Films and other visual aids, expanded orientation, training programs, bulletins, and posters are used to spread the IQ message.

In the Procurement area, special IQ awards are given to outstanding suppliers. An IQ-sponsored Material Problem Avoidance Program and a Supplier Counseling Service are directed to helping vendors maximize efficiency and avoid potential problems. IQ Alerter memos and IQ Announcements are sent to suppliers (about 1000 on distribution). Audio/visual programs augment the information and educational flow.

IQ in the factory has concentrated on group involvement, such as for small-group and individual-task development projects. Participation by factory personnel is encouraged by worker interviews ("What's your IQ?") published with pictures in the employee news magazine. This effort is supported by ongoing activity in the areas of audio/visual aids, surveys, and motivational publicity. RCA management participates *actively* in this effort.

IQ measurement criteria have been established for supplier and manufacturing quality performance, while other measurement criteria are still under development. To date, supplier response has been positive — even enthusiastic. Employee morale has shown a perceptible upsurge, indicating an increasing sense of involvement. As an example, early returns from a recent campaign combining IQ with RCA's internal suggestion program showed a 45 percent increase in the number of suggestions for improved operations; preliminary results of dollar value of the suggestions submitted indicate a 14 percent increase.

The Work Center concept

Another major thrust of the IQ Program is a team-building approach to factory quality, cost, and schedule control. The Work Center concept involves a new look at organizational structure and the way

AEGIS Excellence — Ongoing Nationwide Motivation Program

Citation

Newsletters

Awards

Posters

Moorestown Award Winners

What is AEGIS?

AEGIS is a program, it is a Navy warship, it is a weapon system, it is a combat system that includes the weapon system; but most of all, it is an integrated shipbuilding program.

The AEGIS Combat System is an integrated array of weapons, sensors, and computers that enable the AEGIS ship to handle air, surface, and undersea threats. The primary defense against air and missile attacks is the AEGIS Weapon System, developed to provide the required reaction time from initial target detection to engagement by the ship's missile batteries.

RCA in Moorestown, New Jersey, is the combat system agent and principal manufacturer of weapon system equipment. Special facilities in Moorestown are devoted to development, system engineering, and integration of the combat system engineering model and testing of the weapon system production equipment before shipment to the shipbuilder, the Ingalls Shipbuilding Division of Litton Industries in Pascagoula, Mississippi. The entire program is under the direction of the AEGIS Shipbuilding Project in the Naval Sea Systems Command, Washington, D.C. The first AEGIS Cruiser, CG 47, has been named *Ticonderoga*. Shipment to Ingalls of *Ticonderoga's* AEGIS Weapon System is scheduled for mid-1981.

manufacturing operations are conducted. Teams of people are brought together with all the essential skills — and a sense of dedication for producing a reliable, maintainable product on schedule and within the prescribed cost parameters.

Five Work Center teams are currently in operation — Printed Circuit Fabrication, Module Assembly and Test, Wire and Cable Fabrication, Phase Shifter Assembly, and Beamformer and Antenna Assembly and Test. Total factory implementation (six more areas) is scheduled in 1981.

The team approach generates a sense of unified participation and cooperation, and recognizes individual contributions and responsibilities. Problems are uncovered sooner. In fact, many problems are simply avoided, before they materialize, by thoughtful group planning. The individual worker has been given a voice, visibility, encouragement, and recognition — plus an opportunity for personal growth.

The Future: Continue building

The strong foundation of the AEGIS Excellence Program, combined with the objectives of the Involvement-in-Quality concept, provides continued emphasis on quality and productivity leading to a reliable, maintainable product. Subcontractors, suppliers, and vendors, large and small (and there are more than 500 such companies on the AEGIS team) are people — just like the RCA people who are now convinced that each group is important to success.

Motivation is a personal, individual characteristic that can be externally inspired, nourished, and preserved. This is the challenge RCA is meeting — commitment to quality and productivity as the personal goal of each person on the program.

The ultimate measurement of our effectiveness will be the quality, the reliability, the maintainability, and the system readiness of the AEGIS Ship Combat System as the Ticonderoga-class ships join the fleet.

Left to right: Frank Adams, Bertram Rogers, and Frank McGough.

Frank Adams is Manager, Program Operations in the Naval Systems Department. He has 30 years of inter-disciplinary experience in engineering, project management, general management, and engineering education. He joined RCA in 1959 and was successively involved in the TRADEX-PRESS Program, the AADS-70/SAM-D Army air defense system development, and as one of the original group that proposed and captured the original AEGIS Program.

Contact him at:
Missile and Surface Radar
Moorestown, N.J.
TACNET: 224-3903

Frank McGough is Manager, Manufacturing Operations in Missile and Surface Radar, with overall responsibility for all MSR manufacturing activities, including Planning and Control and Cost and Budget functions. Since joining RCA in 1954, he has been involved in a wide variety of programs and activities, with experience in manufacturing, materials management, and program management. He assumed his current position in January 1980.

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Missile and Surface Radar
Moorestown, N.J.
TACNET: 224-2573

Bertram Rogers is Manager, Business Management for the Naval Systems Department of Missile and Surface Radar. He has 20 years of service with RCA in a variety of project engineering and business assignments and has held his current position since 1978. In that capacity, he is responsible for contracts, subcontracts, program administration, and planning for Naval Systems.

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Missile and Surface Radar
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TACNET: 224-2046

EDITORIAL INPUT

M.W. Buckley, Jr.

Professional societies: Why not go active?

Invest in your professional future.

Professional societies trace their roots back many years to the early days of scientific endeavor, when small groups came together to exchange views and to satisfy their mutual curiosity about things scientific and technical. This inclination for meeting and communicating with one's technical peers has expanded manyfold, and we have seen professional organizations grow and subdivide into thousands of specialized areas.

Professional societies abound today, with formal constitutions and bylaws, and memberships that in some cases number in the hundreds of thousands. As a rough rule of thumb, about 50 percent of those qualified to join these societies actually seek membership. But regardless of membership, every engineer and scientist is affected by the work of these organizations.

Industry and government recognize the value of the technical information interchange and the other benefits afforded by these societies and generally encourage their employees to become involved. RCA has an especially strong reputation for supporting the professional aspirations of its employees and can claim an impressive list of individuals who have contributed to their professions through these societies and who have won many society awards.

With all these advantages, why don't we have a much larger and much more active professional society involvement? That question, of course, begs another: "What's in it for me?"

Reprint RE-26-5-9
Final manuscript received March 13, 1981.

The benefits of active involvement

We all know that there really *are* benefits in involvement, but a few of them bear repeating. Heading the list is staying current with the state of the art in one's own specialty. Attendance at conferences is an enjoyable and cost-effective way to stay current. Some of our eminent engineers and scientists give their time to present current topics—a special bargain in this era of rising costs and high prices. The peer associations fostered at conferences and local meetings are another plus factor in professional development. Study after study has verified that the primary means of technical communication is direct person-to-person contact.

Those who present or publish technical papers gain an even greater benefit—in the form of recognition, reputation, and the opportunity to influence the direction of technology.

Still another area of interest to many engineers and scientists is direct involvement in social issues. In recent years, professional societies have shown an increasing involvement in broad issues such as the public and private investment in research and development, pensions, ethics, accreditation of engineering curricula, technical positions on energy, and other matters of social concern.

Getting involved

To expect every member of every professional society to be actively involved is unrealistic. But the involvement in the last decade has for the most part been on

the low side and it is time for the pendulum to swing in the other direction.

Getting involved is easy. And it is possible to test the waters without overcommitment. One way to start might be to take on a small task for an obscure subcommittee of a local chapter. Offer to serve on a panel, or to find someone to make an informal presentation. Encourage a co-worker to write a paper. Work with a publicity or arrangements committee for a conference. Serve on a papers-selection panel. Every society needs help, and it doesn't necessarily take a lifetime commitment to be a part of the action. But a warning — it's catching. You'll probably become hooked on it and stay active for the rest of your career.

Reaping the rewards

Monetary reward is not the long suit of professional societies and neither, with rare exceptions, is fame. But there are definite pluses, and they are substantial. First is the increase in confidence that always comes from involvement, from having done something to help. Another dividend is the self-development that comes automatically with doing something in the company of one's professional peers. This comes not only in the form of professional growth in your own specialty, but also in other areas where your interests are awakened. Making the society a little better, through your contributions, will bring recognition from others who benefited from your volunteer efforts.

Perhaps the most important reward, though, is an intangible — a self-perception of being a professional. Anyone who has invested the time and effort in an engineering or scientific education and has worked effectively in the rigors of its practice deserves to be recognized and treated as a professional. But this does not happen automatically. It must be earned. And one route to this special status is through a direct, conscious involvement in professional society activities.

Why *not* go active?

Merrill Buckley is Administrator, Planning and Measurement at MSR. After joining RCA in 1953, he served in managerial positions on the Terrier, Tartar, ATE, Talos, Atlas, Minuteman, and BMEWS programs. In the past 15 years he has applied the latest management sciences techniques to many projects including TRADEX, Cobra Mist, LEM, Apollo, Viking, AN/TPQ-27, CAMEL, AEGIS, HR-76, AASP, and MCF. A frequent seminar director at universities and professional societies, he lectures on both engineering and management subjects. Mr. Buckley has actively participated in the IEEE for many years and has held both appointed and elected positions in the Engineering Management Society and the Philadelphia section. He was recently elected to the IEEE Board of Directors as Regional Director for the eastern states.

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TACNET: 224-2554

J.S. Tripoli

RCA, patents, and you

From notebook... to disclosure... to application... to patent

"A large part of what makes the engineering profession grow is the willingness of its members to contribute—in the form of a presentation, a published paper, or a disclosure that leads to a patent. These are things that are given to the profession and yet remain personally identified with the originator."

—B.J. Matulis
Chief Engineer, RCA Missile and Surface Radar

The Radio Corporation of America, now known as the RCA Corporation, was originally organized to establish a U.S. corporation for handling transcontinental communications. Among the chief assets of this fledging corporation were the talents of its employees and a number of patents in the radio field. These patents played an important role in the early history of RCA Corporation, and today patents continue to be an important element in our corporate planning and performance.

Every member of the RCA technical community should know at least a few fundamental patent concepts in order to participate effectively in the patent process. My intention here is to provide a practical guide to the patent process and possibly increase that participation. I will approach the subject from three levels, all of equal importance. The first level is an exposition of the mechanics of the patent process and a discussion of related topics. The second level is the development of a sensitivity in the technical community for some of the important issues affecting the patentability of inventions worldwide. The third level is the improvement of communications and understanding between the members of the RCA technical community and members of RCA Patent Operations.

Reprint RE-26-5-10
Final manuscript received Feb. 23, 1981.

History

A brief look at some of the history of patents might help to put the patent issue in the proper perspective. In the early days, patents were grants by sovereigns or other governmental entities that provided rights to make, use or sell articles of manufacture or processes. For example, in England in 1331, King Edward III granted exclusive rights to Flemish weavers to encourage them to bring their weaving art to England. With such exclusivity, the weavers made great profits, and, as a direct result, England developed a major textile industry. Note that this particular weaving art was not previously practiced in England, although the art was well developed elsewhere.

During the reign of Elizabeth I in the early 1600s, the granting of patents — the exclusive rights to make, use and sell articles — had become a rather arbitrary system controlled by the Crown. Articles that were made in England, such as playing cards, were taken out of the public domain through the grant of a patent in exchange for a percentage of the profits resulting from the monopoly. The grant of patents had become a revenue-raising tool for the Crown.

These abuses grew more flagrant, and Parliament finally had to act. In 1624, Parliament passed the Statute of Monopolies, which provided that the Crown could grant patents only for a fixed term of 14 years and that the subject matter had to be new in England.

In America, the Founding Fathers recognized the importance of securing rights for inventors and authors in and to their discoveries and writings. After several drafts, the present language of Article I, Section 8, Clause 8 of the U.S. Constitution was adopted. This Clause states that

> Congress shall have Power...To Promote the Progress of Science and the Useful Arts, by Securing for Limited Times to Authors and Inventors, the Exclusive Right to their respective Writings and Discoveries.

RCA's Resident Patent Counsel

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Leroy Greenspan	Lancaster, Pennsylvania	227-3191
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Abstract: *The author provides the basic concepts of the patent process as an aid and an inducement for greater participation. There are three types of patents: utility patents, plant patents, and design patents. The most important to RCA is the utility patent, which has a life from date of issue of 17 years. Patents are national in nature, and every country makes its own patent regulations. An inventor who plans to apply for a patent should be aware of these foreign regulations. This paper also describes the Invention Disclosure form and provides a suggested outline for filling it out.*

From the Constitutional point of view, our patent system requires "progress" in the sense of advancement in knowledge. Thus, nothing can be taken out of the existing public domain. The Constitutional right granted is an "exclusive" right. That is, as a patentee, you have the right to prevent others from making, using, or selling your patented invention. No right is granted to use your own patented invention. Thus, if someone holds a valid generic patent and you hold a valid improvement patent, the generic patent holder has a right to exclude you from practicing your improvement and you would have the right to exclude all others (including the generic patent nolder) from practicing the improvement.

What is a patent today?

A patent is considered to be personal property. As such, the rights in a patent can be assigned (for example, in accordance with the RCA employer-employee Invention Agreement), licensed, sold, treated as a business asset, and even passed to a legatee under a will. United States patents are enforceable only in the United States, its territories, and its possessions. The patentee receives the right to exclude others from making, using, or selling the patented invention for a limited period of time (17 years from the date of issue of a utility patent).

In the United States, there are three types of patents. Utility patents are the most common type, and they are the subject of this paper. The other two types are plant patents, which have a life of 17 years from the date of issue, and design patents, which protect ornamental surface configurations of objects and have a life of 3½, 7, or 14 years from the date of issue, depending on the amount of the issue fee paid by the applicant.

In the patent statute, Congress defines what is deemed to be patentable subject matter. The patent statute describes as patentable any new and useful process, machine, article of manufacture, composition of matter, or any new and useful improvement of an item falling within these categories, if certain other conditions and requirements are met.

One of the conditions for patentability in the United States is that the invention must not have been sold or offered for sale, used commercially, or published in a printed publication *more than one year* prior to the *filing date* of the application. That is, if an item is sold or offered for sale, used commercially or non-experimentally, or published in a printed publication, the inventor has one year to file his application in the United States Patent and Trademark Office (P.T.O). If he does not file within the one-year period, then the statute bars him from filing the application.

The requirements for patentability in the United States are, basically, that the invention must fall within the defined statutory subject matter, must not be barred by a condition of the statute, and it must be new, useful, and unobvious. "New" means not identically disclosed in a single prior art reference. "Useful" means that the concept or item must work or operate as claimed. "Unobvious" means that the invention, as a whole, must be significantly different from the prior art when viewed by a person of ordinary skill in the appropriate technology at the time the invention was made.

Logical flow from invention to patent

Research and Development work on a problem will often lead to the conception of an invention. Further work may result in a reduction to practice of the solution to the problem. An Invention Disclosure may be submitted even if there is no reduction to practice.

Patent Operations considers a number of factors in selecting inventions upon which patent applications are based. Sometimes the evaluation leads to the publication of a Technical Note instead of the filing of an application.

The United States Patent and Trademark Office (P.T.O.) examines the case and, if allowed, the invention is patented. If the claims are rejected, then the case may be amended and the amended claims are examined. When the case reaches a final rejection, the Applicant may fold or appeal to the Board of Appeals in the P.T.O.

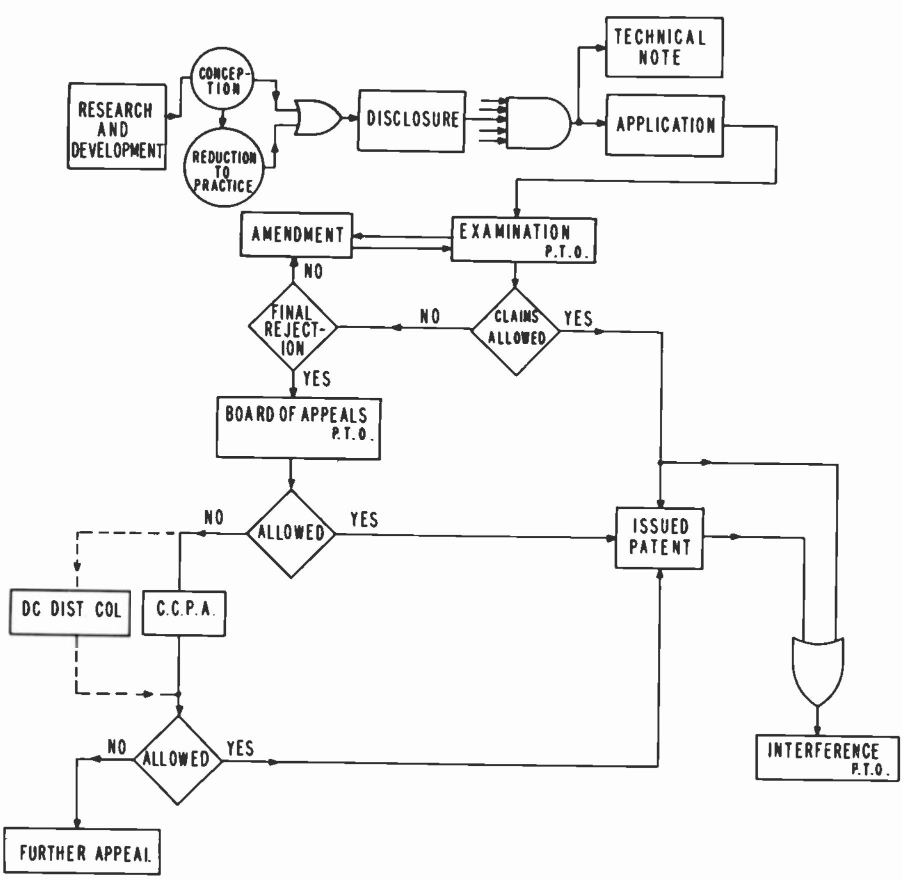
If the Board agrees with the Applicant, then the patent will issue. If the Examiner's final rejection is upheld by the Board, then the Applicant can fold or appeal to the Court of Customs and Patent Appeals or, at his option, the Applicant can appeal to the District Court for the District of Columbia.

Again a successful appeal by an Applicant leads to a patent and an unsuccessful appeal leads to a decision to fold or to further appeal (it is possible to appeal all the way to the U.S. Supreme Court).

When claims have been allowed in an application, it is possible that the case may become involved in an Interference. This can also happen with issued patents. An Interference is a priority contest between two parties disclosing and claiming the same invention.

In the absence of all appeals and Interference proceedings and assuming the case has allowable subject matter, a patent should issue in about eighteen months to two years from the date the application was originally filed in the P.T.O.

The chart shown here is a general pictorial representation of the flow of an invention, from conception to the issuance of a patent.



Foreign rights

So far the focus has been on U.S. patent law. Quite often, RCA patent applications filed in the United States form the basis for corresponding patent applications filed in foreign countries. Again, patents are national in nature and the special conditions and requirements for patentability in each country must be met.

In several of the important industrial nations of the world, the issue of divulgation must be addressed. Divulgation means that if an invention is divulged to any member of the general public in an unrestricted fashion, that invention cannot be patented in that country.

In this country it is possible to have a publication or sale of an invention, and if the one-year grace period has not expired, to file a patent application. However, under these conditions the very same invention cannot be patented in those countries where a divulgation constitutes an immediate bar.

In today's world, foreign patent rights are important, and care must be given to preserve the option to file patent applications abroad. It is, therefore, very important to inform your patent attorney of any prior or planned divulgations of your invention.

Initiating the process

The first step in filing a patent (after the invention, of course) is the preparation of an Invention Disclosure form for submission to RCA Patent Operations.

An Invention Disclosure should be prepared and submitted whenever a problem has been solved or whenever you feel that a useful concept or device has been generated that is different, in an unobvious respect, from the prior art. As I said earlier, the solution, concept, or device must fall within the statutory class of subject matter for patents.

The Invention Disclosure form, which is generally available in local stationery supply cabinets, comprises two parts. The first part is a one-page questionnaire that requests information, such as name and location of the inventor and a descriptive title of the invention. The second part consists of one or more substantially blank pages for describing the invention. These pages should be used to tell the story of the invention. Every page of the Invention Disclosure, including any attachments, must be signed and dated by the inventor and a witness.

The following is a suggested guide for the preparation of the second part of the Invention Disclosure.

1. **Problem** — a very brief statement of the problem the invention overcomes or cures, if applicable.
2. **Prior Art Solutions** — briefly indicate prior solutions to the problem, if known.
3. **Brief Summary** — in one or two sentences, try to describe the key features or elements of the invention.
4. **Detailed Description** — describe the best mode or embodiment of the invention, presently known by the inventor, with reference to sketches if appropriate.
5. **Advantages** — briefly state the advantages of the invention over any known prior art.

This is only a suggested outline for an Invention Disclosure. When the form has been completed, including the dated signature of the witness on each page, it is sent to RCA Patent Operations, Princeton, New Jersey.

Disclosure . . . Application . . . Patent

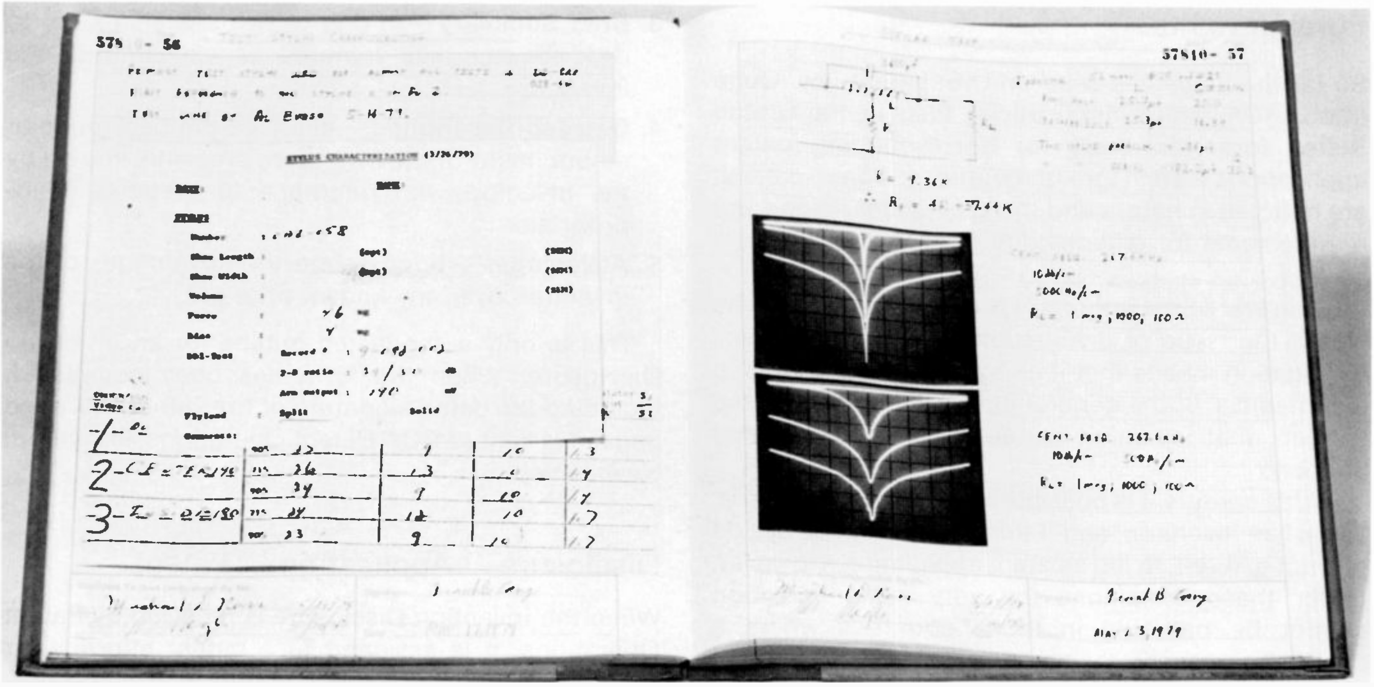
When the Invention Disclosure is received by Patent Operations, it is assigned to a patent attorney for processing. An evaluation is begun by the attorney, and it may include some or all of the following steps: a search of the prior art to determine the level of patentability; a technical evaluation review with key RCA technical personnel; a consultation with key RCA business personnel; an evaluation of the relationship of the invention to present or future licensing programs; an evaluation of the use of the invention by RCA; and an evaluation of the potential for future use by others.

When a case is selected for filing as an application in the P.T.O., the attorney prepares the formal documents. These include a specification containing a detailed description of the best embodiment of the invention known to the inventor at the time of filing, a set of claims defining the metes and bounds of the invention, a drawing showing the elements described and claimed in the case, and an oath.

The oath, which is executed by the inventor (or inventors) in the presence of a notary, states, among other things, that the inventor believes himself (herself) to be the first inventor of the subject matter claimed and that he (she) is unaware of anything that would bar the valid filing of an application in his (her) name.

An Examiner in the P.T.O. receives the application and conducts a search of the prior art. The Examiner then prepares an Office Action that indicates acceptance or rejection of the claims presented and the reasons for the action taken.

The Applicant, through counsel, has the right to respond to a rejection by arguing against the position of the Examiner or by modifying the rejected claim. In many cases, there will be only two Office Action rejections and two responses permitted. Thus, the rejections and responses must be well thought out and carefully written.



All entries in the notebook should be dated and signed by the researcher and by the witnesses.

The proceedings before the P.T.O. may be, and often are, much more complicated than I've outlined, and they may even involve appeals to higher legal authority if the Examiner and the Applicant cannot find a mutually acceptable solution. If a mutually acceptable solution is found, then the claims are "Allowed" by the Examiner and the application is sent to the Issue Branch of the P.T.O., where it is printed and subsequently made available to the general public on the date of issue of the patent. Again, a utility patent has a life of 17 years from the date of issue.

The proceedings in the P.T.O. are *ex-parte* in nature. That is, it is not an adversary proceeding. The Examiner and the Applicant's attorney may disagree, but they work jointly toward a common goal. This goal is the issuance of a valid patent, and patents possess a distinct public interest element. The Applicant, his attorney, and everyone else substantively connected with the preparation and filing of a United States patent application has a legal duty of candor in dealing with the P.T.O. There is an obligation imposed on all of these people to bring to the Examiner's attention any information, including, but not limited to, prior art, which might be material to the examination of the application. An intentional failure to fulfill this duty of candor is fatal to the enforceability of any patent that might be issued under these circumstances.

Infringement

A patent infringer is anyone who makes, uses or sells another's patented invention within the United States during the term of the patent. In order to determine the existence of an infringement, the accused article or process is measured against all of the elements recited in at least one claim. If a claim has four elements, then an infringer would have to make, use, or sell all four of the elements in an article or process that performs the same function as the patented article or process.

In the United States, a judicial doctrine has evolved that constitutes an exception to the general requirement that all elements of a claim must be found in an infringement. The "Doctrine of Equivalents" states that an equivalent element may be substituted for a recited element of a claim when the equivalent element performs substantially the same function in substantially the same manner as the recited claim element.

The remedy at law for patent infringement is the right to enjoin or stop the infringer from making, using, or selling the patented invention, or the patentee may collect a reasonable royalty for the unauthorized use of the invention.

Keeping a notebook — Interference proceedings

There are several important technical reasons for conscientiously maintaining an Engineering Notebook, but it is perhaps even more important to keep a proper laboratory notebook for patent reasons.

The United States is one of the few industrial countries of the world that is a "first to invent" country (Canada is the only other major country). All the others are "first to file" countries. That is, when it appears that two or more people have filed patent applications claiming the same invention, most countries of the world would hold that the first inventor to file the application is the one who is awarded priority. In the United States, the issue of priority is determined by which of the inventors was first to complete his invention in this country. An invention is "completed" when a concept is followed by an actual reduction to practice, or when a constructive reduction to practice is made by filing a patent application. The patent applicants who are "first to conceive" but last "to reduce to practice" may still be awarded priority if it can be shown that the "first to conceive" diligently worked on the invention during the period between conception and reduction to practice. Diligence may be thought of as an elastic band connecting conception and reduction to practice which permits the "first to conceive" to prevail over the "first to reduce to practice."

The laboratory notebook, when properly kept, is an excellent format for creating a body of evidence to support allegations of conception, diligence, and reduction to practice. Indeed, such evidence is often used in an Interference.

An Interference is a procedure used by the P.T.O. to determine priority. It is conducted just like a trial, but without a jury. Every element of the case for priority must be proven and corroborated by someone other than the inventor. This is why a bound notebook, kept up to date and witnessed by someone other than an inventor, is so important. The notebook, if properly used, may be the evidentiary base for a successful priority contest.

The notebooks provided by RCA Corporation are obtained from the local librarians in those areas having a technical library. The librarians also see to it that completed notebooks are properly stored for future reference.

Joseph Tripoli is Managing Patent Attorney, Consumer Products and Broadcasting Equipment, VideoDisc Group. In 1965, he joined RCA MSR at Moorestown, as a microwave engineer. In 1969, he transferred to Patent Operations, Princeton, as a Member of the Patent Staff. After he was graduated from the Temple University School of Law with the J.D. degree, he was appointed Patent Counsel. He served as Resident Patent Counsel in Camden from 1972 through 1974. In December 1974, he was appointed Staff Patent Counsel. He served in this post until February 1978 when he was promoted to his present position where he supervises a group of attorneys functioning on behalf of the RCA CED SelectaVision® VideoDisc system.

Contact him at:
RCA Laboratories
Princeton, N.J.
TACNET: 226-2992

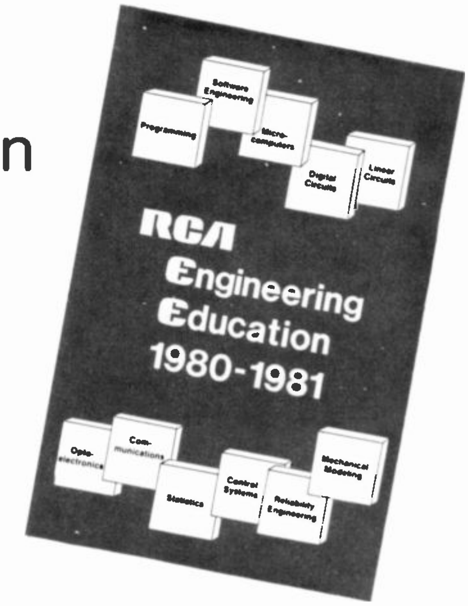
Conclusion

RCA has a long history of activity in the patent field. The patent process can be a mechanism for achieving individual professional recognition, and patents make a significant contribution to the Corporation.

F.E. Burris

Corporate Engineering Education Resource Guide

The Manager of RCA's in-house continuing education program wrote a "bluebook" to answer the questions he hears most frequently from prospective course participants.



Abstract: *Corporate Engineering Education (CEE) provides corporate leadership for the continuing education of the RCA engineering and technical community. It provides videotape-based courses and educational consultation services to all RCA locations. CEE maintains a videotape library and has a color-equipped TV studio. The staff of CEE have both engineering and technical education backgrounds, and they are qualified to offer assistance and guidance on a wide variety of technical education problems.*

A recent survey of 2,000 randomly selected *Electronics* magazine subscribers indicated that engineers believe that companies have an obligation to plan and support the professional growth of electrical engineers.* Of the survey respondents, those under the age of 30 felt the strongest about such corporate support—89.7 percent felt that companies should provide such support.

RCA has long been active in providing programs for the professional development of its technical personnel. One such program, offered by the Corporate Engineering organization to virtually all RCA technical personnel, is Corporate Engineering Education or CEE.

During the past 13 years, CEE has enrolled over 16,000 employees in videotape-based continuing education courses. RCA was among the first to use a videotape-based educational delivery system to provide continuing education programs for technical personnel in widely scattered geographic locations.

The purpose of this article is to guide you to more effective use and more complete understanding of this CEE resource.

What is CEE's charter?

The principal charter of CEE is to provide primary corporate leadership for the continuing technical education of RCA engineering and technical personnel.

What services does CEE offer RCA technical personnel?

CEE Services	*Percent of Total Effort*
Videotape-Based CEE Courses	85%
CEE Videotape Library	5%
Educational Consultation	8%
Contractual TV Studio Services	2%

Who is eligible for CEE course participation?

Employees of RCA and its subsidiaries, domestic and foreign, are eligible to participate in courses offered at their locations. Non-employees are not eligible for CEE participation.

* Hamilton, P., "Engineers Of The '80s Look To The Future With Optimism," *Electronics*, Vol. 53, No. 24, pp. 134-144 (Nov. 6, 1980).

Reprint RE-26-5-11
Final manuscript received Dec. 1, 1980

What is the cost of CEE course participation?

There is no monetary cost to the individual. The course participant's Division is assessed a fee that typically ranges from $40 to $80 for each participant. Most of this Division Assessment covers the cost of printed materials (study guides, texts, etc.).

What is the format of a typical course?

A typical course consists of thirteen or fourteen two-hour weekly sessions; 12 are instructional sessions and one or two are examination sessions. The instructional sessions typically use the allotted two hours in the following manner:

- 40-60 minutes of video presentation; and
- 60-80 minutes of supplemental lecture, class exercises, questions and answers, and class discussion led by an Associate Instructor.

What elements make up a typical CEE course package?

A complete CEE course package typically consists of the following elements:

- On-site Associate Instructor
- Set of 12 videotape lectures
- Study Guide
- Textbook(s)
- Homework solutions
- Examinations
- Certificate and CEU Record (transcript)

Each of these elements is provided by CEE, with the exception of the Associate Instructor, who is designated locally to deliver the course. Upon course completion the set of videotapes is returned to CEE. All other materials, including the Study Guide and text(s), are retained by the course participants.

What is the role of the Associate Instructor?

The Associate Instructor, or AI, is a "classroom manager" who possesses some knowledge of the subject matter and works at the location offering the course. The AI provides supplementary instruction, examples relevant to a particular location's needs, discussion leadership, and course administration and coordination. In effect, the AI is the principal course instructor, who is merely using a learning package supplied by CEE.

Indeed, it is the AI who makes the system run. RCA owes a lot to the many employees who serve as AIs, giving of their time and expertise for the benefit of others.

How can I become an AI?

Register your interest in teaching a particular course with the person responsible for CEE courses at your location.

What level of effort is expected of course participants?

While the level of effort will vary depending on the particular course and the individual's background, participants are expected to attend sessions regularly, complete assignments on schedule, and generally engage actively in the learning experience. One or two examinations are administered in each course to assist in the evaluation of participant progress.

How are CEE courses publicized?

CEE publishes a catalog of courses every year, and during the summer months CEE uses the *RCA Engineer* mailing list to distribute copies of the catalog for the forthcoming academic year. If you do not normally receive the *RCA Engineer* but want a CEE Catalog, consult the CEE Contact Guide. In addition to the *RCA Engineer* distribution, advance copies of the Catalog are sent to the CEE Network and other key individuals who will aid in the advance planning of fall course offerings.

As new courses are added during the academic year, formal announcement of availability of these courses is made in the CEE News section of *TREND*, and advance announcements of new courses are made to the CEE Network.

What is the CEE Network?

The CEE Network is a corporate-wide network of approximately 100 key personnel in Industrial Relations (IR) and Engineering. This Network helps to keep us posted on educational needs of the RCA technical community. CEE supplies information to the Network periodically to help keep the educational programs at all locations functioning smoothly.

May I take a CEE course as an individual rather than as a member of a formal class?

There are circumstances, such as frequent business travel, which make regular course participation difficult. It is not, however, currently possible to make courses available to individuals.

CEE courses are designed to be delivered in a formal classroom atmosphere with an on-site Associate Instructor aiding in the achievement of learning objectives. The courses are not designed to serve as individualized learning packages.

How will my course participation be recognized?

Participants who satisfactorily complete a course are awarded an RCA Engineering Education Certificate. For unusual excellence, the certificate will carry the notation "With Distinction." Certificates are awarded by Corporate Engineering through the participant's local management. A copy of the Certificate is forwarded to IR for entry into the employee's personnel file.

Participants who satisfactorily complete a course will also be awarded the number of CEUs (Continuing Education Units) specified in the course description. A CEU Record (transcript) of all courses satisfactorily completed is kept on file in the CEE office and a copy is sent to each participant upon successful completion of a course.

In addition to these CEE-initiated actions, some locations sponsor local recognition programs such as "graduation" dinners, publication of names of successful course participants in newsletters, etc.

What is a CEU?

The CEU has evolved nationally to recognize and catalog adult education outside the formal academic credit system. The CEU is officially defined as

> Ten contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction.

The number of CEUs earned for a given course also depends on such things as the amount of homework required, whether the course is lecture or laboratory, etc.

CEE adopted the CEU as a measure of continuing education achievement in 1976 and we are currently tracking the development of other, perhaps more appropriate, measures within the engineering education community.

What can I do if I want a particular course offered at my location?

Local course offerings are determined by IR training personnel, Technical Excellence Committees, Education/Training Committees, and personnel designated by Engineering to act as liaison with CEE. The manner in which decisions are made to offer a certain course varies widely from location to location.

Register your interest in a particular offering with your supervisor and whichever group determines offerings at your location. The staff of CEE can assist you with the identification of appropriate channels for registering your interest.

What are CEE's requirements for making a course package available?

Any CEE course may be offered to an organized class at any RCA location. CEE requires that a formal class with a minimum of three participants and a regular meeting schedule be formed. In addition, a qualified Associate Instructor must be designated to lead the course and to be responsible to CEE and to the local training administrator.

Further details of course administration, such as registration and space, are the responsibility of local training administrators.

How does CEE determine which educational needs are to be addressed?

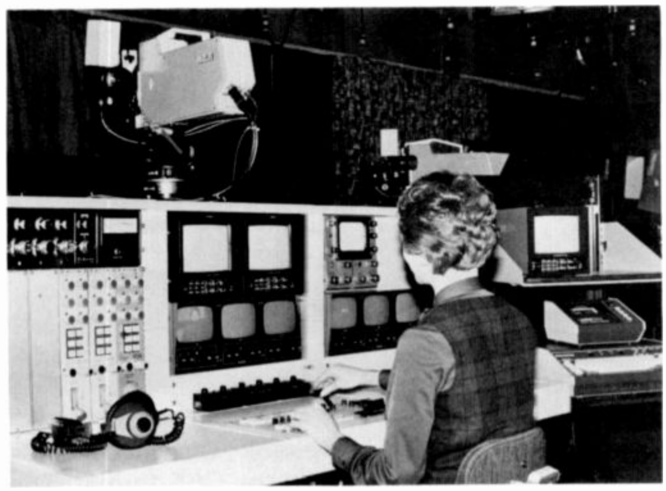
CEE course-development personnel assess RCA's technical needs through frequent contacts with Associate Instructors, IR training personnel, Technical Excellence Committees, Education and Training Committees, and through meetings and conversations with engineers and engineering management. The inputs from these sources help CEE develop educational programs to meet the most significant needs. Once a plan of action has been established, contact is maintained with key technical content advisors, and they provide critical review throughout the course development effort.

Where do the video instructors for an internally developed course come from?

When a course is to be developed internally and the course material is within the field of expertise of a CEE staff member, the videotapes and study guide may be developed by this staff member with content advice from key contacts within the Corporation.

More frequently, RCA engineers are sought who are known experts in a particular area and who have promise as teachers. The development of the videotapes and study guide by these engineers is guided, managed, and evaluated by one of the CEE staff members. Thus, the technical expertise of these video instructors is spread throughout the Corporation. The engineers who serve in this role benefit greatly from the experience and the resulting corporate-wide recognition. CEE is constantly on the lookout for potential video instructors. If you are an expert in an area where there is a broad-based corporate educational need and would like to participate in an internal course development effort, let us know.

Another source of video instructors, tapped only when internal sources cannot be found, is the pool of known content experts from academic institutions and consulting practices outside RCA.



Do you purchase videotape-based packages from outside vendors to meet course needs?

Only recently has the selection of videotape-based technical course packages become wide enough to make course package purchase feasible. Once a corporate-wide technical education need has been defined, CEE routinely searches for a suitable course package available for purchase from an outside vendor.

Your CEE Contact Guide

To inquire about:	*Contact:*	*Extension:*
Course Administration Procedures Scheduling/Ordering CEE Courses Scheduling/Ordering Library Tapes Transcripts	Margaret Gilfillan	5255
Teaching Considerations Technical Content of Course Offerings	Frank Burris, Bob Horen, or Ed Duffy	4326 5020 5141
Contractual TV Studio Services	Frank Burris	4326
To request:		
CEE Catalogs CEE Videotape Library Catalogs	Margaret Gilfillan	5255
Consultation on Educational Problems	Frank Burris	4326
To submit:		
Ideas for new courses Suggestions/criticisms of current courses New tapes to CEE Videotape Library	Frank Burris, Bob Horen, or Ed Duffy	4326 5020 5141

CEE's offices are in Building 204-2, Cherry Hill, NJ 08358. Use telephone number (609) 338-(extension) or TACNET 222-(extension).

If a suitable package is available, CEE investigates its quality and adaptability to the CEE format. The CEE staff, with the help of other invited RCA reviewers, makes the decision to purchase or not to purchase.

If the package is judged unacceptable for purchase and the need is top priority, CEE proceeds with the internal development of the needed course. In-house development of a 12-session course package typically takes nine months and represents a very significant effort by members of the CEE staff. However, there are significant advantages to in-house development. The course package can be tailored to RCA's specific needs, RCA engineers can be tapped to teach RCA engineers, and CEE has complete control over content, format, and other factors that affect the educational process. The principal tradeoff in the "make or buy" decision is the cost. Historically, however, the advantages of in-house courses have outweighed the cost, and this has led to a decision to make rather than buy in the great majority of cases.

What is the CEE Videotape Library service?

CEE operates a videotape lending library in which videotapes of various technical presentations are collected. The growth of videotape production and playback capabilities at various RCA locations, and the increasing use of videotape as a communication medium, have been responsible for significant recent growth in this CEE service.

Videotapes in the library are lent to RCA employees on request and at no charge. In general, the tapes are Company Private and are available only for showing to RCA audiences.

Tapes are constantly being added to the CEE Videotape Library, and approximately 30 loan requests per month are currently being serviced. As of February 1981, contents of the library include:

- 40 Princeton Laboratories Colloquium tapes
- 37 RCA Technical Symposium tapes
- 18 Seminar tapes
- 20 Miscellaneous tapes

CEE maintains a CEE Videotape Library catalog and updates it as new tapes are acquired. Copies of this catalog are not widely distributed but are available on request (see CEE Contact Guide). As tapes are added to the library, their availability and ordering information are announced monthly in the CEE News section of *TREND*.

May I offer tapes to the library that may be of interest to the RCA technical community?

You bet! CEE Staff members are always looking for tapes that are of significant interest to the technical community. We cannot possibly know about all of the videotapes of potential interest that are sitting on shelves around the company. If you know of tapes that are gathering dust and that may be of interest to others, please let us know.

What is CEE's Educational Consultation service?

The three CEE staff members who are principally involved in course and program development have backgrounds in electrical engineering *and* technical education, and they are available as consultants to help solve technical education problems.

Recently, these CEE staff members helped establish graduate education programs at several locations. They also evaluated a short course that was offered at an RCA location by an outside vendor, and they have located short courses on specific technical topics. In general, CEE responds to numerous inquiries on technical education resources and problems.

In addition to a staff that is in technical education, CEE maintains extensive files of educational resources. CEE staff members maintain contact with technical education personnel outside RCA through active roles in several professional societies and by visiting other industrial education organizations.

The role of CEE in educational consultation is evolving, and this role will grow as corporate technical education programs become more important to the success of RCA's business. The direction of this growth is largely dependent upon the requests for help that we receive. Please call us whenever you have an education-related problem.

Tell me more about the CEE TV studio facility

Since the inception of the CEE program, a black-and-white videotape production capability has been an integral part of the CEE operation. Early in 1981, the TV studio was significantly upgraded and the new equipment gives us a color video production capability.

Our new studio can accept video feeds from any one of three color cameras, a color character generator, a film chain, or another videotape. A new production switcher is used to mix inputs from these various sources and to create a number of special effects. Tape mastering is typically done on four ¾-inch video cassette recorders. A ½-inch VHS video cassette recorder has also been added to meet an anticipated increase in the use of ½-inch video cassettes.

Is the TV studio available for use other than CEE course development?

While the studio facility is principally dedicated to CEE course development, it is available for other types of video production jobs. CEE welcomes inquiries about use of the TV studio facilities for video production work or tape duplication. However, such work is done strictly on a time-and-equipment-available basis and at a nominal charge to cover CEE expenses.

What is the make-up of the CEE staff?

Principal responsibilities of the eight-person CEE staff are as follows:

Management and Course/Program Development
Course/Program Development (2 persons)
Coordination of Services
TV Studio Technical Services/Maintenance
Video Production/Direction
Study Guide Formatting/Typing
Secretarial

Anything else?

CEE is indeed *your* resource and we hope that the information presented here helps you to use this resource efficiently and effectively.

Frank Burris joined RCA in 1978 as Manager, Engineering Education in the Corporate Research and Engineering organization. He has general responsibility for corporate leadership in the development and implementation of continuing education programs for RCA's technical staff. He manages the CEE staff in assessment of corporate technical education needs, in development of educational resources to meet those needs, and in service as consultants on technical education. Prior to joining RCA, he had eleven years'experience as an EE faculty member and three years' engineering experience. He served as a Vice-President of the American Society for Engineering Education (ASEE) in 1977-78, and is currently a member of the Executive Board of ASEE's Continuing Professional Development Division and a member of the Ad Com of the IEEE Education Society.

Contact him at:
Corporate Engineering Education
Cherry Hill, N.J.
TACNET: 222-4326

In many of the answers, you found repeated references to our use of "key contacts," "key personnel," etc. Although our full-time staff is small, effectively our staff consists of these full-time people working with all of RCA's engineering and industrial relations personnel. *You are CEE's primary resource!* We rely heavily upon you to guide our direction and, on occasion, to participate directly in the course development process. Give us a call if you still have questions.

B.A. Eisenstein

Electrical Engineering Education:

From static to what's current

Here's an opportunity for industry to cooperate with academia and revitalize the education of future engineering talent in the U.S. The author is Head of the Electrical and Computer Engineering Department at Drexel University, Philadelphia, Pennsylvania.

Electrical Engineering, throughout its brief history, has not evolved gracefully, but has instead been rocked by revolutionary changes in concept and in practice. If the past is prelude to the future, one would expect that the profession will be rocked by further revolution. The challenge of Electrical Engineering education is to prepare the graduates to confront and master the new technologies.

Prior to World War II, the education of Electrical Engineers lagged behind scientific developments. Engineering academics madly scrambled to catch up. After the war, universities moved more into research and they began to assume leadership in technology and, for a time, perpetrated new revolutions. Now, as the profession seems poised to undergo radical changes brought about by the revolution in microelectronics, we find the educational system debilitated. Ironically, this debilitation is caused, in part, by the system's own success in preparing students so well that they are being drawn away from university teaching by the attraction of high starting salaries and better research facilities in industry.

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The challenge of electrical engineering (E.E.)

Electrical engineers are concerned with the control and transmission of what Benjamin Franklin called the "Electrical Force." The nature of the electrical force—its power, its speed, and its ability to travel through empty space—has made it awesome to mankind, whose habit is to measure physical surroundings by human attributes—distance by the foot (the length of a foot), time by the second (an eyeblink or heartbeat), and work per time in horsepower (roughly, the amount of power exerted by a beast of burden). The human counterparts of the electrical force fall short in all respects. Transmission of information without the use of electromagnetic radiation is limited both in distance as well as information transfer rate.

We can transmit the electrical force at the speed of light, and also can control, shape, and switch it millions of times in a second—millions of times faster than the human standard of speed. I remember looking condescendingly—some years ago—at our old, slow minicomputer and having the "gut reaction" that a new computer card reader we were testing was just too fast for it. As each card entered the reader, mechanical brushes read each hole in 80 column

format, 800 columns per second. But wait, that is *only* 1.25 milliseconds per column and our "slow" minicomputer had a basic cycle time of 1.5 microseconds. When the card reader was connected to the mini, the computer "idled" 833 cycle times between columns read. There was more than enough time to check each brush 5 times while it was over the hole (or no hole).

The power of the electrical force is not only great but insidious. Invisible microwaves can roast the unsuspecting. Radio signals can be transmitted around the world, to submarines beneath the sea, and to robot space explorers hundreds of millions of miles away. There is no human or mechanical analog for the ability of this force at a distance to carry information with such power and range.

The challenge of electrical engineering education always has been to make the unintuitive electrical force intelligible to the novice.

E. Guillemin,who was a distinguished professor of E.E. at M.I.T., relates an anecdote of a student hearing about the commonly used impulse function. "Most of the time it's so small you can't see it, except at $t = o$ where it's so big you can't see it. So you can't ever see it, at least I can't." In addition to framing the problem confronting the teaching of electrical engineering, Professor Guillemin offers the answer — a well-trained faculty.

> "I have always held that, where the teaching of basic concepts and procedures are concerned, no distinction should be made between the so-called "elementary" and the "advanced" methods. We refer to things as being "advanced" only so long as we understand them insufficiently well ourselves to be able to make them clear in simple terms. Once we understand a subject fully and clearly, it is no longer difficult to make it understandable to the beginner. And, if we do not warn the beginner beforehand, he will not be able to distinguish when we are teaching him the "elementary" methods and when the "advanced." Such a distinction will reside only in the teacher's mind; to the student both will be equally novel and equally clear."[1]

Maintaining a well-trained faculty over the next decade may be the greatest challenge to have ever confronted our profession.

The revolutions in E.E. education

Electrical engineering was the first engineering discipline based on applied *science* (as opposed to art or

Table I. Electrical engineering chronology.

Approximate year	*Event*
1790	Coulomb discovers force between charges
1800	Voltaic cell discovered
1837	Cooke and Wheatstone telegraph
1842	Morse's telegraph between Baltimore and Washington
1864	Maxwell's equations published
1876	Bell demonstrates the telephone
1898	Marconi and Jackson transmit a signal 60 miles
1904	Fleming demonstrates the diode
1906	DeForest invents the triode
1918	Armstrong perfects the AM radio
1929	Zworykin develops television
1936	FM advantages recognized
1938	World War II — radar, statistical decision theory
1948	Shannon and information theory
1948	Transistor invented by Bardeen, Brattain, and Shockley
1956	First transoceanic telephone cable (36 channels)
1962	Satellite communications begin
The 1960s and 1970s	Cable TV, laser communication links, fiber optics, helical waveguides, charge-coupled devices, microcomputers, large-scale integrated circuits, optical computers, phased-array antennas, speech synthesizers, color TV, and more
The 1980s	Video disc, personal computers, computer mainframes on a chip, space shuttle, and more

practice) and, consequently, its beginnings mark a turning point in the history of engineering. It is based on electricity, one of the youngest branches of physics. A brief chronology of electricity in Table I emphasizes this point.

Originally, Electrical Engineering was taught in Physics departments or, in some cases, Mechanical Engineering departments. The first "revolution" to strike the profession and the one that birthed it was the near simultaneous public acceptance of electrically powered motors, electric illumination, and the telephone. These developments, all occurring in the last two decades of the 19th century, created a mass desire that all homes and factories be equipped with electricity and telephones. The problems encountered now were not science but truly engineering: how to generate, transmit, and distribute huge amounts of electrical power and how to establish the necessary switching schemes to forge a person-to-person, private communication network.

The universities were not ready for this revolution in 1890 and E.E. professors had to be retread from Physics, Mechanics, Mathematics, and Chemistry departments. The E.E. experts were in industry. Students graduating with E.E. degrees needed years to develop enough "feel" for the profession to be helpful.

If the first revolution is called the Power and Communications Revolution, the second is most definitely the Electronics Revolution. Following the invention of the vacuum triode in 1906, an irreversible change was made in social interactions, military strategy, and world politics. Radios were in such demand that, by the mid-1920s, they were as well known as they were unknown a scant 10 years earlier. For perspective, a typical floor model radio sold for $400-$700 in 1920 at a time when the Model-T Ford sold for $500.

Were the universities ready? By 1920, there were a number of E.E. Departments that were flourishing,

The electrifying revolutions.

Date	*Revolution*	*Spin-off technologies*
The 1890s	Power and communications	Electric utilities, telephone
The 1920s	Electronics	Radio, consumer electronics
The 1940s	Mathematics	Information theory, coding
1948	Computer	Business machines, data processing
1948	Solid State	Consumer electronics
1960	Space	Optimization, modern controls
The late 1960s	Microelectronics	Integrated circuits
The mid 1970s	Microcomputers	Games and everything else
1980	Manpower	- - - -

but they were all "power" departments. As the crisis was recognized, some called for new departments — Electronic Engineering or Radio Engineering — while a new professional society, the Institute of Radio Engineers, was founded as a competitor to the older American Institute of Electrical Engineers. Faculty tried valiantly to bring the Electronic Revolution into the classroom. Power engineering, although advancing technologically, had stabilized academically. But electronics was advancing so rapidly that academic institutions never did catch up. Whether or not they would have caught up is moot, because events overtook the profession — the Second World War.

During World War II, we had the Mathematics Revolution. The pioneering works of Norbert Wiener, Claude Shannon, Kolmogoroff, and others were the harbingers of the Mathematical Revolution. Academicians previously had been wrestling with incorporating into the E.E. curriculum such esoteric subjects as Heaviside's Operational Calculus, Fourier techniques, and the work of Bode and Nyquist. But the invention of radar and the imperatives of the war effort to extract maximum performance from the systems required engineers trained in Detection Theory, Estimation, Stochastic Processes. I have heard many first-person accounts of engineers taking the course from N. Wiener's book[2] nicknamed "The Yellow Peril." The engineers were devastated! It became clear to the leaders of E.E. education that the then current training of engineers, even at the most prestigious universities, was inadequate to cope with the new technologies.

Following the end of World War II, E.E. educators resolved that the universities would not be caught again. The perceived answer was that academic departments had to engage in research so as to be the *forerunners* of the revolutions to come rather than the victims of them. The revolutions were now coming closer together. The transistor (1948) heralded the Solid State Revolution. Shortly thereafter came the Computer Revolution which is still unfolding. In 1960, President Kennedy challenged the nation to reach for the moon within a decade and launched the Space Revolution. The Sixties saw the start of the Microelectronics Revolution, which may yet prove to be the most far-reaching and profound. By the Seventies, we were well into the Microcomputer Revolution, the impact of which in robotics, computer-aided design, and consumer products, has just scarcely been felt. During the Sixties and Seventies, there were several "mini-revolutions": Medical Electronics, Energy, Electrical Materials.

Were the universities ready? This time, yes. Since the founding of the Institute of Electrical and Electronic Engineers (IEEE) by merger of the American Institute of Electrical Engineers and the Institute of Radio Engineers, a very large fraction of the research results contained in all of the IEEE publications have come from university E.E. departments. In such a large fraction, in fact, that letters to editors often contain complaints about "academic domination" of the *IEEE Transactions*. The fields of Information Theory, Coding, and now Packet Switching were developed, in large part, at universities. The present controversy concerning encryption is between the National Security Agency and the *academic community*, and points up the fact that the most advanced work in this heavily theoretical area is done at universities. Estimation theory, pioneered by Wiener at M.I.T., and continued in the work of Kalman, Bucy, and the late David Sakrison, to mention a few, point up the large influence of academe on the profession today. Modern control theory, optimal control, adaptive and model-referenced control owe their origins and development to university research. State-variable and time-domain system analysis including state estimation were exported from the groves of academe to industry. The new technologies

Curricula in Flux

New curriculum in place

The name of the Electrial Engineering Department at Drexel was officially changed to Electrical and Computer Engineering Department in September, 1980. We anticipate a program leading to a B.S. in Computer Engineering to be in place by June, 1982. The proposed curriculum looks like this:

Computer Engineering Curriculum (Proposed)

Mathematics	7 courses—through complex variables, linear algebra, differential equations
Physics	5 courses—through atomic physics
Engineering Science	4 courses—including thermodynamics, materials, dynamics
Liberal Studies	11 courses—including technical writing
Basic E.E.	6 courses—(and labs) including circuits, systems, fields
Advanced E.E.	2 courses—Communications and Control
Computer Engineering	Introduction to Digital Computers Advanced Digital Microprocessors Minicomputers Fundamentals of Digital Computers E.E. Algorithms Introduction to Operating Systems I, II Computer Hardware Digital Signal Processing I, II, III

Curricula in Flux

Senior Design: Three courses

Senior design is required of all Electrical Engineering and Computer Engineering students. Working in teams, the students take an engineering problem from the initial formulation of the problem through to a finished, tested prototype with a formal presentation at the annual Senior Design Conference held in May. Here is a place where engineers in industry can help out. By suggesting projects for senior design teams and by working with the teams over the year, the students can get a more realistic appreciation for engineering design as it is practiced in industry.

Co-op experience is a requirement.

All Drexel students must work in industry a minimum of 18 months (3 six-month assignments) to satisfy the co-op requirements. This work experience makes our students singularly able to appreciate the advantages (and disadvantages) of the curriculum. The co-op experience also makes our graduates more valuable on their "first" postgraduate job.

of today — computer graphics, robotics, image processing, pattern recognition, biomedical technology, and many others — are being developed by university researchers. This is a contrast to the prewar situation when industry dominated the new technology and academics scrambled to catch up.

The process of information transfer from universities to industry has been most successful in certain geographical sections of the country. A recent article[3] traces the explosive growth of "Silicon Valley" (Stanford, Berkeley), the "Electronic Seedbed" around Boston on Route 128 (M.I.T., Harvard) and "Bionic Valley" in Salt Lake City (U. of Utah). The greater Philadelphia area has been noticeably absent from the list of "explosive enclaves of technology," and I have long maintained that this is due to the spotty relationships between the local universities and industry — *to their mutual detriment.* Students are better prepared today because they are trained by faculty who are at the forefront of today's technology. The faculty recognizes that the complexity of modern society necessitates engineering solutions which are creative and responsive to the problems without being reactive. The training of engineers should foster creativity and entrepreneurship[4] without sacrificing tne engineering science base of our profession.

It is a mistake to judge the quality of an engineer's training by how well he fits in any particular company. Judge an engineer by the creativity and responsiveness to engineering problems. There will always be some time required to bring a new engineer up to speed but, as the problems become more complex, the well-trained engineer will survive in the end. In my experience, I have seen many cases where a recent graduate is the best-trained member of his group and the best problem solver. The universities are doing a good job of training electrical engineers to perform at the forefront of the state-of-the-art, and industry has responded with a demand for new graduates that borders on hysteria. It is precisely this demand which has spawned the latest revolution — the Manpower Revolution — and, in the process, has spawned a crisis in E.E. education from which there may be no recovery.

The crisis in engineering education

The keystone of the modern university engineering department is a research-oriented faculty. Why must faculty do research? Because it makes the undergraduate students they teach more current by shortening the technology transfer time. Contrast the case where a professor can tell his class about the latest results of his research to the case where the professor must wait until a good text on the subject is available. The latter case could add three years to the time it takes to bring a new technology to the classroom (not to mention the time required for the non-practicing teacher to learn the new material himself).

Maintaining and expanding a research-oriented faculty is an interconnected dynamic process that goes like this. There must be *money* to support both the professor's time spent on research and the graduate students. The graduate students are necessary to the research, but they also provide a fulcrum about which new research ideas are leveraged. The new research ideas and the work of the graduate students lead to publications, information dissemination, and recognition of the researchers by their peers. Hence, more money. And this is where we started. The spin-off from this process is better educated undergraduates *and* better educated graduate students. The components of the dynamic process are research funds, graduate students, and peer recognition. If one is missing, the dynamics fail.

On Feb. 8, 1980, President Carter requested the Secretary of Education and the Director of the National Science Foundation to prepare a review of the state of engineering education. The following is an excerpt from the IEEE's response to that request.

> "Now we have a new problem. Most engineering schools cannot find qualified doctoral level engineers to fill the open faculty positions. Universities have real difficulty competing with industrial salaries. Even when the salary is competitive, the job often is not. Undergraduate classes are so large that there is no time for innovative teaching. ...there is a severe shortage of PhD students who are able to interact with the undergraduates. This reflects in a situation wherein the faculty member must spend excessive time with routine teaching chores.... Salary alone will not permit universities to attract the creative engineers with industrial experience to their faculties. The environment must be changed."[5]

My colleagues in E.E. departments around the country will issue forth a hearty "Amen." Why not cultivate more PhD students? From a little further down in the IEEE reply, we have a partial, albeit unsatisfying, answer.

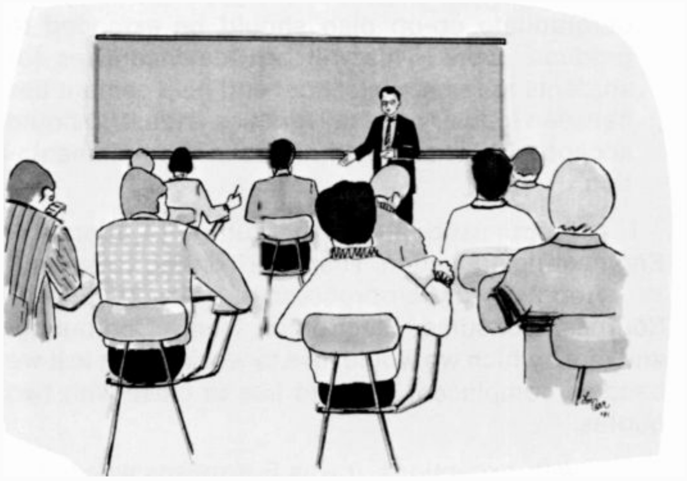
> "For PhD education, there are few American students. Most universities use PhD students for the various lower level chores associated with teaching and research.... Nationally, 36 percent of our graduate students are foreign. At the PhD level, it is 40 percent."[5]

The current crisis in engineering education is that the demand for our graduates is so great that there are few incentives for them to disregard the attractive offers made by industry and remain in school for the PhD. Furthermore, those few who do receive the PhD see their research opportunities better served in industry (not to mention their compensation). As a nation, we are consuming the seed we should be saving to plant next year's crop.

Prospects for the future

The recently announced cutbacks in Federal spending should remind us that government is not the answer. I believe that industry and universities should unite in a program to improve engineering education and to assure the continuity of the research-oriented departments. Some suggested programs are:

1. *Focus.* The problem is not just one of funding; there is also one of attitude and understanding. I have the impression that many engineers do not understand the dynamics of an academic engineering department. Engineering education needs special consideration like medicine, law, and agriculture.
2. *Graduate Students.* Direct funding immediately by industry to attract more of our BS degree holders to begin or continue postgraduate education on a *full-time basis.* A fellowship program restricted to graduates of accredited BS engineering curricula would do much to solve this problem.
3. *Equipment.* The equipment needs of engineering schools are urgent. The computer needs are at a crisis stage and laboratories must be modernized. Industry should give serious consideration to balanced programs to fund the equipment necessary to teach modern engineering.
4. *Industry/University Joint Projects.* There should be joint major projects between universities and industry. Areas such as design automation, and robotics are fruitful areas. But in almost every project, a place could be carved out for university participation. This would give our faculty the professional practice that many of them need.
5. *Continuing Education.* To ensure better utilization of technical manpower, the government must support continuing education to keep people in engineering as the job picture changes. A comprehensive program to train technicians and other technical support personnel would enhance engineering productivity. The cost of continuing education should be considered part of the cost of every federal project.
6. *Faculty/Industry Interchange.* Opportunity should be provided by industry to allow employees to spend up to a year teaching at a university; in addition, having professors spend time in industry is desirable, but, frankly, exacerbates our manpower problem.
7. *Graduate Co-op.* The very successful un-



Curricula in Flux

New courses offered

Many of the courses we offer today did not exist 5 to 10 years ago. The presence of a research-oriented faculty allows us to bring these courses into the curriculum and allows the curriculum to grow. Some of the "new" undergraduate courses are:

- *Introduction to Microprocessors* — An introductory course for Freshmen in microprocessors. The details of course content are presented in reference 8.
- *E.E. Algorithms and Applications* — How to solve E.E. problems on a digital computer efficiently. Digital controls, data structures.
- *Electronics I* — Physical electronics, properties of electronic material. Devices are fabricated and characteristics measured in the laboratory.
- *Electro-acoustics* — Vibrating systems, acoustic impedance, waves in fluids, design of transducers.
- *Introduction to Plasma Physics* — Hydromagnetics, Alfven waves, dispersion relations, applications.
- *System Design* — Optimization of design, computer-aided design, objective functions and constraints, applications to controls, communications, power systems.
- *Solid State I* — Crystalline structure, x-ray diffraction, quantum and statistical mechanics.
- *Advanced Electronics, Thick-Film Electronics* — System fabrication of thick-film and thin-film circuits, printed circuits, design and packaging. Students must design and build a thick-film device.
- *Digital Signal Processing and Digital Filters* — Sampling, Z-transforms, Fast Fourier Transform (FFT) algorithm, discrete time signal processing, periodograms, spectral estimation, design and implementation of digital filters.
- *Introduction to Robotics* — Basic properties of industrial robots, computer control, applications to computer-aided manufacturing.

dergraduate co-op plan should be extended to graduate work. This will provide incentives for students to remain in school and help cement ties between industry and universities. Industry should accept this concept and aid us in its implementation.

I am optimistic about the future of Electrical Engineering education. There are exciting areas such as Robotics, Microprocessors, Novel Energy Sources, Consumer Electronics, Home Computing, and more which we would love to work in. But lest we become complacent, I would like to close with two quotes.

"...with exceptions, it was Europeans who made the initial, fundamental scientific discoveries and early applications on which Electrical Engineering is based. This statement is true for the telephone, radio, television, and for the generation and transmission of power."[6]

and

"Our present policy is moving (America) toward becoming a colonial supplier of raw materials and food to more advanced countries and is placing us in a position of increasing peril. Unfortunately there is no crisis to alert the public."[7]

Consider this article the first alarm.

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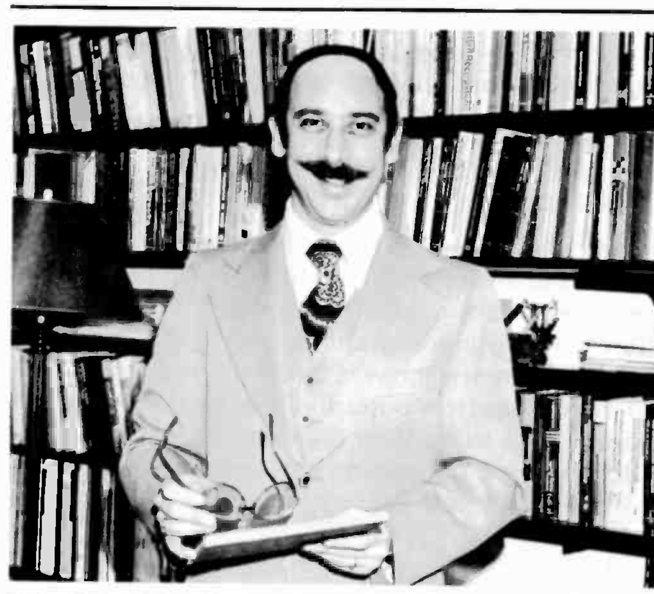

Bruce Eisenstein is Head of the Electrical and Computer Engineering Department, Drexel University, Philadelphia, Pa. In 1976, Dr. Eisenstein received the C. Holmes MacDonald Award of Eta Kappa Nu given to the Outstanding Young Electrical Engineering Teacher in the U.S. He is presently Secretary-Treasurer of the IEEE Education Society.

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K. Traub

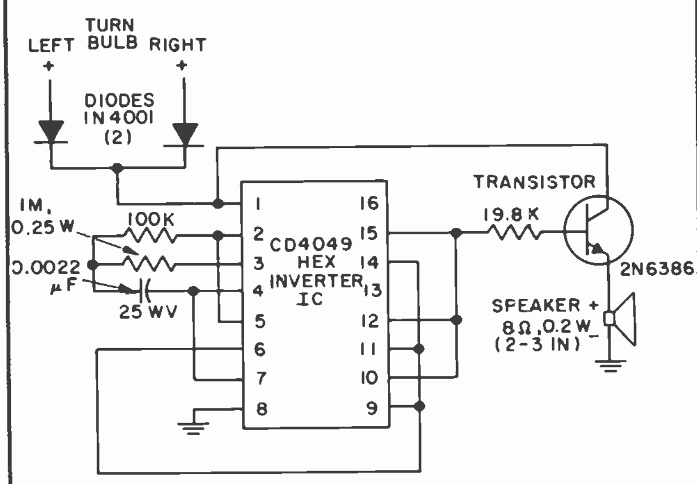
Motorcycle turn-signal beeper

Build an inexpensive turn-signal alert that gives an audible warning when cycle (or auto) flashers are on.

Just about anyone who has ever ridden a motorcycle for any distance has, at one time or another, discovered a still-flashing turn signal long after completing a turn. This is an especially common experience with cyclists because of the concentration necessary to operate a motorcycle and the high level of wind and other background noises. This article shows how to construct an inexpensive, compact, low-power, turn-signal alert that beeps every time the signal light flashes, and warns the cyclist (or motorist, since the beeper will work equally well in an automobile) that a turn is being signalled.

The parts used in the beeper circuit, shown in Fig. 1, have been found to be very reliable, so that the circuit should require little maintenance. The integrated circuit (IC) used is a standard CMOS IC commonly available in electronics supply stores or through their catalogs. The CMOS device was chosen because of its extremely low-power consumption and because it has a high degree of noise immunity (it is not bothered much by variations in current and voltage), both especially helpful features in the harsh environment characteristic of a motorcycle or under the hood of an automobile.

The circuit, as described below, draws power only when the turn signal is activated and should provide an adequate level of audible warning under most conditions because it produces a warning signal of between 1 and 1.5 kilohertz, a frequency easily heard above typical motorcycle background noises.



Parts List
1 CD4049B CMOS Hex Inverter IC
1 1M, 0.25 W Resistor
1 100 K, 0.25 W Resistor
1 19.8 K, 0.25 W Resistor
1 0.022 μF, 25 WV Capacitor
1 2N6386 n-p-n Darlington Transistor
2 1N4001 Diodes
1 8 ohm, 0.2 W, 2—3 inch Speaker
1 IC Socket, Low Profile 16-pin Type (optional)

Circuit description

The circuit, with only four active components, is relatively simple to build. An RC oscillator is used in the "front end" of the circuit to provide the audio signal for the gating network. The oscillator consists of two inverters, which are housed in the one IC and which provide amplification, and two resistors and a

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capacitor that provide positive (regenerative) feedback and voltage stability. The oscillator can be constructed with only one resistor, but the additional 1-megohm resistor assures a very stable audible tone in spite of voltage variations. The oscillator signal is fed to three inverting buffers, also housed in the IC, that function in this circuit as oscillator inverters. These three paralleled driver inverters drive the base of a type 2N6386 bipolar Darlington transistor to provide drive to the speaker.

By connecting the base of the transistor to the hot side of the turn-signal bulbs, either the actual signal bulbs or the pilot lamps, +dc is applied to the circuit through either of the two diodes shown in the circuit diagram. The beeper circuit will not affect turn-signal operation if constructed and connected properly because of the relatively low-power consumption inherent in the design. When either of the bulbs is turned on, the +dc is gated through simultaneously to the CD4049 chip — the heart of the beeper circuit — and the power output transistor.

The two type 1N4001 diodes are used to isolate one turn circuit from the other. If they were not incorporated in the circuit, both turn-signal bulbs would come on at the same time.

A 2- or 3-inch diameter transistor-radio speaker will suffice for this circuit. The speaker can be waterproofed, and its tonal quality preserved, by giving the paper cone a light coating of flexible rubber-base paper cement. If additional output volume is needed, the value of the 19.8-kilohm base-limiting resistor can be lowered; however, care must be taken not to exceed the power rating of the speaker.

Kevin Traub joined the Solid State Division Automotive Programs Engineering Department in Somerville in 1978, and has been involved since then in the selection and application of LSI devices for automobile control systems. His major responsibility has been the technical interface with, and support of, customers using RCA's microprocessors and other standard and custom LSI devices for ignition and fuel control in automobile engines. He is presently a member of the LSI Automotive Product Engineering Group.

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Circuit construction

The beeper circuit may be constructed using perforated circuit board to mount the IC and other components. Socketing of the IC is recommended to give the IC a better chance of surviving the soldering phase of construction. The CMOS IC should be left on a conductive surface until needed, and the builder should be grounded through a resistance of approximately 1 megohm when handling the circuit to prevent the body's static discharge from destroying the IC.

The construction of the entire circuit can be accomplished in roughly an hour's time; installation should take only a few minutes, and consists of tying the anodes of the diodes to the positive side (flasher side) of the turn-signal bulbs.

Correction note: Jan./Feb. 1981 *RCA Engineer*

Two figures in M.J. Kurina's article "Electronic packaging for an artillery-delivered sensor" are incorrectly captioned. Below Fig. 2 (p. 64), the caption should read:"(a) Schematic of the 155 mm projectile and (b) isometric view of the TDV." Below Fig. 3 (p. 65), the caption should read "Artillery deployment scenario shows stresses the unit must withstand." Also, ignore the reference to Fig. 6 on p. 66.

Patents

Astro-Electronics

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Minimization of residual spacecraft nutation due to disturbing torques—30429

Pistiner, J.S.
Closed-loop roll control for momentum-biased satellites—4230294

Strother, J.A.
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To obtain copies of papers, check your library or contact the author or his divisional Technical Publications Administrator (listed on back cover) for a reprint.

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Engineering News and Highlights


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Major Executive Appointments Announced

The RCA Corporation Board of Directors has elected **James M. Alic,** Vice-President, Electronic Services and VideoDisc Planning. He will be responsible for RCA Service Company and for "SelectaVision" VideoDisc Planning.

George D. Prestwich was named President of the RCA Service Company. Mr. Prestwich will report to Mr. Alic.

James J. Badaracco, former President of the RCA Service Company, has been appointed Division Vice-President, Special Marketing Programs on Mr. Prestwich's staff.

In another staff change, **Joseph W. Karoly** was appointed Division Vice-President, Finance, RCA Communications.

—Mr. Alic joined the RCA Corporate Staff in 1970 and, after holding several posts in corporate planning activity, was named Staff Vice-President for profit analysis in 1972. Later that year, he was appointed Staff Vice-President for financial planning.

In 1973, Mr. Alic was transferred to the RCA Consumer Electronics Division in Indianapolis and was named Division Vice-President of operations for the RCA Consumer Electronics Division. From 1977 to 1979, he was an Executive Vice-President with the National Broadcasting Company, a wholly-owned subsidiary of the RCA Corporation.

Prior to joining RCA, Mr. Alic was associated with the Ford Motor Company, holding analytical and supervisory positions in the Ford Division and the Product Development Group.

A native of Birmingham, Michigan, Mr. Alic was graduated from Northwestern University in 1964. He earned an M.B.A. degree from the University of Chicago in 1955.

—Mr. Prestwich joined RCA in 1969 as Division Vice-President of defense marketing for the Defense Electronic Products activity. In 1969, he became Division Vice-President of marketing for the RCA Government and Commercial Systems organization. Since 1976, he has been Division Vice-President for marketing in the Government Systems Division.

Before joining RCA, Mr. Prestwich was with the General Electric Company for 13 years, primarily in marketing positions in the electronics, defense and aerospace areas.

Mr. Prestwich was graduated from the U.S. Naval Academy in 1943 and received an S.M. degree in Nuclear Physics from the Massachusetts Institute of Technology in 1952.

The RCA Corporation Board of Directors has elected **Jack K. Sauter** a Group Vice-President. As a Group Vice-President, Mr. Sauter will direct both the company's Consumer Electronics Division and the Distributor and Special Products Division. Mr. Sauter will report to **Roy H. Pollack,** Executive Vice-President.

From August 1, 1979, Mr. Sauter was Vice-President and General Manager of the Consumer Electronics Division which he will continue to direct. **Donald M. Cook,** Division Vice-President and General Manager of the Distributor and Special Products Division since June 12, 1979, will report to Mr. Sauter.

Mr. Sauter joined the Consumer Electronics Division in 1975. He served four years as Division Vice-President, Marketing. In January 1979, he was named Division Vice-President and General Manager and eight months later was elected Vice-President of the division.

He joined RCA in 1950 as an advertising field representative. He became Sales Manager of the RCA Victor Western regional operations. In 1957, he moved into the Division's sales development activity. Mr. Sauter was appointed Manager of the RCA Sales Corporation's TV sales, Planning and Development in November 1960. Four years later, he was appointed a Vice-President of the RCA Sales Corporation. In 1966, he was named Executive Vice-President of that RCA subsidiary.

Mr. Sauter was graduated from UCLA with a bachelor of arts degree in 1947.

Named to new posts were **John D. Rittenhouse,** as Division Vice-President and General Manager, Picture Tube Division and **Paul E. Wright,** as Division Vice-President and General Manager, Government Systems Division. Both Mr. Rittenhouse and Mr. Wright report to **Dr. James Vollmer,** Group Vice-President, who oversees Commercial Communications Systems Division, Government Systems Division and Picture Tube Division.

Charles A. Schmidt has been appointed Division Vice-President and General Manager, Astro-Electronics. He reports to Mr. Wright.

Joseph H. Colgrove, the former Vice-President and General Manager, Picture Tube Division, has been named Vice-President, Commercial and Business Planning, reporting to Dr. Vollmer.

—Mr. Rittenhouse joined RCA in 1958 and held a series of managerial posts in such projects as the Apollo program's lunar excursion module communications system, the Navy's Trident submarine integrated radio room, and in a number of classified intelligence programs. In 1976, he was named Division Vice-President and General Manager, Government Communications Systems. In 1979, he was appointed Division Vice-President and General Manager, Government Systems Division.

Mr. Rittenhouse received a bachelor's degree from Drexel University in 1958 and a master's degree from the University of Pennsylvania in 1960. He also graduated from the Harvard Business School's Program for Management Development.

—Mr. Wright joined RCA in 1958 and in the ensuing years, held several engineering posts. In 1977, he was named Division Vice-President, Engineering, Government Systems Division. He then held the post of Division Vice-President, Operations, at Astro-Electronics Division for a year before being named Division Vice-President and General Manager, Astro-Electronics, in September 1979.

Rittenhouse

Wright

Schmidt

Colgrove

Firestone

Mr. Wright received a bachelor's degree from California Polytechnic State University in 1958 and a master's degree from the University of Pennsylvania in 1960. He also graduated from the Harvard Business School's Advanced Management Program.

— Mr. Schmidt joined RCA in 1950 and since that time has held several key engineering and managerial posts with Government Communications Systems. From 1970 to 1974, he was Manager, Test Engineering. During the following three years he was a program manager. In 1978, Mr. Schmidt was appointed Manager, Integrated Radio Room Programs, Government Communications Systems Division.

Mr. Schmidt holds a bachelor of science degree from LaSalle College.

Dr. William L. Firestone has been appointed Division Vice-President and General Manager for RCA Cablevision Systems Division. Dr. Firestone reports to **J. Edgar Hill,** Division Vice-President and General Manager for Commercial Communications Systems Division.

Dr. Firestone previously was Division Vice-President and General Manager of Avionics Systems which was sold by RCA to the Sperry Corporation in January of this year.

Dr. Firestone joined RCA as a Division Vice-President at the Avionics Systems activity in 1975. Before that he had been a Vice-President with the General Instrument Corporation and a Vice-President of the Whittaker Corporaion.

Dr. Firestone holds a bachelor's degree from the University of Colorado, a master's degree from the Illinois Institute of Technology and a doctorate from Northwestern University. He also received a certificate in business administration from the University of Chicago.

Staff Announcements

RCA Communications, Inc.

RCA Communications, Inc., will consist of three subsidiary companies:

RCA American Communications, Inc.
RCA Global Communications, Inc.
RCA Network Services, Inc.

The Board of Directors of RCA Communications, Inc., made the following officer elections: **Julius Koppelman,** Chairman of the Board; **Eugene F. Murphy,** President and Chief Executive Officer; **Francis J.D. DeRosa,** Executive Vice-President and General Counsel, Law and Regulatory Affairs; **Andrew Gaspar,** Vice-President, Strategic Planning; and **Joseph W. Karoly,** Vice-President, Finance.

RCA Global Communications

The Board of Directors of RCA Global Communications, Inc., appointed **Eugene F. Murphy** as Chairman of the Board and elected **Valerian F. Podmolik,** President and Chief Executive Officer.

Mr. Podmolik will report to the Chairman of the Board.

Valerian F. Podmolik, President and Chief Executive Officer, RCA Global Communications, Inc., announces the organization of RCA Global Communications, Inc., as follows: **Lawrence M. Codacovi,** Executive Vice-President, International Services and Marketing; **Adam Irving, Jr.,** Director, Administration Planning; **Kenneth H. Lassig,** Vice-President, Finance; **Donald R. Stackhouse,** Vice-President, Operations; **Joe T. Swaim,** Vice-President, Engineering; **Leonard W. Tuft,** Vice-President, Corporate Affairs; **Charles H. Twitty,** Vice-President, Industrial Relations; and **Valerian F. Podmolik,** Acting, Service Planning and Development.

Joe Terry Swaim, Vice-President, Engineering announces that **John P. Shields** is Manager, System Planning; **Alexander Avanessians** is Manager, Customer Engineering; **Walter N. Bauer** is Manager, Engineering Administration and Network Control; **Solomon J. Nahum** is Manager, Construction and Installation; **Richard H. Roth** is Director, Computer Programs (KCC); and **Anthony J. Falco** is Manager, Central Office Engineering.

David Mer, Director, Operations and Engineering, for RCA Globcom Systems, Inc., announces the appointment of **John A. Kruk,** as Manager, Engineering.

RCA Network Services

The Board of Directors of RCA Network Services, Inc., appointed the following: **Eugene F. Murphy,** Chairman of the Board; **Andrew F. Inglis,** President. **Mr. Inglis** will report to the Chairman of the Board.

RCA American Communications

The Board of Directors of RCA American Communications, Inc., appointed **Eugene F. Murphy,** Chairman of the Board.

Mr. Andrew F. Inglis will continue as President and Chief Executive Officer and will report to the Chairman of the Board.

Consumer Electronics

J. Peter Bingham, Division Vice-President, Engineering, announces the appointment of **James A. McDonald** as Manager, Display Systems Engineering.

James A. McDonald, Manager, Display Systems Engineering, announces the organization of Display Systems Engineering as follows: **Jerrold K. Kratz,** Manager, Magnetics Engineering; **Leroy W. Nero,**

Powell Is New Ed Rep for Americom

Carolyn Powell was recently appointed Editorial Representative for American Communications in Princeton. She succeeds Betty Stotts and has been with RCA since 1975. Under the title of Technical Administration Specialist, Ms. Powell serves as technical editor for all Technical Operations' proposals, reports, articles, and so on. She is also responsible for the Engineering Library.

Contact her at:
RCA Americom
Princeton, N.J.
TACNET 258-4194

Manager, Deflection Sub Systems; **George C. Waybright**, Manager, Deflection and Power Supply; and **James A. McDonald,** Acting Manager, Advanced Yoke Development.

Promotions

Consumer Electronics

Robert D. Altmanshofer, from Manager, Project Engineering to Manager, Engineering at Juarez.

James J. Kopczynski, from Member Engineering Staff to Manager, Project Engineering.

Laboratories

Appointment of **Paul W. Lyons** as Manager of the VideoDisc testing center has been announced by **Robert D. Lohman,** Director of VideoDisc Systems Research, at RCA Laboratories in Princeton, N.J.

Professional Activities

Dr. James Hillier, Retired RCA Scientist, To Receive IEEE Founders Medal

Dr. James Hillier, who retired as Executive Vice-President and Chief Scientist of RCA in 1977, received the 1981 Founders Medal from the Institute of Electrical and Electronics Engineers. The award was presented to Dr. Hillier at the IEEE Convention in New York on April 6. Dr. Hillier is being honored for "original contributions in electron microscopy and leadership in fostering a creative laboratory environment."

In 1980, Dr. Hillier was inducted into the National Inventors Hall of Fame for his development of the electron microscope. The electron microscope provides extremely high-power magnifications and is widely used in medical, biological and metallurgical research studies.

Dr. Hillier received his education at the University of Toronto where he and a fellow graduate student, Albert Prebus, designed and built the first successful high-resolution electron microscope in the Western Hemisphere. In 1940, Dr. Hillier joined RCA as a research physicist and, in a few months, designed the first commercial electron microscope in the United States.

Having developed the instrument in practical form, he then undertook the introduction of the electron microscope into general use as a new and powerful research tool, particularly for the biological and medical sciences. For several years, he continued to develop major engineering improvements in the instrument and several new techniques of biological specimen preparation. In his quest for complementary microanalytical techniques, he invented the electron microprobe.

For his contributions to the electron microscope as a vital tool of medical research, Dr. Hillier received an Albert Lasker Award from the American Public Health Association in 1960. In 1967, he was elected to membership in the National Academy of Engineering.

Following his work on the development and use of the electron microscope, Dr. Hillier was named General Manager of RCA Laboratories in Princeton, New Jersey, in 1957. A year later, he was elected Vice-President. He was named Vice-President, Research and Engineering, in 1968, and Executive Vice-President in 1969. He was appointed Executive Vice-President and Chief Scientist in 1976.

Brown wins Sarnoff Award

Dr. George H. Brown, retired RCA engineering executive, received the David Sarnoff Award for Outstanding Achievement in Radio and Television from the University of Arizona on November 21, 1980.

The award was presented at the annual meeting of the Arizona Broadcasters' Association in Scottsdale. The national award was established in 1978 by the University of Arizona and its department of radio and television. It is named in honor of the late David Sarnoff who was Chairman of the RCA Board from 1947 to 1969.

Dr. Brown joined RCA in 1933 after his education at the University of Wisconsin. While at RCA, Dr. Brown was active in the research and development of the company's compatible color television system, subsequently approved by the FCC.

Weimer elected to National Academy of Engineering

Paul K. Weimer, Fellow of the Technical Staff, has been elected to the National Academy of Engineering. Dr. Weimer was cited for "innovative, imaginative, and significant contributions to television camera tubes, to thin-film active devices and to solid state image sensors."

GE honors RCA men

Paul Moneika and **Mike Petrisko** of HS BIC, SSD, Somerville, N.J. were honored for a job well done at a dinner on January 29, 1981, hosted by General Electric, Re-entry Systems Division. These men are involved in making hybrids for the MARK 500. (The re-entry vehicle for the Trident Missle.)

Awarded Degree

Christopher H. Strolle, Video Systems Research Laboratory, has received an M.S. degree in systems engineering from the University of Pennsylvania.

Blaney receives award

Arthur C. Blaney, retired from RCA, has been given the Samuel L. Warner Memorial Award for 1980 by the Society of Motion Picture and Television Engineers.

The Samuel L. Warner Memorial Award is presented to Mr. Blaney for his research and development of photographically recording sound on film, his pioneering of cross-modulation testing and quality control techniques related to variable area tracks, and more recently, his contributions to the design of the optical system used in recording stereo variable area photographic soundtracks, as well as an optical system for super-8 photographic sound tracks.

Carver wins AIAA award

The American Institute of Aeronautics and Astronautics (AIAA) recently presented its Support Systems Award for 1980 to **Oliver "Tom" Carver,** Manager of Automatic Test Systems Operations at RCA Automated Systems.

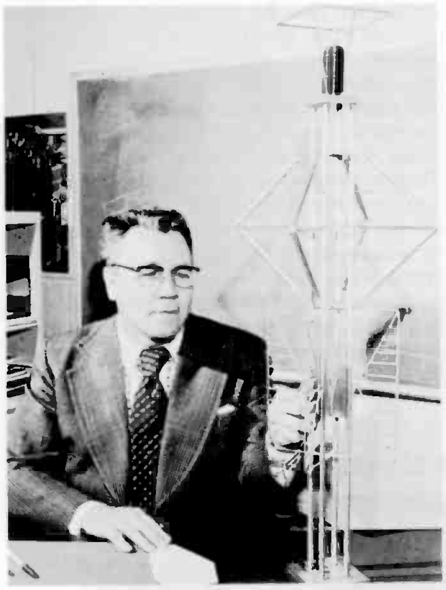
The AIAA award is presented annually "for significant contributions to the overall effectiveness of aerospace systems through the development of improved systems technology." Mr. Carver was singled out "for his long-term sustained technical and managerial contributions to the automatic testing field by providing exemplary leadership in conceiving innovative test systems architectures, promoting standardization of test program languages, and fostering intra-industry and user/developer cooperation."

Author publishes transistor projects

Bob Mendelson, Applications Engineer in the Linear IC activity of the Solid State Division, Somerville, has just had published his second book for the Hayden Book Company, Rochelle Park, New Jersey. This book, *103 Simple Transistor Projects*, is the second edition, an update of a popular collection of circuits of interest to literally every type of electronics hobbyist. The text supplied with each circuit is devoted to what the circuit does and how to build it. The reader is asked to seek elsewhere for information as to why the circuit does what it does. Each circuit—including "World's Smallest Transmitter?"; "Clorox-Powered Oscillator"; and "Mystifying Motion" is accompanied by a schematic diagram and a parts list. The book tells where to get the parts needed and gives equivalents for the RCA SK-series devices called out in the schematics.

Obituaries

Matti S. Siukola



Matti S. Siukola, Unit Manager of Advanced Development for RCA Broadcast Systems' antenna engineering center in Gibbsboro, N.J., has died at the age of 58.

Siukola collapsed and died on September 19, 1980 while presenting a technical paper to a meeting of the Institute of Electrical & Electronics Engineers in Washington, D.C.

Siukola joined RCA in 1952 and has been a major contributor to the development of radio and television broadcast antennas.

A native of Finland, Siukola was graduated from the Finland Institute of Technology with a bachelor's and a master's degree in Electrical Engineering. He received his Ph.D. in Communications Engineering from Oregon State University in 1952.

He was a Senior Member of the IEEE, and a Fellow of the Institute of Electrical Engineers in the United Kingdom. In 1974 Siukola received the David Sarnoff Award for Outstanding Technical Achievement, the company's highest technical honor, as a member of the team that designed the multiple TV antenna installation on Mt. Sutro in San Francisco.

Matti S. Siukola could be synonym for fastidious, meticulous and punctilious. His attention to particulars made him a vertible source for a variety of unrecorded data on RCA's antennas. We will miss him when the next multiple antenna system is to be proposed. His attention won the confidence of customers and consultants. They accepted his judgment when the test results were reviewed. His contributions to new product lines, including circular polarization, are too numerous to mention.

He was a paradigm of loyalty and devotion to RCA. A severe cold, a sore throat, or even the misplacement of his eyeglasses did not matter. Lucky for RCA that he was managing others, because he expected and communicated that they should emulate him. Work came first, and the rest (family or health) came second.

"Sisued" (with guts and gumption, as they use the term in Finland), he died in the harness.

——*Krishna Praba*

Herman Gurin

Herman "Hank" Gurin died on January 9, 1981, at the age of 66. Hank retired in 1979 after a long and brilliant career as an outstanding engineer and scientist. Following his retirement he devoted much of his time to local and community activities.

In 1936, he received the BS degree in mechanical engineering from New York University, graduating with honors. Even before graduation, he began his career at NBC in 1934 in the engineering department concerned with the design and operation of broadcasting studios. He was on active duty from 1941 to 1945 with the United States Navy and completed his tour of duty with the rank of Commander.

Following the war, he resumed his activities in the engineering department at NBC, and was deeply involved in the rapid post-war expansion of television broadcasting, particularly in the design of studios suitable for broadcasting televisions programs in color. During this period, he made major contributions to the design and lighting equipment and acoustic facilities.

In 1957, he obtained a year's leave of absence to serve on the staff of Radio Free Europe in Munich, Germany, the greater part of the time as the Chief Engineer. In 1958, he transferred to RCA Astro-Electronics in Princeton, New Jersey, and participated in the engineering and management phases of major satellite programs including the development of the first weather satellite, TIROS, launched in 1960.

He left RCA in 1969, after 34 years of service, to become the Executive Officer of the American Astronomical Society at its Princeton headquarters. In this important position, he was involved in numerous

activities of the Society, including fund raising, program planning, organizing technical conferences and editing the official bulletin of the Society.

During his long career, Hank was an active member of a number of professional societies, and he participated in the work of a number of committees engaged in preparing technical standards for the industry. The SMPTE recognized his many contributions to television broadcasting by electing him to the grade of Fellow. During these years, he also maintained his membership in the Naval Reserve and was promoted to the rank of Captain, USNR, in 1956.

In his community of Princeton Junction, New Jersey, he participated in a wide variety of local activities, and is remembered for his unselfish devotion to such local causes as the township Shade Tree Committee.

— W.J. Poch

technical excellence

Fourth quarter 1980 Award Winners announced by MSR

F.J. Reifler — for innovative solutions to missile terminal homing guidance control problems resulting in 2 to 1 reduction in semi-active homing times for target engagement. This achievement, in turn, potentially doubles AAW ship firepower while providing reduced miss-distance and higher kill probability. Dr. Reifler's work significantly enhances AEGIS Weapon System defensive capability against massive raids.

D.R. Shaw — for conceiving and developing the specialized firmware required to provide the P-50M airborne radar system with its extraordinary automatic scan and track capability. Mr. Shaw defined both the basic algorithms and the system simulation software, and then provided continued technical leadership from the integration phases through final acceptance testing.

Astro-Electronics Engineering Excellence Awards


Swale


Joshi

Due to the creativity, skill, and perseverance of **James F. Swale** and **Ragini T. Joshi,** RCA Astro-Electronics can now provide a developed attitude initialization program for STS launched spacecraft such as ATN/STS and NOSS. For such launches, long periods of time elapse between the last opportunity for on-pad alignment and the deployment from the Orbiter. Unacceptable errors can accumulate. Therefore, an accurate attitude reference must be established in orbit. Direct transfer of attitude information from the Orbiter is subject to significant errors due to mechanical alignment tolerances and thermal distortion in the Orbiter bay.

Jim and Ragini devised a post-separation initialization by means of orbital gyrocompassing. This technique is used for acquisition control of DMSP Block 5 and TIROS spacecraft. Since estimation of yaw attitude, the most critical guidance parameter, has to be more precise than gyrocompass control accuracy, a method was developed which estimates yaw by means of a simplified Kalman filter, which will be part of a special ascent load package. This YAWES algorithm estimates spacecraft attitude using pitch and roll information from an earth sensor along with gyro and ephemeris data. After formulating the algorithm, Jim and Ragini conducted an extensive simulation program which substantiated the feasibility of the approach, defined key parameters such as cycle time, updates, and measurement noise, and determined the sensitivity with respect to all important variables. This effort resulted in a software technique which represents an important step in RCA's efforts to use STS.

Reifler is 1980 Annual Technical Excellence Award Winner at MSR

— For innovative conceptual and developmental contributions to missile midcourse and terminal guidance technology, leading to important advances in modern anti-air guided missile system effectiveness.

Dr. Reifler's achievement involved two major, and independent, contributions to missile guidance technology. The first of these deals with the midcourse guidance phase, for which he developed algorithms that produce major enhancements in missile effectiveness. These algorithms, called KAPPA guidance, provide reduced time of flight to intercept with an attendant increase in missile speed at the start of terminal engagement. A major contribution was his invention of elegantly simple, effective, and powerful algorithmic approximations for the complex optimal solutions, well within computer resources allocated to an operational warship.

His second contribution, of even greater importance, was in the area of terminal homing where his work provided a dramatic increase in terminal engagement capability without an attendant increase in shipboard equipment. This technique, called RAF guidance, reduces semi-active homing times by factors of 2 to 1, thereby providing a potential doubling of anti-air warfare ship firepower. This spectacular increase in firepower, moreover, is achieved concurrently with reduced miss-distance and higher kill probability. The result is a system vastly more capable of operating against massive raids while maintaining its fighting posture.

Left to right (standing): MSR Award-Winners Staiman, Yorinks, Chandler, Breese, Risch, Povilonis, Shaw, Costello, Stachejko, Landry. Seated: Matulis (Chief Engineer), Reifler (1980 Award Winner), Volpe (Director, Product Operations).

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