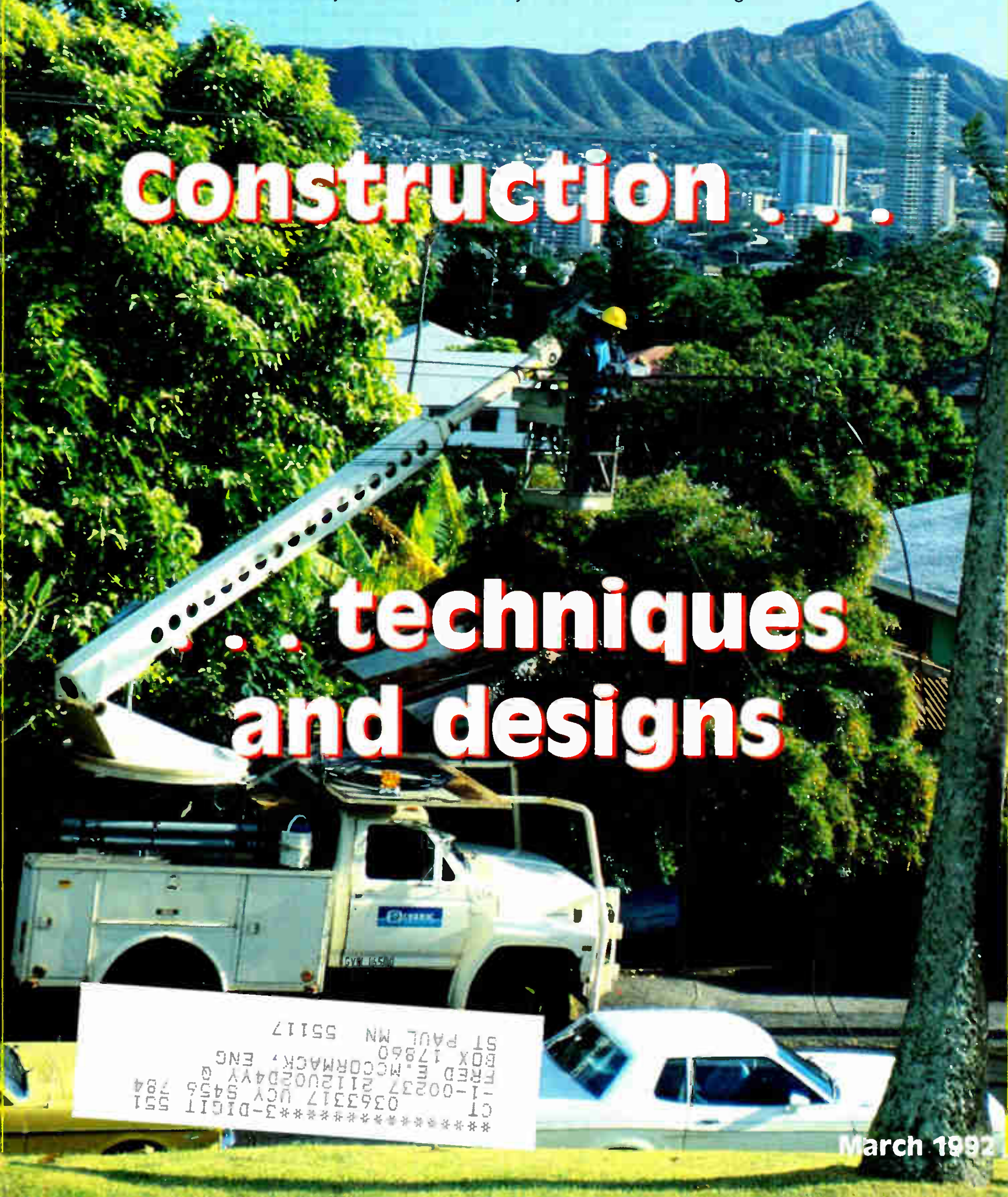
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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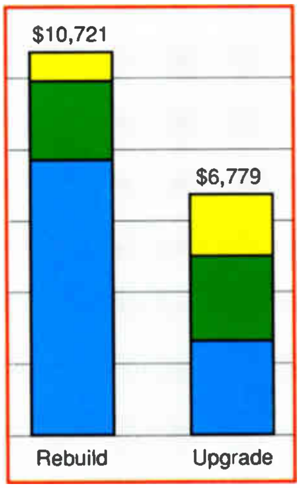

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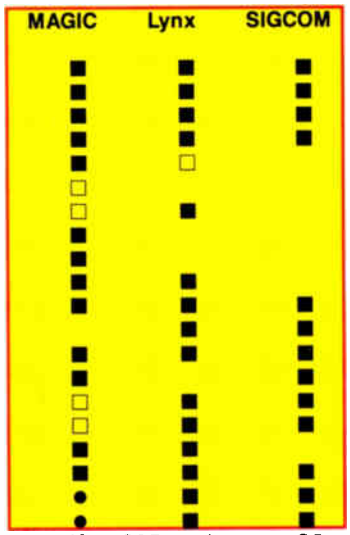

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ONI OPTICAL NETWORKS INTERNATIONAL

Optical Network News

The following highlights are from Optical Networks International's quarterly newsletter.

■ External modulation extends fiber reach

Recent developments in external modulation techniques have yielded performance results unforeseen two years ago. With this new addition to the system operator's "toolbox," fiber can now be economically deployed over much longer distances with ever smaller node sizes.

(See related story on hybrid external modulator/DFB architectures in an upcoming issue of ONN.)

■ Now that you've got it, flaunt it!

The fiber upgrade process can be a community relations coup, if properly coordinated between engineering and general management. ONI has designed a comprehensive launch kit specifically to help operators get the greatest possible public relations mileage out of their fiber upgrades. The kit, "Getting The Most From Fiber Optics: A Cable Operator's Handbook For Community Awareness," includes print ads, bill stuffers, and numerous tools for promoting optical technology in the community. To order a copy, call ONI at 1•800•FIBER•ME.

(See related story in *Communications Technology*, January, 1992, pg. 32.)

■ Taking It to the Streets

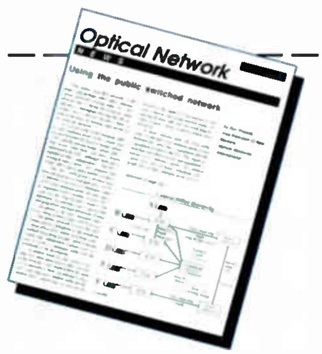
ONI has developed one and two-day training courses, "Taking It to the Streets", specifically for those contractors and installers who do not have the time to attend ONI's week-long "FIBERWORKS". Designed to be taught at the operator's location, Taking It to the Streets includes two separate courses on splicing and construction. The courses can be held independent of each other, or taught on consecutive days, depending on operator requirements.

(For more information call 1•800•FIBER•ME.)

■ Headend interconnects a new focus for technical community

Lately, a few operators are giving thought to streamlining business operations through a process called headend interconnects. This "master headend" concept will have tremendous implications for ad insertion, as well as reducing maintenance and real estate costs. Headend interconnects will be especially economical when digital compression technology is added, by consolidating expenditures for digital receiving equipment.

(See related story in the Summer issue of ONN.)



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EDITOR'S LETTER

Keeping in touch

Well, I finally did it. I have become one of the hundreds of thousands of "communicators by computer." You know, a person who connects his or her PC to a modem, and in turn connects to a remote bulletin board system (BBS) via the phone lines.

Oh, sure, I have used similar technology in ham radio — it's called packet communications. Packet is much the same, except that the PC is linked to a BBS or another PC via amateur radio rather than the twisted pair network of the telephone companies. And even though I had even checked in to a couple boards via phone modems in the past, I just wasn't a full-fledged user.

Hooked

What did I do? I gave in and joined CompuServe. And I joined the National Cable Televison Association's BBS, as well as two ham radio telephone-based BBS systems. While I'm still very much a novice at this communication by computer, I have to admit that I'm hooked. I think it's addictive. I'm downloading files and programs, uploading messages, and otherwise running up my phone bill. I've even uploaded articles that I write for a ham radio magazine.

But the serious side of this is that both CompuServe and the NCTA's BBS can be useful in the day-to-day technical side of our business. In CompuServe, for example, is something called the broadcast professional forum (GO BPFORUM). A forum, by the way, amounts to a special interest "computerized" meeting place. It features a message board, a conference area (for real-time conferencing), news and announcements, a forum member directory, and even a library that include downloadable software and other files. CompuServe has forums for just about any hobby or professional interest you can think of. It also has games, online references (encyclopedias), educational resources, travel services (you can access OAG, make reservations, etc.), financial and investment services, home shopping (names like JCPenney, Brooks Brothers, and Spiegel can be found in the "Electronic Mall"), news, weather, and sports. Now I know what happened to the interactive services promised by cable back in the '70s. They're on computer services like CompuServe and Prodigy.

Within the broadcast professional forum is a subsection on cable TV. Here you'll find news about the industry, as well as inquiries and messages from other CompuServe users. (I recently read an interesting note from a student who is a DJ/VJ on his high school's CATV access channel. He was curious about Federal Communications Commission regulation of CATV program content.) When I checked in tonight, I was greeted by E-mail messages welcoming me to CompuServe from Jeff Noah of Tektronix, Steve Johnson of ATC, and forum sysop John Hoffman. CompuServe is so big it has its own monthly magazine. For more information, you can contact its customer service department at (800) 848-8990.

The NCTA also has a BBS; it's run by NCTA's Roger Pience. It, too, contains information useful to the technical side of our business. Industry news, NCTA engineering committee meeting minutes and meeting notices, and other items can be found here. I downloaded the complete text of the proposed new FCC technical standards. This BBS is a great idea. If you're interested in finding out more about it, give Pience a call at the NCTA's Office of Science and Technology. The number is (202) 775-3637.

Online wish list

Of course, the only trouble with these things is the ideas they conjure up: I'd love to see a complete Society of Cable Television Engineers online member directory, the text of *Interval*, articles from *Communications Technology*, online shopping for SCTE videotapes and publications, chapter meeting notices, an industry calendar of events, an online reference that includes all FCC rules and regulations pertinent to cable, technical tables and charts, satellite "bird-in-the-box" info ...

Ronald J. Hranac
Senior Technical Editor


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Jerrold makes upgrade deals

HATBORO, Pa. — Jerrold Communications announced two freshly penned deals (one for Cableoptics and one for addressability).

Time Warner Cable's ATC will use Jerrold's Cableoptics to upgrade Greater Rochester Cablevision's approximately 190,000-subscriber network in Rochester, N.Y. ATC is building a 550 MHz fiber-to-the-feeder network with approximately 600 two-way Jerrold fiber links. This represents the largest single system deployment of AM fiber optics ever, according to Jerrold. As well, ATC will be the first user of Jerrold's new 80-channel 550 MHz single fiber Starfire laser.

Additionally, the Lenfest Group, a Pottstown, Pa.-based MSO, is rolling out Jerrold Communications addressability, including the first large-scale order of the CFT-2000 on-screen display converters. The equipment will be installed over the next three years in systems in Lambertville, N.J., and the Pennsylvania towns of Coatesville, Jamison, Pottstown, Sellersville and King of Prussia. Jerrold will supply addressable headend gear, including all addressable controllers and scramblers, CFT-2000 and Impulse 7000 addressable converters and remote controls.

Augat inks $8 million deal for ATC upgrade

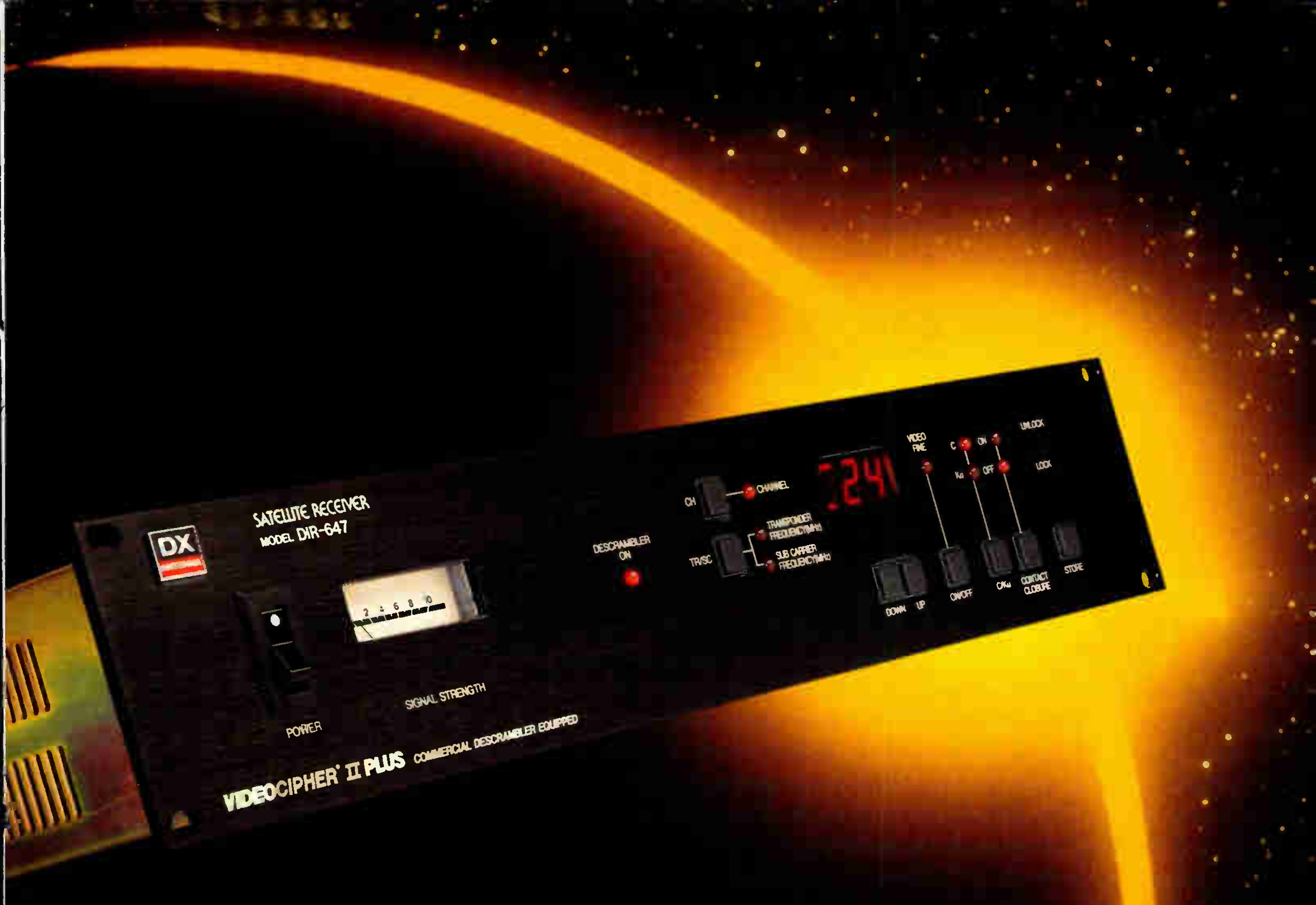
MANSFIELD, Mass. — Augat's Communications Division was awarded an exclusive contract, worth more than $8 million, to supply ATC with all RF distribution amplifiers and line extenders for its Greater Rochester (N.Y.) Cablevision system upgrade. The project, which will span 3,100 plant miles, will expand the system's bandwidth to 550 MHz and increase channel capacity from 36 to 77 channels using a new line of amplification products that can accommodate 1 GHz.

- C-COR acquired a European marketing arm, DataCable B.V. It is to be consolidated with C-COR Europe B.V.
- ComSonics announced repair agreements with TCI, ATC and Warner Communications under its new service protection program, which makes available a wide range of management information reports to facilitate the tracking of repair trends by system, by division and for the total MSO operation.

ONI to market Harmonic's YAGLink

DENVER — Harmonic Lightwaves Inc. and Optical Networks International announced they reached an exclusive OEM marketing agreement for Harmonic Lightwaves' YAGLink fiber-optic system in North America. ONI will do marketing and sales to MSOs and Harmonic Lightwaves will concentrate on providing training and technical support to ONI.

ONI placed a multimillion dollar order for 100 HLT transmitters and 600 HLR 3000 receivers to be delivered throughout this year. ONI reports that the agreement will not affect its relationship with AT&T. According to ONI, it wants to distribute Harmonic Lightwaves' products because they are complementary to those of AT&T.



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DX ANTENNA

Reader Service Number 12

"Fiber Optics Plus" draws 590 attendees

Five-hundred and ninety people were in atttendance when SCTE held its "Fiber Optics Plus 1992" conference Jan. 8-9 at the Loews Coronado Bay Resort hotel in San Diego. This figure represents a 3 percent increase over the attendance of "Fiber Optics 1991," held Jan. 9-10, 1991, in Orlando, Fla.

This event marked the first time that the annual fiber-optics conference, which the Society has presented since 1988, also addressed other emerging technologies, including digital compression, digital transmission and large screen display technologies. In total, 26 technical papers were presented over the two days of the conference.

It is important to note that of the nearly 600 people who attended the conference, one-third did not preregister for the event, preferring to arrive without prior notice and register on-site. While we greatly appreciate the tremendous response that the conference received, the unprecedented on-site attendance resulted in the overextending of the facilities and provisions of the conference site for all attendees. This can be prevented through making the effort to plan ahead and preregister.

Everyone who attended the event received a copy of the *Fiber Optics Plus 1992 Proceedings Manual*, a 258-page collection of all of the papers that were presented at the conference. This manual, which presents a comprehensive look at the utilization of fiber optics in today's cable TV industry, is currently available through SCTE for only $35.

In addition, the Society is offering a complete set of videotapes of the sessions presented at the conference for the discount price of $250. This set also includes a copy of the proceedings manual. For further information on ordering the videotape set or manual, please see the complete SCTE publications and videotapes catalog in this month's issue of *Interval*.

"SCTE Room" added to Cable Museum

The "SCTE Room," a special area in the National Cable TV Center and Museum coordinated and sponsored by the Society, recently held its grand opening following one year of extensive construction, and is currently open to the public for viewing.

The concept for the SCTE Room had its origins in the mind of SCTE Executive Vice President Bill Riker. One day, while walking through the museum, Riker, who serves on the NCTCM board of directors, noticed that there was a great deal of cable TV equipment at the museum that was not being presented in its natural environment. He suggested to the NCTCM board that the Society could organize a coherent presentation of how an actual cable system works using actual equipment. The NCTCM board felt this would be a valuable addition to its exhibits.

Riker next asked the SCTE board to allot him the time to design and build this presentation, which would also include information about the Society and would serve as an effective promotional tool. With the board's approval, he went to work, designing and overseeing the paint-


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ing of a mural of a street scene referred to as "Anytown, U.S.A." that takes up three entire walls in the room and would serve as an attractive backdrop to the model of a residential cable system. Chuck Horner and Glen Smith of TCI assisted him with the planning of a sample cable plant in the room.

Riker spent many long hours in the room erecting actual phone telepoles and organizing the equipment to assure the authenticity of a working cable system. In addition, a sample headend was constructed using actual antennas and two racks of signal processing equipment.

NCTCM Director Marlowe Froke comments, "Bill Riker and his SCTE colleagues have given the students, teachers, government leaders and the general public a major educational and information resource. Anyone who visits the SCTE Room of the center and museum gains, in a very short time, an understanding of how CATV works. Equally important is the sense of the complexity and magnitude of technology that cable now uses to bring information, education and entertainment to our homes. The center is grateful to SCTE."

Expo program announced; registration packages mailed

Packages containing registration materials and information for the SCTE Cable-Tec Expo '92, to be held June 14-17 at the convention center in San Antonio, Texas, were recently mailed to all active national members.

This packet also will contain a schedule of events planned for the expo and information on accommodations and services available to attendees.

SCTE has coordinated the event to make it comfortable to attendees. Registration rates for the expo have not changed since 1986. The expo promises to be a well-attended event and the exhibit floor is rapidly selling out.

In related news, the Society recently announced the preliminary program for this year's event. As of this writing, the program (subject to change) for Cable-Tec Expo '92 is as follows:

Engineering conference

Session A — Digital Compression: Expanding Channel Capacity While Enhancing Video and Audio Quality

Session B — Technical Compliance: How FCC Reregulation Will Impact Your System Operations and Maintenance Practices

Session C — Customer Service: Technology Meeting Subscriber Expectations

Session D — Current Events in Cable TV Technology: Fiber Optics, HDTV, PCN and Outage Reduction

Expo workshops

- Assessing Your System's Picture Quality
- BCT/E Certification: An Overview of Technical Certification and Related Category Examinations
- The Best of "Fiber Optics Plus '92"
- Customer Service: Doing the Job Right the First Time
- EBS and the Cable Industry
- How Will the New NEC, NESC and OSHA Regulations Impact Your System?
- One-on-One with the FCC
- Outage Reduction Techniques
- Primary Testing Under Technical Reregulation
- Secondary Testing Under Technical Reregulation

In addition, BCT/E and installer certification exams will be administered, and more than 200 cable hardware vendors will be exhibiting.

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Reader Service Number 16

Do you know where your system is?

By Herb Longware
Technical Consultant, Magnavox CATV Systems Inc.

If you're reading this article, no doubt you've also been reading many articles relating to bandwidth (or lack of it) and the various reasons for increasing channel capacity. Whatever your reasons, this article will give you some help in determining what you have right now. Your decision to expand bandwidth will be based on what your capacity is now and how expensive it will be to increase bandwidth, and how the system will recoup those expenses.

The accompanying table below provides some popular system parameters from the mid-1970s and 1992. A top frequency of 270 MHz will allow 30 6 MHz channels in the standard cable frequency assignments. With cable systems today approaching this capacity, any additional channels will require more bandwidth or some type of channel compression process. Carrier-to-noise of 43 dB and carrier-to-cross-modulation of 51 dB performance numbers have increased in recent years to take into account larger viewing screens. Tap specifications have increased to take into account multiple TV set/VCR connections and higher drop losses due to expanded frequencies, and most recently more stringent Federal Communications Commission specifications.

Popular system parameters

Middle 1970s
- Top operating frequency: 270 MHz
- Carrier-to-noise: 43 dB
- Carrier-to-composite triple beat: 51 dB
- Carrier-to-cross-modulation: 51 dB
- Tap specifications: High: 11 dBmV
  Low: 6 dBmV

1992
- C/N: 47 dB
- CTB: 53 dB
- X-mod: 50 dB
- Tap specifications dependent on top frequency:
  1) Upgrading 270 to 330 MHz with power doubling and/or feed forward technology.
  2) Upgrading to 450 MHz available with the use of feed forward and fiber.

Figure 1: Calculating peak-to-valley vs. frequency bandwidth

Up to and including 300 MHz: P/V = n/10
Over 300 MHz: P/V = n/10 + 1

Where:
P/V = peak-to-valley in dB
n = number of amplifiers in cascade.

This discussion so far makes the assumption that your system is performing according to the original design specifications. To ensure that we are operating according to the specifications intended, it is necessary that certain tests be done. The annual system proof will give a good indication of distortions and the regular sweeping that is done will check frequency response. But what is the existing system really capable of as a whole or by its individual parts? While rebuilding the entire system may be out of the question, replacing certain parts can give you increased bandwidth at a cost that you can budget for.

The following tests are based on the premise that the system presently makes all of its original specifications. Divide the system into three areas:

1) The worst part of the system — This is quite possibly the oldest portion, or the sections that have been most affected by weather, pollutants, frequent pole replacements, or poor maintenance and construction techniques.

2) The average part of the system — This is usually the section of the system that is middle-aged with more recent equipment.

3) The best part of the system — This is usually the newest part of the system. Chances are, the best part has been recently designed and built to newer, more recent distortion and bandwidth parameters so that this part of the system will need little or no upgrading.

You will want to concentrate on the first two sections of the cable plant. The major components of the outside plant are cable, passives and electronics. After the entire plant that has been evaluated with routine performance testing and sweeping, a field check should be conducted starting with the cable. Test as many sections of cable as possible as this can easily be the most expensive and time-consuming to replace.

Figure 2: Calculating cable loss at higher frequencies

$\sqrt{f_2/f_1}$ x attenuation (dB) of cable at f_1

Where:
f_2 = new higher frequency
f_1 = present frequency

Example: If the cable loss at 270 MHz is 20 dB, what is the loss at 330 MHz? (An increase in 10 channels.)

$\sqrt{330/270}$ = 1.11

20 dB x 1.11 = 22 dB @ 330 MHz.

Testing the cable

With a high level sweep check the response/loss input and output levels on the test piece of cable. This should be in 6 MHz increments up to and including a proposed new frequency limit. Be generous with this frequency limit. Based on system performance, the highest frequency goal can always be adjusted based on final test performance. If a sweep system is not available, add several channels at the input to the section of cable under test with agile modulators, and measure levels with a field strength meter.

The actual level measured in each section of cable is not important at this time, the difference in loss from input to output is. The measured loss of trunk and feeder cables will be subtracted from verified tap, directional coupler and line power inserter losses that are in the line. This will determine how the cable alone will perform. (Figure 2 shows how cable loss at higher frequencies can be calculated from a

(Continued on page 34)

MEMBERSHIP APPLICATION

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Underground coaxial construction — Part 1

The following is adapted from the National Cable Television Institute's lesson, "Underground Construction, I," which is part of the NCTI Service Technician Course. The second part of the lesson — on plowing, and dry and fluid-assisted boring — will run in a future issue. This article will cover chain trenchers, digging the trench, burying coaxial cables and conduit, pulling coaxial cable through conduit, installing cable-in-conduit, and backfilling the trench.

By the National Cable Television Institute

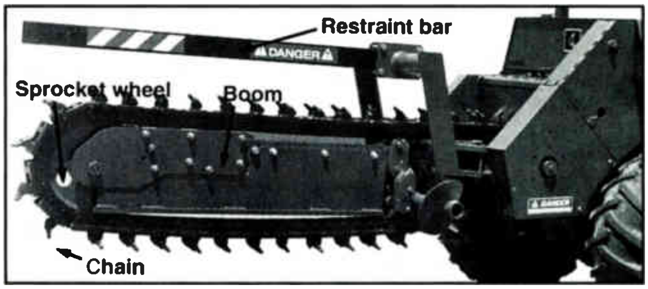
The major kind of trenchers used in CATV underground construction are chain trenchers. These machines dig a trench of varying desired depth and width, the bottom of which is normally level and relatively free from rocks and loose soil. The material removed from the trench is deposited in a uniform pile beside the trench, handy for convenient and efficient backfilling.

There are many types of chain trenchers with a variety of chain assemblies, applications and accessories. Chain trenchers also vary in size and include: walk-behind units; medium-sized, self-contained riding units; larger tractor-mounted units; and, finally, the very large, track-type units. Small and medium trenchers are used most often in trenching operations in easements and along streets in developed areas. Large trenchers are most often used to trench across large open areas, or alongside roads or streets in undeveloped areas.

Although there are many sizes of chain trenchers, they all have one obvious thing in common — the chain. The chain trencher has a roller-type chain to which are attached teeth of various sizes and styles that are suited to varying soil conditions. These teeth are spaced at various intervals on the chain. It is the method of attaching these teeth and their spacing on the chain that determine the width of the trench that is dug. The chain, powered by the trencher's engine, moves continuously along the boom over the sprocket wheels (Figure 1). The boom is usually spring-loaded to create tension on the chain and to keep it tightly in position on its sprockets.

The uninterrupted motion of the chain flows over the top of the end sprocket wheel, down into the ditch, and then up along the undug portion of the trench. Thus, dirt is continuously pulled up out of the ground and dumped against a mechanical auger, which spreads the dirt evenly on both sides of the trench or sweeps it all to one side. Chain trenchers also might have a crumbing or trench cleaner blade attached to the end of the digging chain's restraining bar. This crumbing blade is simply a small scooping blade that smooths the bottom of the trench by pulling along the loose dirt and placing it where it can be picked up by the chain.

Figure 1: Trencher chain assembly



Courtesy The Charles Machine Works Inc.

Trencher accessories make it possible to use the trencher for more than just digging trenches. These accessories include a boring machine and a small backhoe. The boring machine accessory is used to bore under obstacles, such as streets and driveways, without disturbing the obstacle. The backhoe attachment is used to dig a larger hole than the trencher chain will cut. This attachment can be used at pedestal installations and for digging a relatively large hole or exit and entry pits where a boring operation is required. Some soil conditions require the use of the backhoe when the chain trencher will not dig efficiently.

The trenching machinery and acces-

(Continued on page 37)

NOTE:
All construction activities in your system may be governed by OSHA standards set forth in Title 29 Code of Federal Regulations 1926. Always follow your state and local regulations governing all construction activities.

Analysis of upgrade and rebuild alternatives

This article will review the various options available in upgrades and rebuilds. Actual system design analyses were performed to support the findings. In addition, actual dollar values will be provided for the various alternatives.

By Robert E. Young
Director of Distribution Product Marketing
Jerrold Communications

For this analysis, we will investigate an 800-mile system now operating at 300 MHz with trunk amplifiers spaced at 20-22 dB. The system typically has trunk cascades in the mid-20s with some cascades exceeding 40 amplifiers. The present trunk cable is .750 with feeder cables of .500 and .412. Three hundred miles of the 800-mile system have cable that is deemed to be unusable beyond 400 MHz and, therefore, this section of the system will require a total rebuild. The remaining 500 miles have cable that can be used for the bandwidth expansion program and attempts will be made to save this cable via an upgrade rather than a total rebuild.

Franchise requirements mandate

Figure 1: Fiber-to-the-feeder

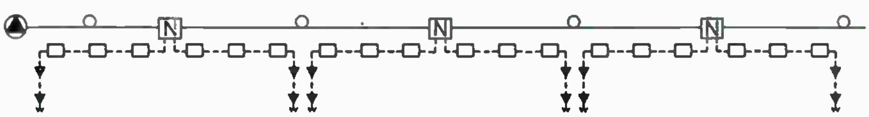


Figure 2: Fiber backbone

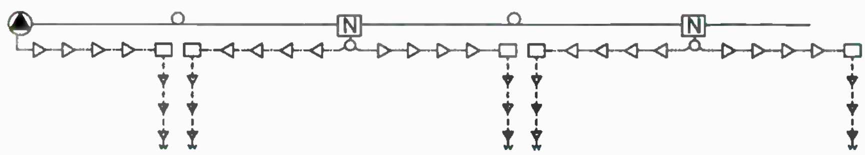


Table 1: Cost estimate parameters

Hardware, cable and equipment	
Strand/hardware	$0.15/ft.
Fiber cable	$0.07/glass ft.
Splice enclosures	$422/each
.860 cable	$0.60/ft.
.750 cable	$0.45/ft.
.540 cable	$0.35/ft.
.500 cable	$0.25/ft.
Connectors	$5/each
Power supplies	$700/each
Labor	
Strand	$0.18/ft.
Lash cable	$0.20/ft.
Lash fiber	$0.50/ft.
Fiber splice	$0.05/sheath ft.
Coax splice	$ 0.09/ft.
Proof and balance	$0.05/ft.

Figure 3: 550 MHz electronics and spacing/headend splitting/49 dB C/N

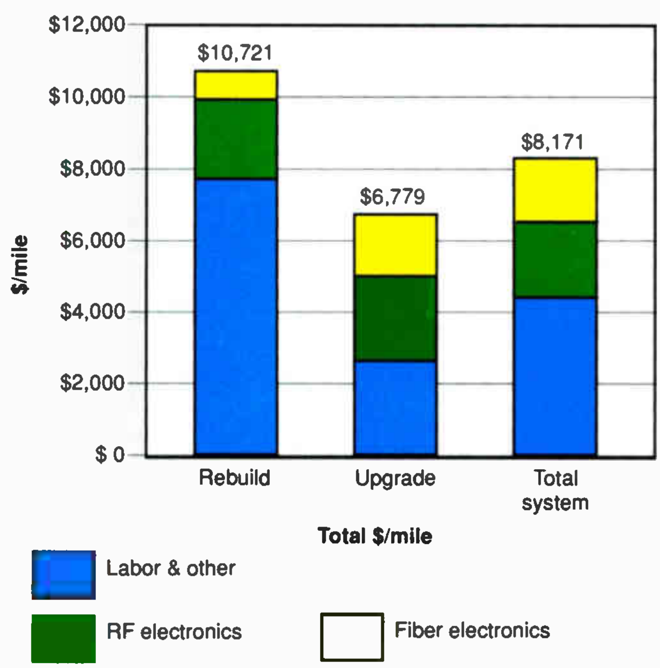


Figure 4: 550 MHz electronics and spacing/field splitting/49 dB C/N

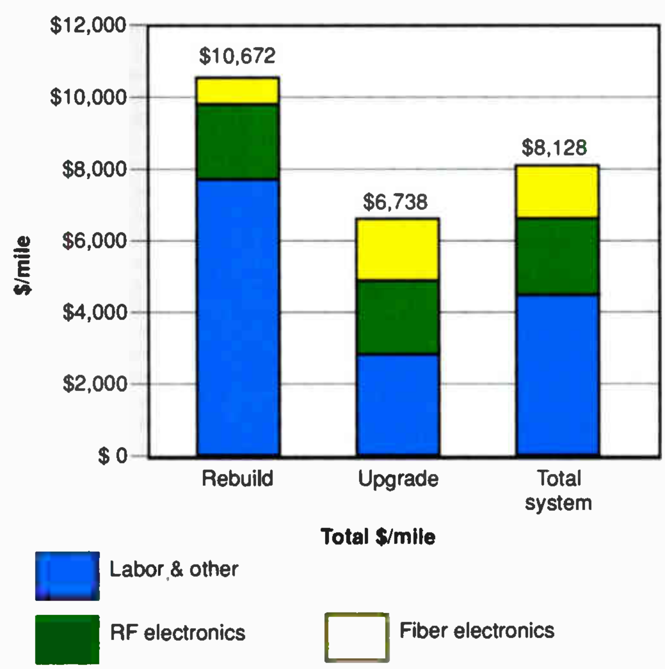


Figure 5: 550 MHz electronics and spacing/headend splitting/47 dB C/N

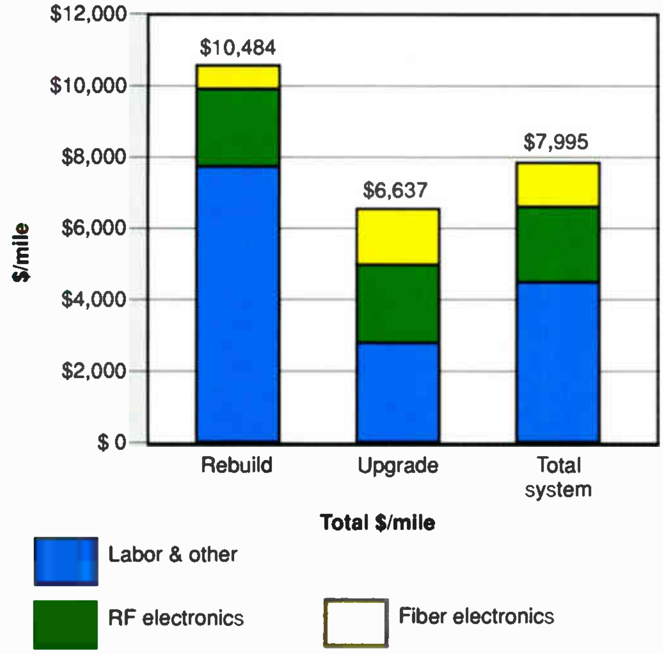


Figure 7: 550 MHz electronics and CAN spacing/headend splitting/49 dB C/N

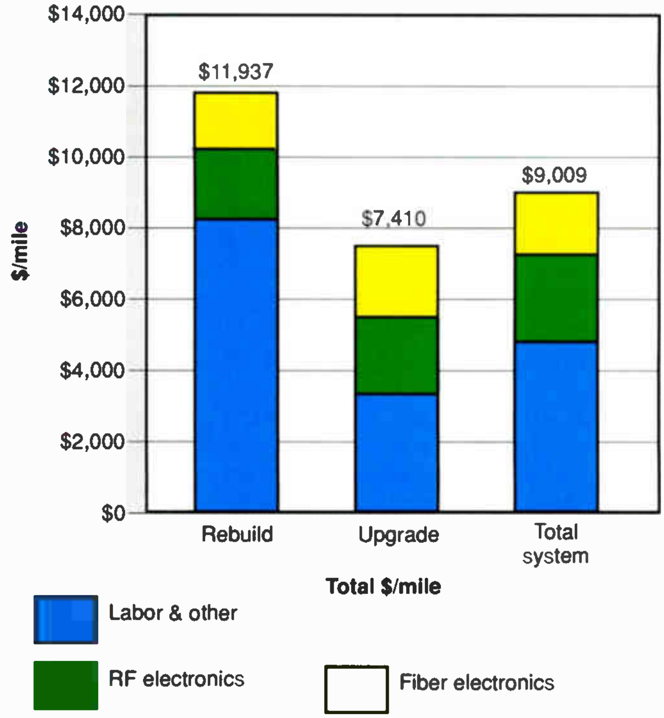
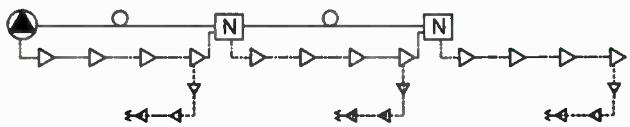


Figure 6: Cable Area Network



the system expand to 550 MHz capability.

Besides the equipment cost associated with the upgrade/rebuild, an attempt also is made to estimate the costs associated with strand, hardware, fiber cable, coax cable, connectors and power supplies. Labor costs also are estimated for hanging the strand, cable, fiber and for proof and balance following construction. The cost estimates for these parameters are provided in Table 1.

550 MHz upgrade/rebuild

The first design analysis for this system called for implementation of 550 MHz electronics, spaced at 550 MHz to provide system distortion performance of 49 dB carrier-to-noise (C/N) and 53 dB composite triple beat (CTB). This initial system design also used headend splitting to feed the fiber nodes. This analysis will serve as a base line for the additional analyses that will follow throughout this article.

The rebuild section of this plant will primarily use a fiber-to-the-feeder (FTF) architecture depicted in Figure 1. This fiber-rich approach breaks down the 300-mile portion of the system into micro cells. FTF architectures have proven to be the most cost-effective approach for total rebuild requirements. The 500 miles of upgrade will use a fiber backbone (FBB) architecture with 31 dB gain feedforward trunk stations and three cascaded line extenders in the feeder system (see Figure 2). Where densities are extremely low, portions of the rebuild sections also will use a fiber backbone architecture. All of these existing trunk locations were maintained ensuring that the feeder tie points remain consistent with the existing system.

Figure 3 provides a breakdown of the costs associated with implementing the system architectures just described. As could be expected, the FTF architecture, used in the rebuild portion of the plant, requires optoelectronic and RF electronic bill-of-material costs approximately $1,000 per mile less than the FBB upgrade portion of the system. Still, the $5,000 per mile of additional expenditures for cable, labor and other equipment (which is the cost penalty of a rebuild vs. an upgrade) more than offsets the electronic equipment savings. The resulting cost-per-mile is $10,720 for the rebuild portion and $6,779 for the upgrade portion, yielding an aggregate system cost of $8,171 per mile.

The next analysis reviewed the potential cost savings associated with field splitting as opposed to headend splitting. All other parameters of the system design remain consistent. Figure 4 shows that field splitting yields a mere $50 per mile reduction in the total system cost. It seems that losing the strategic value of headend splitting would easily justify a $50 per mile incremental expenditure.

The next variant in system design was to lower the C/N performance to 47 dB from the original 49 dB C/N system design target, to test the cost-sensitivity for this parameter. Figure 5 shows that only a 2 percent savings can be associated with the 2 dB reduction in C/N specifications. In review of the components of these costs, however, it is important to note that only the optoelectronic cost components are affected by the change in system performance requirements. The RF electronics and other cost components remain relatively unchanged. Lower

(Continued on page 48)

How to select a CAD system

In addition to general hardware and software considerations, this article will take a close look at three of the popular computer-aided drafting software packages available and how each of these packages will meet the needs of the cable TV industry. The information was compiled and verified by Buckley Communications Services. Functional features have been determined based on the manufacturers' latest software releases as of January 1991.

By Eric Buckley
Owner, Buckley Communications Services

For years, cable TV design has been accomplished in a wide variety of ways. Some remember when designing an extension or an entire system was done with the use of a calculator and a pad of paper. But with the technological advances in the computer and cable TV products, a more sophisticated means of engineering and maintaining a system is being sought by many within the cable TV industry.

With the introduction of computer-aided drafting, cable systems have been looking for a way to economically implement a computer system that will handle their system design and drafting tasks and help maintain the system in the future. But what does the computer market have to offer cable? Which software package is going to be the best investment for the engineering staff?

The computer industry has always been subject to rapid and drastic changes, and the cable industry is beginning to see the effects of the changes. Engineering departments have been longing for a way to make maps presentable and easily updatable with little effort. (See accompanying article, "Scanning CATV maps to CAD," on page 28.) During the past few years, a CAD package has been the tool for accomplishing these tasks, but the CATV industry is looking for more out of its CAD systems. Engineering departments are requiring intelligent graphic maps and data bases that integrate with the graphic information. Cable TV systems would like to begin using the data stored for design and drafting, and apply this information to marketing or to the maintenance of the system.

Before examining some of the software packages available, let's consider what should be expected from a design and drafting computer system. First of all, two terms need to be clarified for our discussion of computer products: design software will be referred to as CAE (computer-aided engineering) and drafting software will be referred to as CAD.

Some people would like a CAE/CAD

(Continued on page 54)

Software packages — general information

General information	MAGIC	Lynx	SIGCOM
Computer hardware	Alpha Micro	IBM/Compatible	IBM/Compatible
Additional software required	None	None	AutoCAD
Single user price * (Includes hardware, all necessary software, training and setup)	$39,995	$29,950	$18,999
Support included	1 year phone	1 year phone	Unlimited phone
Additional support	Available	Available	Available
Phone support	7 a.m.-6 p.m. Mountain	8 a.m.-5 p.m. Eastern	8 a.m.-5 p.m. Mountain
Modem support	Yes	Available	No
Warranty	90 days-1 year	1 year +	90 days-1 year
Users group	Yes(1)	No	No
Documentation	Good	Good	Adequate
Tutorial manual included	w/class only	Yes	No-Videotape
Mailing address	SECAGRAPHICS 350 Indiana St. Suite 200 Golden, Colo. 80401	A.D.S. Inc. 3150 Gateway Dr. Suite 700 Norcross, Ga. 30071	SIGCOM Inc. P.O. Box 5314 Englewood, Colo. 80155
Telephone number	(303) 279-7322	(800) 333-5223	(303) 979-3337
FAX number	(303) 279-2546	(404) 242-8583	(303) 933-4149
Company will build database	Yes	Yes	Yes
Service firms will build database	Yes	Yes	Yes
Company will customize software	No	No	Yes

* Single user price includes cost of additional software required

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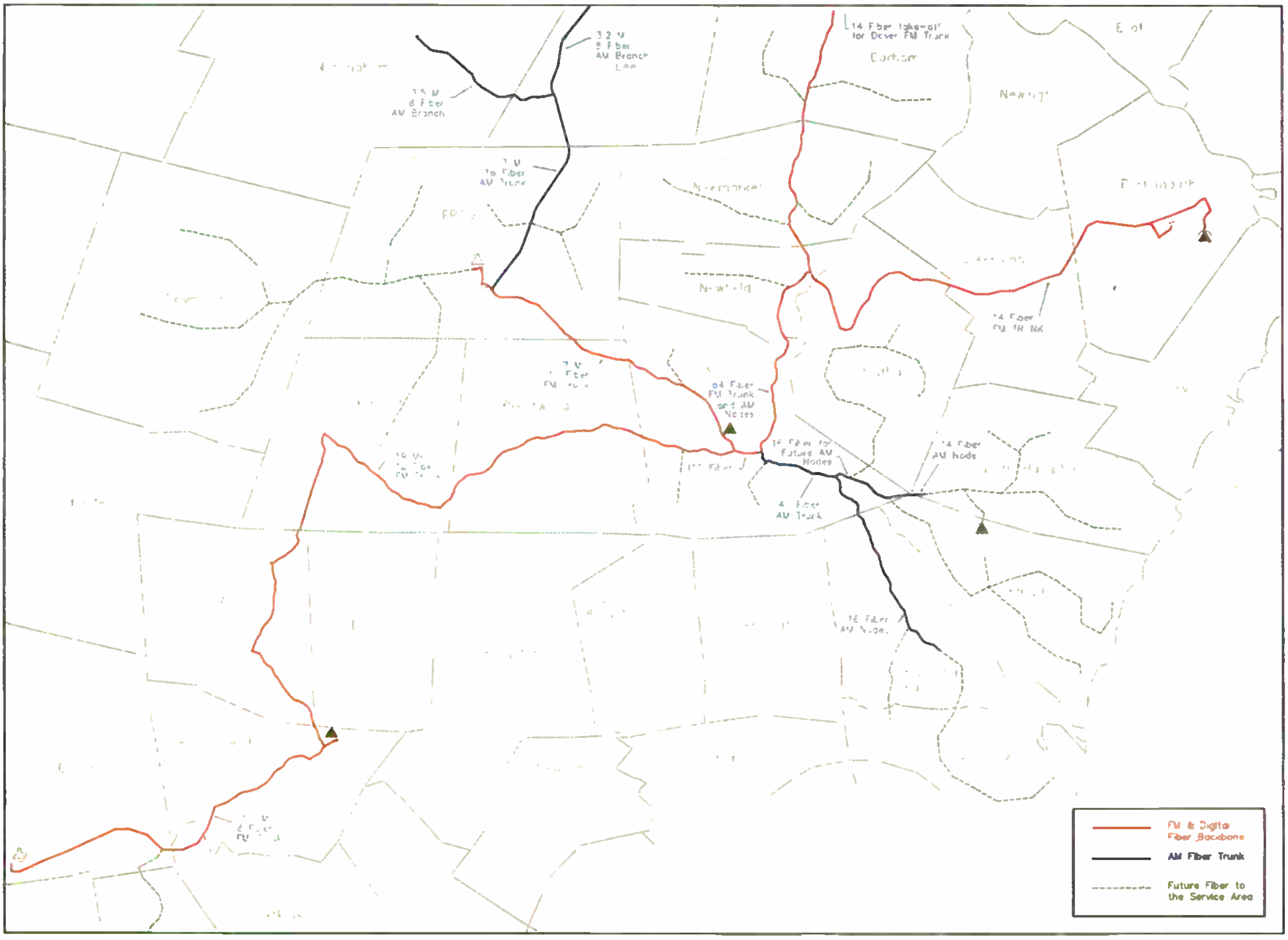
Fiber path for Continental's southern New Hampshire upgrade



Courtesy Continental Cablevision

Fiber optics: Shaping cable's future

By Jon K. Chester
Market Development Manager
Telecommunications Products Division, Corning Inc.

If an ambitious optical fiber upgrade is any indication, cable TV's heralded "broadband network of the future" may arrive well ahead of schedule.

Over the past few years, industry observers have speculated that certain cable TV operations may evolve into advanced communications networks, offering a multitude of programming options, along with new services, such as alternate access, wireless communications and internal data transport. This progression would be driven by the network's optical fiber infrastructure.

The industry's emerging fiber-to-the-feeder network architecture, combined with its investment in fiber throughout the late 1980s, could begin to pay dividends as soon as the end of the century, these experts say. One scenario calls for cable TV operators, having already benefited from fiber's technical and customer service advantages, to channel the medium's incredible bandwidth into additional communications revenue sources. By leveraging its fiber-rich network in this way, cable TV could speed its transition from an entertainment provider to a full-fledged telecommunications concern.

A vision of the future

Continental Cablevision, the country's third largest multiple system operator and an active proponent of lightwave technology, has embarked on a

(Continued on page 62)

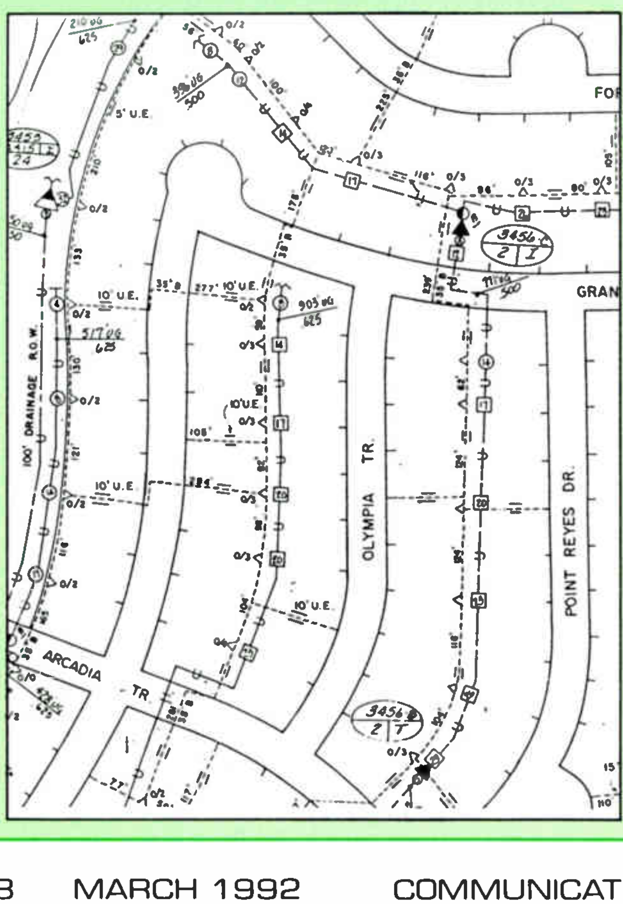
Scanning CATV maps to CAD

Many CATV companies "hand draw" their design maps on paper before they are copied to mylars, which become the permanent record of the system design. To extend the life of the original mylars, they are copied as reproducible sepias, which are then used to produce bluelines or working maps. Design updates and design extensions are noted on the original mylars for permanent record keeping. However, after each change, replacement copies require new distribution. Large systems, or ones supporting sister systems, usually have hundreds or thousands of maps, and the cost of managing updates and retrieval using manual methods is expensive and error-prone. Today, there is an increasing effort of many systems to explore and implement computer-aided drafting (CAD) to improve design productivity and document management. (See accompanying article, "How to select a CAD system," on page 24.) But putting in a CAD workstation creates other economic issues — like how to get existing drawings into the computer quickly and economically. This article focuses on this drawing conversion issue. There are several good CAD packages to choose from, but there is one that stands out in front. AutoCAD from Autodesk is the defacto CAD standard because of its open architecture and because it holds 70 percent of the PC CAD market share.

By John S. Gutierrez
President, ComNet Co.

Many MSOs operate and maintain their systems using hand-drawn design maps. It's a constant struggle to get the latest design information. Drawings often fail to reflect the latest design changes and errors are made, costing money and budget overruns. Design updates usually are done with a calculator, costing nearly $200 per mile rather than about $40 per mile using cable design software. Map updates or as-builts are traced in with fresh ink at a similar cost per mile as designing with a calculator.

Figure 1: Original system design map as an RLC raster format after scanning



When it comes to upgrading or rebuilding a system, misinformation makes it difficult to know enough about the existing system to help save costs. Many cable system engineers recognize these problems and would like to enjoy the benefits of advanced design controls and cost savings afforded by computer-aided engineering and CAD software tools. But this is easier said than done.

When a CATV operator decides to implement a CAD system, the first concern is how to convert existing system drawings to CAD without breaking the budget. Well, the answer seems simple enough — you redraw them. There are several ways of doing this: First, you could use a pointing device (mouse) to recreate the drawing, which is the most time-consuming and tedious method. Second, you could lay the drawing on a digitizing table and trace the drawing with your tablet pointer or puck. Third, you could scan the drawing with a large format scanner then import that image as a drawing image overlay to CAD, then simply use a mouse to trace a new drawing. And fourth, you could just sub it out to a third party.

The major problems with all of these methods is that the conversion costs are very high, thus breaking the budget, and you are still manually redrawing system maps to your new CAD system. What is needed is a method to accurately scan system maps and automatically convert them into a vector CAD file. But this hasn't been easy by design until recently. The automatic conversion of mechanical drawings to CAD software is rapidly becoming recognized as a method to significantly reduce or eliminate the need redraw them. In the past, there were serious shortcomings about the scanning process that left a trail of myths behind.

Scanning overview

As mentioned before, an important cost issue for a new CAD installation is getting existing drawings into the PC. Tracing mylars or bluelines on digitizing tables has been the most popular method to recreate old drawings to CAD. But this is tedious, time-consuming and expensive.

There was a failed attempt by Autodesk to use a TV camera to capture

"Design updates usually are done with a calculator, costing nearly $200 per mile rather than about $40 per mile using cable design software."

drawings into CAD, but the method lacked accurate scaling and did not live up to the need to vectorize the image automatically. It was quickly pulled from the market about a year from its introduction.

Scanning was overzealously promoted to eliminate the need to redraw, and it left many people misinformed and ultimately dissatisfied. In all cases, all scanning did was to eliminate the use of a digitizing table. With a scanned image (or ghost image) running behind the AutoCAD screen, you used your mouse to recreate the drawing by tracing over the image with lines and arcs. This method became to be known as CAD overlay drawing.

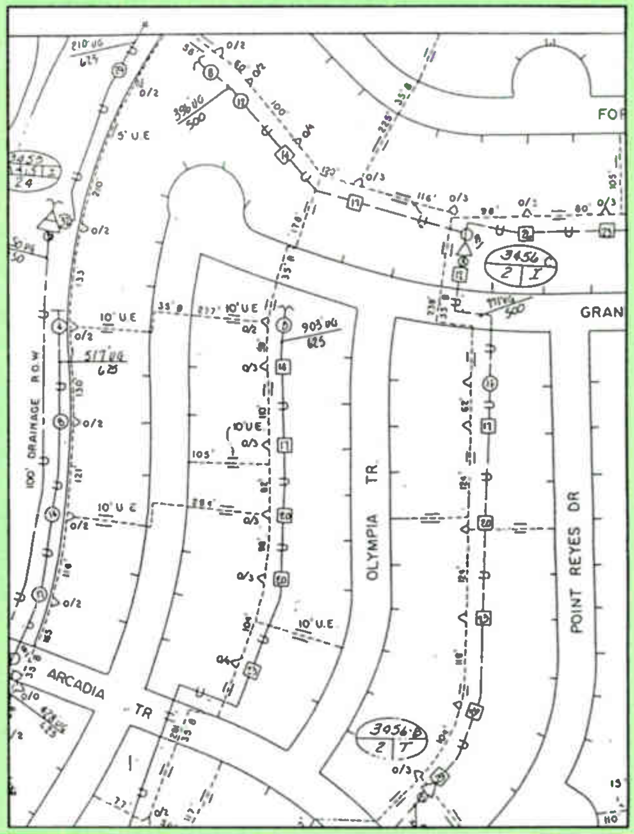
Ironically, tracing over a scanned image wasn't any different than hand-digitizing from a tablet with the exception that you didn't have to hover over a digitizing table and you kept 100 percent eye contact on the screen while digitizing.

The popularity of desktop publishing opened the door for a rebirth of the scanning market. Company logos, caricatures, photos, etc., could be imported into text documents. WYSIWYG (what you see is what you get) became the buzzword. With this came the improved technology for large format scanners with the ability to capture the large E-sized drawings into PCX, RLC, Gp4, TIFF and other raster file formats.

How scanning works

Scanning works like a video camera. A picture image is focused on a X-Y array of thousands of coupled charged diode (CCDs) on a target plate. Each CCD is sequentially scanned to capture a luminance level that is recorded onto magnetic tape. The tape can be played back to reproduce a replica image on a TV set that uses a similar scanning method to trace the image on the picture type.

Figure 2: Pen-plotted output in CAD format after auto-vectorization of scanned map



Here, the scanner operates in the same manner, but with several variations. The CCDs are lined up in a straight line instead of rows and can be programmed to sense two light levels — on or off (called bitmapping) or a stair-stepped incremental increases to light brightness (called dithered or gray scaling). For CAD purposes, bitmapping is preferred because no method exists for CAD to data base gray scale levels.

Using a scanner is much like using a copying machine. As the drawing passes by the line of CCDs, they are scanned in very rapid succession. Each CCD collects a light level that is reflected off the drawing from a light source. Each recorded light level represents a pixel or a dot and is recorded to the PC's hard disk. Resolution is expressed by the number of dots per inch (dpi). Image resolution is dependent on how many CCDs are used and the speed that the CCDs are scanned vs. the speed of the paper feed.

A raster file is a bitmapped image corresponding to the dots or pixels the scanner sees. The raster file is recorded on the computer's hard disk. The larger the drawing size and complexity and the higher the scan resolution, the larger the raster file will be. Scanned images can be recorded in various file formats — PCX, TIFF, RLC, Gp4, IMG, PCL, HPGL, DXF, DXB and others.

Scanner scale accuracy is often better than 0.25 percent, which is better than doing it by hand. A typical D-sized run length code (RLC) drawing with an average drawing density will use an average of around 1 megabyte of disk space after the border, legend and title box is removed. These will be replaced later with CAD block symbols if desired. After vectorization, the original scan can be erased to regain disk space. Most scanning software feature automatic skew correction. This ensures that you'll get a drawing that is in horizontal alignment. Editing scanned images can be done by third-party graphics software, but be aware that lots of extended memory will be needed to handle large scan formats. Otherwise, editing can be painfully slow. Therefore, 8 to 12 megabytes of RAM memory is recommended.

Some scanners provide software to convert a captured raster image into a DXB or DXF format. But this conversion is *not* a true vectorized drawing that all AutoCAD commands would recognize. Instead, each pixel is converted into a short polyline, and pixels that lie in a straight horizontal or vertical row are converted into a longer polyline. These are called trace files and can be very large — exceeding 35 megabytes for a D-size drawing, which overwhelms the PC and slows it down like cold molasses. This type of conversion is not suitable for CAD or CATV design and should be avoided.

Large format scanners have become less expensive. Five years ago a fast E-size scanner could cost about $70,000. The cost today is about one-fifth of that (about $14,000) for a scanner supporting up to an E-sized drawing at 400 dpi. D-sized scanners are available for less than $10,000. As an alternative to purchasing a scanner, service bureaus offer scanning to a raster format for a small fee. Then all you need is the raster editing and vectorizing software and you're in business.

How auto-vectorizing software works

All CAD files are made up of data base records having vector coordinates (X1, Y1) and (X2, Y2). In addition, the data base records can have other attributes such as a radius dimension for arcs and circles. A raster file is made up of rows or clusters of pixels or dots. The higher the number of dpi, the greater the picture resolution will be.

Pixel information cannot be recognized by CAD software until converted to vectors. Today's auto-vectorizing software does this in several steps. The first step is to thin clusters of pixels, leaving a center column of pixels. This thinning process reduces hundreds to thousands of pixel information as a single line, which accounts for the file size reduction.

The column may appear to be straight, staggered or curved. Once the column is found, the thinning process stops, and the raster-to-vector software makes judgements on the column based on what program parameters have been set. Thinning reduces a thick line into a thin line (but can still be a polyline). Solid fills or very thick raster objects are hollowed out, but can be automatically filled in with trace entities if desired. Program parameters can be set to reduce the number of thinning passes to prevent total thinning. Scanners tend to generate imperfect line edges because of thermal noise or using improper contrast settings. In the majority of cases, this jaggedness is caused by ink bleeding into the paper fibers. Look at any drawing under a 20X magnifying glass and you'll see the problem. The line image appears to have sharp edges, but when magnified, blotchy or jagged line edges are seen. This anomaly plays havoc with the thinning process that can cause minute "wiggles" on any line segment, particularly

"The CATV industry is a prime candidate to benefit from CAD and document scanning and cannot afford to stay behind waiting for a 'standard' before making a decision."

when converting very small text images or highly detailed areas.

Smoothing techniques help to line up the pixels either in a straight line or.a curve. Gap jumping permits a line to enter into an area where the pixels do not touch, creating a single line rather than two or more lines. This is done by specifying the number of pixels that separate lines. Lines separated less than the specified parameter will be joined. On the other hand, a line that is broken by several pixels can be automatically joined as one. Line snapping helps to square up horizontal and vertical lines, where the scanned image was sightly skewed. Lines crossing at intersections are confusing for most raster-to-vector programs that create four lines instead of two, which increases the file size. Speckles can sometimes be impressed on the scanned drawing because of background noise or speckles on the original drawing. The size of any speckle can be removed by setting a pixel value during the setup procedure. Any pixel cluster equal or smaller than the set parameter will automatically be erased during the vectorization process. Setting a very large speckle size can erase wanted information, (such as punctuation marks).

The notion that all raster-to-vector software creates many tiny lines for arcs and horrendous file sizes is no longer the case. Arcs are true arcs and lines are lines, unless set for polylines. However, vectorized files are larger than files originally created by AutoCAD. File size disparities will vary in accordance to the drawing itself due to resolution, density and size, but nevertheless, vectorized files will be larger. Several reasons account for this: text is recognized as line segments; hatch patterns and dashed lines are independent small line segments; and long lines may be divided into several short lines.

PC requirements

Running raster-to-vector software requires a fast 386 or 486 PC and lots of free disk space. Avoid 286 and slow running 386 SXs. A minimum of 8 megabytes of RAM should be installed. A tape backup is a must, but if you're going to store hundreds to thousands of drawings, you better look at the rewritable optical storage systems. DOS 4.01 should be used to get over the 32 M maximum disk size hurdle imposed by earlier DOS versions. DOS 5.0 is even better. A math chip is required for the 386 or 486 SX PC. Because raster-to-vector software runs automatically, image vectorizing can be processed overnight using a batch file. An uninterruptable power supply (UPS) is highly recommended. One power glitch during an unattended weekend vectorizing run can ruin your enjoyment of your morning coffee to say the least.

Vectorizing pros and cons

While there are many good reasons to use raster-to-vector conver-

Figure 3: Layout in preparation for a rebuild or new-build

sion software, don't be deceived that it produces the same quality of manual drawing input. Any drawing can be converted — even one hand-drawn on a napkin. Common characteristics of raster-to-vector conversion are:

• Drawings that use hatch patterns can create larger than usual vector files.

• The smaller the text size, the more difficult it is to vectorize it faithfully. Small letters will appear wiggly or even undistinguishable. Drawings with a lot of text, like hatch patterns, will demand extra disk space. Vectorized text is made up of lines instead of text strings. Some CAD text editing or re-entry may be required. Currently, there is one company that offers text recognition for AutoCAD and has a better than 90 percent hit rate. However, it comes with a mighty price tag.

• Dot matrix printer drawings are difficult to vectorize because of the extreme amount of printer jaggedness. Whatever the scanner sees, that's what you're going to get!

• Old, faded and taped-up drawings are not candidates for automatic vectorizing. As the saying goes, "Garbage in = Garbage out." Vectorized drawings, like a paper drawing, have no attribute intelligence. Some programs allow for the creation of a vectored layer and its color, while another creates a separate layer for lines, circles, solids and arcs.

• There is no automatic layering of symbols to data base the drawing. CAD technology improvements bring the designer a wealth of "intelligent" information such as BOMs, symbol attributes, house counts, etc. These drawings require the use of WBLOCKs or drawing symbols having attributes that can be extracted and used on a data base. Also, a data base program can search for an amplifier number, locate the drawing, and automatically bring it up on AutoCAD. These are called drawing data base management systems (DDBMS). But, just remember that a drawing does not have to be in an "intelligent" vector format to be data based — raster files and auto-vector files also can be used, if you use the right software package.

While there are a few minor annoyances about raster-to-vector software, you're going to save lots of time and money. Importantly, you'll have a 100 percent vectorized drawing. For CATV design, basic base maps showing boundaries, property lines and streets are great for scanning. The worst possible case (for very poor maps) is that you can trace over the vectorized drawing. All you have to do is to make new layers, set to a desired layer, and then superimpose lines, arcs, circles, design symbols or text over the vectorized layer. The drawing scale remains the same as that of the scanned drawing. When you've traced all that you need, you can delete the vectorized layer in whole or in part. In many other cases, you can use the AutoCAD CHPROP command to move lines and text to other layers without the need to redraw. Good examples are lot and street lines, drainage ditches, or things that do not change, thus saving an enormous amount of editing time.

The best side of raster-to-vector software is the time saved to redraw a map. A D-size (24- x 36-inch) base map drawing is typically scanned at 200 dpi and vectorized in less than 30 minutes of computer time, regardless of content density. Scanning at 300 dpi offers little image improvement but at the cost of a much larger file size. By comparison, it might have taken 16 hours to redraw this same map on a digitizing table or about 14 hours using a CAD overlay method. After a drawing is scanned and vectorized, it becomes a permanent CAD record. Converted drawings also can be saved on an optical disk, which is preferred for its capacity over magnetic storage for archiving drawings. Drawings will be kept intact for many years long after the mylar has cracked or faded away.

Conversion samples

Figure 1 (page 28) illustrates a section of a D-size system design map (hand-drawn) scanned at 300 dpi in an RLC raster format. It is identical to the original bluelines. The overall size is 10.75 x 8 inches.

Figure 2 (page 29) illustrates the same scanned raster design map after automatic vectorization using Draftsman software. The drawing was pen-plotted at the same scale. The process took less than six minutes on a 386-25 PC. This drawing has true vector lines, arcs and circles and is ready for CAD editing or updating. While it is not, by definition, a "perfect" CAD drawing, it is a very usable and readable drawing. You can add new layers for the amplifiers, for example, and insert amplifier drawing WBLOCKS superimposed above the scanned amplifiers to data base the drawing. After inserting all the amplifiers (also taps, passives, text, etc.), just simply erase all scanned entities you replaced. This is how simple it is to convert a hand-drawn design map to a CAD drawing.

Figure 3 illustrates the same street layout in preparation for a complete rebuild (or new-build). Preparing this drawing required a different approach. Before auto-vectorizing, the original raster design drawing was "edited" using GTXRaster CAD software, which only runs under AutoCAD

Release 11. The raster elements were easily and quickly erased leaving only the street lines. The edited raster image was auto-vectorized within minutes as a DXF file format. After bringing the DXF file into AutoCAD, the street names were entered using AutoCAD's DTEXT command. We have now taken an existing design drawing and have prepared it for new system design using a CATV design software program *without* buying new maps that, unfortunately, may not be current.

Document storage and retrieval considerations

The cost of manually looking up and retrieving a drawing is not exactly free. It has been estimated that it costs about $35 to retrieve a drawing, make copies, then deliver it in-house (arriving a day later). Some systems work with hundreds of drawings per month and the retrieval costs can be staggering.

What can be done to reduce the costs? The best solution is to scan all drawings into a raster format rather than to have them all vectorized. It is a false notion that every paper drawing needs to be in a vector format for CAD usage. It's just too expensive, especially for drawings that are rarely used or are just for archival purposes. Vectorization is not necessary for viewing, editing and printing/plotting. What is important is that all of your drawings can be scanned as raster information, data based and retrieved from your PC when needed — even on a modem from another site.

This is methodology called "imaging." Many industries are using imaging to store and retrieve documents to eliminate paper clutter and waste. For CATV operations, it is relatively inexpensive to raster scan design maps for storage on a large capacity hard disk. A scanned drawing can be vectorized at some future time when the need arises. Why rush to get everything vectorized?

Cataloging the drawings is a simple matter. By using drawing data base software, you can define each map with multiple fields of information such as drawing number, amplifier or power supply numbers, house counts, real world coordinates (excellent for cumulative leakage index), etc. When you need to find a map, simply enter the requested information and a global search of all drawings initiates. When a match is found, it is presented on the screen without using AutoCAD. Press another key and it's off to a laser printer or raster-compatible plotter. Press another key and you can redline design changes for permanent updates by the design department.

In closing

Converting paper drawings and documents to electronic format is big in many large industries. The CATV industry is a prime candidate to benefit from CAD and document scanning and cannot afford to stay behind waiting for a "standard" before making a decision. There will be many to choose from! The one that will work best for your system will be the standard that gets the job done. System design documentation needs to get out of the reams of paper and bulging filing trays and into a computer system that delivers information at the touch of the keyboard. **CT**

Readers wishing more information or to discuss the content of this article may contact the author at (512) 288-6120.

Where's your system?

(Continued from page 16)

known frequency.) In the process of checking the cable, you also will have the connectors under the same test. Large deviations in expected performance should bring cable and connectors under closer investigation.

Testing passives and actives

Check all values, preferably several of each value of passive used. Note the test stamp or date code on the printed circuit board of the passive device if available. Test as many different production runs as possible to give you an idea of average losses. Tests should include frequency response, return loss and insertion loss.

As with passives, several samples of different production runs will give you good documentation of how an "average" amplifier works in your system. The types of testing that should be done with the mainstations and the line extenders are frequency response, gain, return loss and distortions with increased channel loading. If your test bench is not equipped to do these tests, units can be sent into the manufacturer to evaluate for upgradability.

If necessary, hybrids can be replaced with newer ones offering larger bandwidths and better distortion characteristics. Also, RF circuits can be replaced and/or retuned to pass higher frequencies. Upgrading is unit/manufacturer-specific; check with the appropriate manufacturer for options that are available.

When all of the data has been gathered for the three major components, compare them on an individual basis to see what the maximum allowable bandwidth of each will be. Don't expect equipment to exceed the original equipment specifications! Although manufacturers often exceed the published specifications, factory adjustments in achieving these parameters may have been done at the expense of frequency response and return loss outside the original bandwidth.

While working in the system, study its construction. While you are checking components in the field or removing them for bench testing, study the present condition of the system. Cable should be examined for abrasion, particularly around the 3-bolt clamps, lashing wire clamps, straps/spacers and tree branches. Amplifiers should be checked for broken hinges, loose port plugs, flattened gaskets and other items that should be replaced. Passive devices should be inspected for proper attachment to the strand and loose or missing port plugs. Replacement parts are readily available for active and passive devices.

While cable and connectors will be evaluated in the field, the testing of actives and passives will provide more accurate results if it is done on the test bench. While amplifiers can often be upgraded in frequency, it is not cost-effective to do this with passive devices. New baseplate assemblies are often available to upgrade the passive housing without removing it from the system.

In conclusion, if you are considering increasing your bandwidth, look to your existing plant first to see what it is capable of, test the major components in different parts of your system for performance at expanded bandwidth, and inquire about what changes can be made to your existing plant to give you revenue-generating bandwidth at a price you can budget for. **CT**

Figure 2: Typical depth of coaxial cable in a single trench

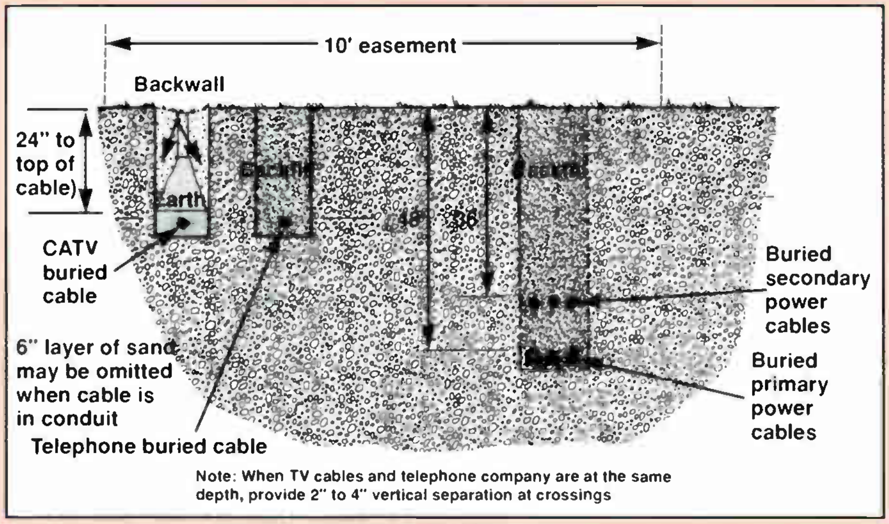


Figure 3: Typical depth of coaxial cables in a joint telephone trench

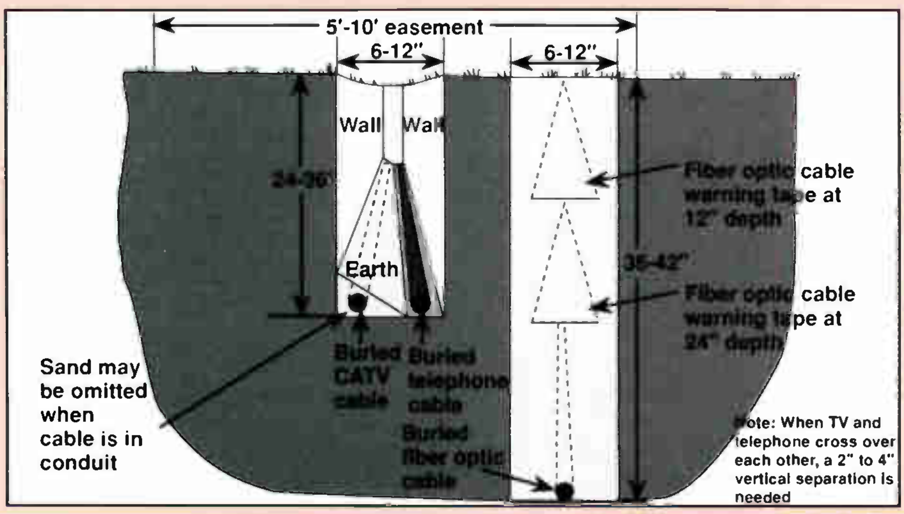
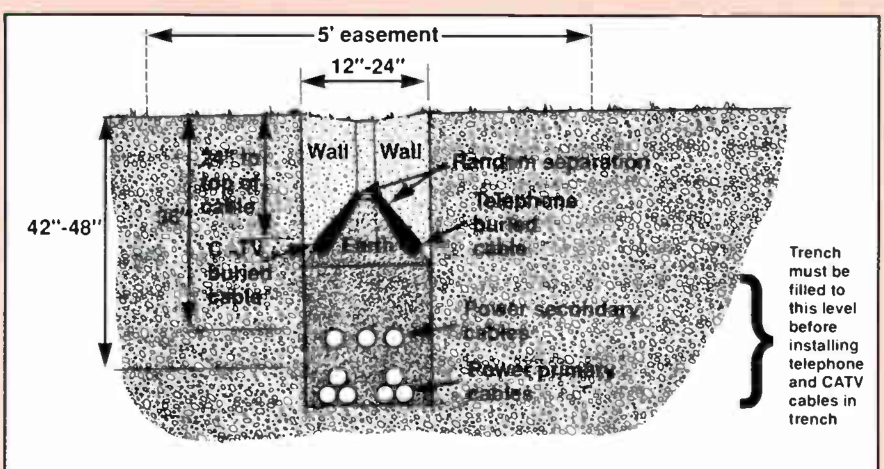


Figure 4: Typical depth of coaxial cables in a joint utilities trench



Underground coaxial construction

(Continued from page 20)

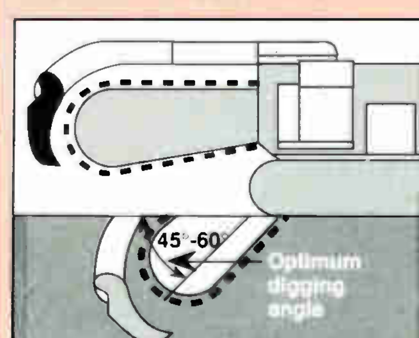
sories are mechanical devices and, like all other such devices, are capable of inflicting serious injury. The importance of fully observing all safety precautions cannot be overemphasized. Only technicians who have been trained in the safe operation of the chain trencher should be allowed to operate the machine. Always follow the manufacturer's and your system's safety guidelines during operation. Keep loose clothing and long hair away from the moving parts. Always keep bystanders away from the trenching operation, and, if necessary, assign someone to direct traffic away from the work. A safe distance of 10 feet or more should be used by workers observing the trencher during operation. Before operating the chain trencher, visually inspect it for any loose bolts, broken chain teeth or any types of fluid leaks that could cause injury to the operator or severe damage to the trencher.

Digging the trench

Trenching involves three operations: digging the trench, burying the coaxial cable or conduit, and backfilling the trench. Before any of these can performed, the other utilities must be contacted for the location of their lines.

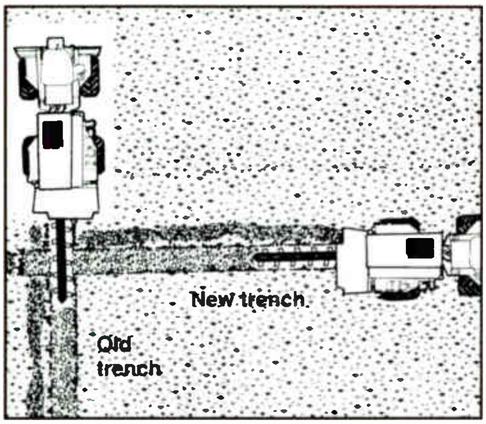
Many states have a one-call system where the company doing the digging calls the one-call number and is then required to give all the necessary information: location, date and time of the trenching. The one-call system will contact all of the utilities to locate their lines in that area. This utility location step is very important in the prevention of electrocution, gas explosion or waterline breakage. This step will ensure

Figure 5: Trenching using optimum digging angle



Courtesy Vermeer Manufacturing Co.

Figure 6: Sharp turns with a trencher



personal safety and prevent costly accidental utility line cuts. Ask homeowners for the location of all private underground electrical, phone and water sprinkler system lines. If the homeowners are not sure of the direction of the underground water lines or the underground water sprinkler maps are not accurate, dig down at the sprinkler heads to determine the direction of the underground water lines.

At the site where the cable burial is to take place, unload the trenching equipment. Take it to the place of the first pedestal location as indicated on the CATV system design map. Using a sod cutter, cut a strip of sod the entire distance between the proposed pedestal locations. Cut this strip into 5-foot lengths, roll up and remove the strips, and place them off to the side, or on plastic/plywood, keeping the strips moist. Replace and water the strips of sod after backfilling and tamping is completed. Where rock or bark landscaping is encountered, the rock or bark should be moved. Care should be taken not to damage the underlying plastic or landscape fabric during removal, trenching, or replacement. Any tears in the underlying material should be overlaid with the same type of covering.

After the sod is removed along the cable route, dig a trench with a trencher or with a digging shovel as narrow as possible and at the depth required by local codes and/or cable TV company policy. Examples of typical depths of cables for single and joint-use trenches are shown in Figures 2-4 on page 37.

The maximum digging depth to be dug by a trencher can be regulated by its depth adjustment. In some cases it is desirable to use a smaller trencher to maintain the optimum digging angle for the chain. The optimum digging angle varies for different sizes of trenchers, but will be approximately 45°-60° (Figure 5 on page 37). A digging angle that is too steep may produce too much stress on the boom and require a much slower machine movement than if a larger trencher were used to allow a more nearly correct boom setting. Conversely, a boom angle that is too flat may produce an excessive amount of machine vibration, making the operator extremely uncomfortable.

No matter what type of earth you are operating the trencher in, eventually you will encounter large rocks. Although trenching machines are capable of removing large rocks, a considerable amount of vibration in the chain can shorten the life of the trencher. The best procedure is to raise the digging boom, pass the trencher over the large rock(s), and then remove it (them) with a manual-type digging bar and/or a digging shovel after the trenching operation is completed. A backhoe may be required to remove larger rocks.

Figure 7: 6-inch sand screen

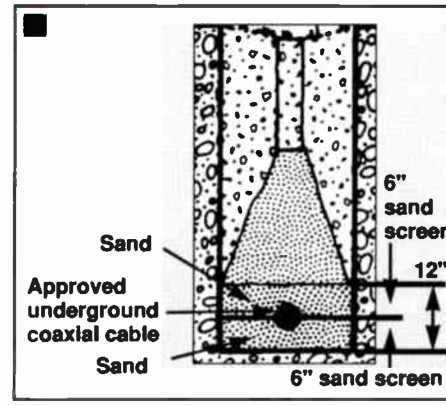
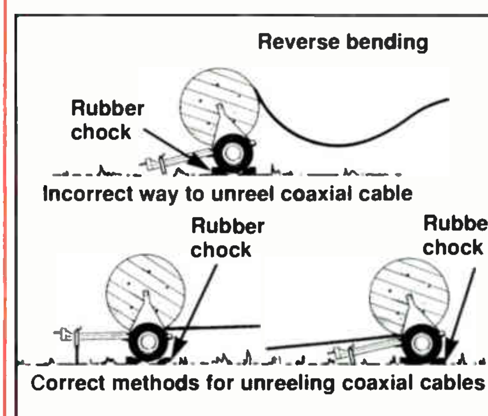


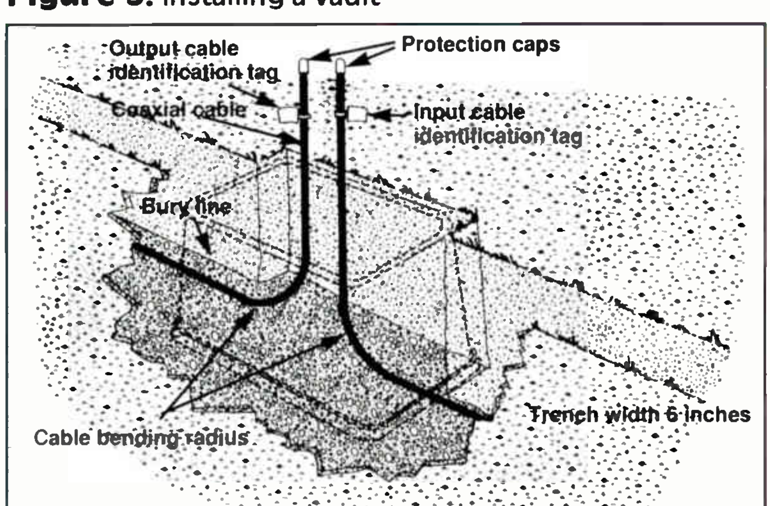
Figure 8: Unreeling coaxial cable



Gravel-laden soil is perhaps the most troublesome type of terrain. Although it might be assumed that gravel can be easily handled by the trencher, small pieces will frequently jam the chain in the sprocket wheels. When this happens, the engine will die if the clutch is not disengaged quickly enough. When trenching graveled earth, proceed with caution.

If the digging chain becomes jammed, there are two ways to free it. The first and most practical method is to shift the chain operation into neutral and stop the machine, back up the chain, forcing it with a bar, until the offending rock can be pried out

Figure 9: Installing a vault



Courtesy Associated Plastics Inc.

SIGNAL LEVEL METER ACCURACY

VS.

Plant Performance

Signal level meter accuracy has profound effects on broadband (CATV) performance. Specifications on meter accuracy, however, can be unclear. Flatness is not an overall accuracy measure. It doesn't quantify the instrument's abilities at different levels, meter ranges or temperatures. Meter scaling, tracking or linearity is the ability to accurately track a change in input level at a given attenuator setting. Another specification is attenuator step-to-step accuracy, which is the ability to display correct levels across differing attenuator settings.

Signal level meter specifications can be listed separately, then added for overall accuracy. The accuracy stated may not give a true picture if specifications are omitted. Some manufacturers also specify accuracy by listing *overall* accuracy. The overall accuracy specification takes the above mentioned inaccuracies into account and provides one reliable number.

What does this mean to your system performance? For example, the meter used for system alignment has an overall accuracy specification of +/-3 dB, the carrier-to-noise and second order distortion performance will have a total window of 6 dB. The third order distortions (cross-modulation and composite triple beat) will have a window of 12 dB. These parameters may be further aggravated by temperature variations and channel loading. A system working well with 20 channels may produce substandard pictures with 30 channels. So the big roll-out of new channels turns into a service nightmare.

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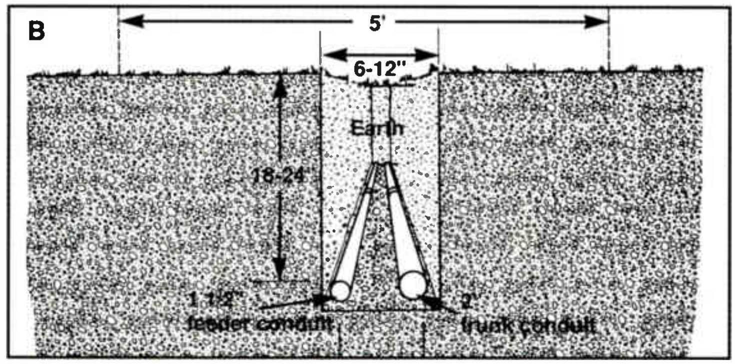
Figure 10: Typical size and depth of conduit for trunk and feeder coaxial cable



with a small pry bar. Many trenchers have a reverse to aid in removing rocks or other obstructions from the digging chain. The second method is to break up the rock with a hammer and cold chisel. This latter method, while effective, can be very difficult. Always wear safety glasses when using a hammer.

To prevent gravel from becoming jammed in the trencher, frequently raise and lower the boom while trenching in this type of soil to help keep the soil and rocks from piling up around the sprockets. Some booms are designed with rollers instead of sprockets. Many of those booms are designed with deflectors and shields to reduce the possibility of rocks, tree roots, etc., from getting between the chain and sprockets or rollers.

Since sharp turns are impossible to execute, only long, sweeping arcs can be maneuvered. If it is necessary to make a sharp turn, drive the trencher slightly past the location of the turn, raise the trencher's boom, and maneuver the trencher into position to start the new direction of the trench (Figure 6 on page 38). This complicated procedure is required whether the trencher is the track type, is mounted on wheels, or is the type you walk behind and manipulate by means of handlebars.

If a fence or sidewalk is encountered before the next pedestal location is reached, use a digging shovel to extend the trench under the obstacle. Extra caution should be taken when trenching close to fences and buildings to protect yourself and private property. A trencher can crawl up a chainlink fence or building if it gets too close to either of these. If hand digging is not possible, make a short bore to go under a sidewalk. Continue trenching until you reach and mark the next pedestal location. Repeat the process as necessary between each successive pair of pedestal locations.

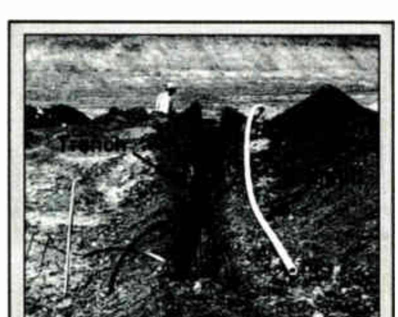
"Certain soil conditions make it necessary to backfill with a different material than was removed from the trench."

Directly burying coaxial cable

Once the digging has been completed, the coaxial cable can be installed in the trench either by direct cable burial or conduit burial.

When the direct burial method is utilized in an open trench (whether random-lay or specified-spacing in a joint-use trench), precautions must be taken to prevent damage to the coaxial cable during installation. Once the trenching is completed, a groundperson should go through the trench with a trenching shovel to ensure a uniform depth and to locate and remove any rocks that could cause damage to the cable. If the soil is rocky, use a minimal 6-inch sand screen (Figure 7 on page 38). Use only coaxial cables designed for direct burial, because this type of cable is protected by an outer steel tape (armor shielding) and/or a flooding compound (direct bury) between the sheath and outer jacket to provide the additional protection to the sheath during installation. All types of coaxial cable can be placed in conduit to prevent accidental damage by rocks and rodents.

Figure 11: Determining conduit length



Courtesy Dynasty Communications Inc.

When there is only an open trench between the designed pedestal locations, directly bury the coaxial cable by unreeling the underground cable (flooded or armored) and installing it directly into the trench. Avoid reverse bending of the coaxial cable when unreeling by following the correct method for unreeling cable shown in Figure 8 on page 38. If there are small bores under obstacles or open trenches under fences, unreel the coaxial cable into one end of the trench and feed the cable under all fences and through all bores until it reaches the next pedestal location.

Use a digging shovel to widen the trench for positioning the vaults or pedestals prior to feeding the ends of the cable into them (Figure 9 on page 38). If the cables are already in the trench, use extreme caution not to damage them while widening the trench. Do not violate the minimum bending radius of the coaxial cable when bringing the cable out of the trench at the designed pedestal or vault location. Check with the manufacturer of the cable for the proper bending radius. Before cutting the cable, ensure that it extends a minimum of 3 feet out of the trench at all pedestal locations. Once the cable has been cut, place protection caps or electrical tape on the ends of the cable and attach identification tags to the input and output cables. Put the pedestal or vault in place as soon as possible to avoid damage to the cable during installation of the pedestal or damage due to vandalism.

Burying conduit

The second method of installing coaxial cable in an open trench is by first burying the conduit in the trench and then pulling the cable through the conduit. Even though direct cable burial is more economical than the conduit burial method because of substantial savings in materials and labor costs, the conduit burial method does have several significant advantages. First, it

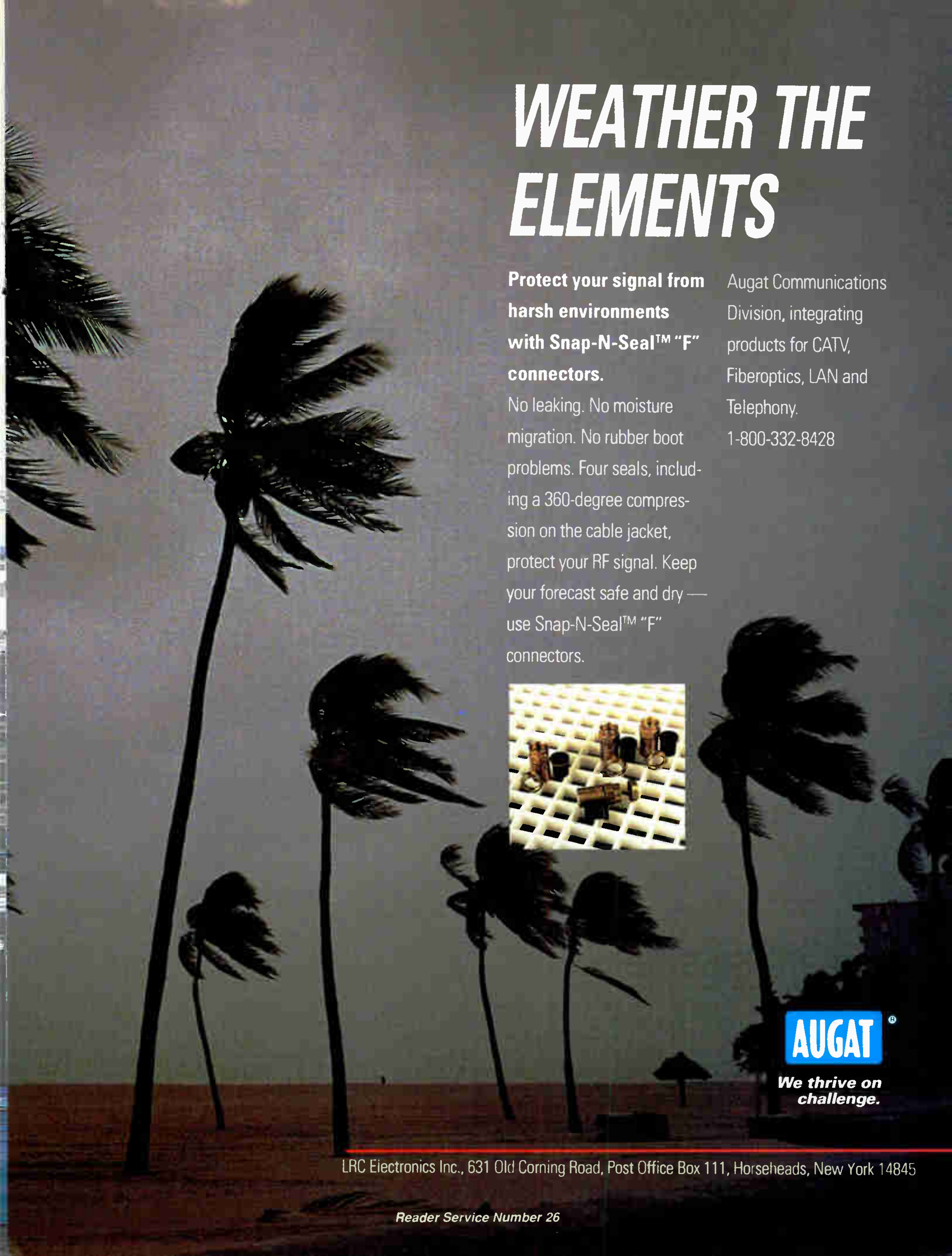

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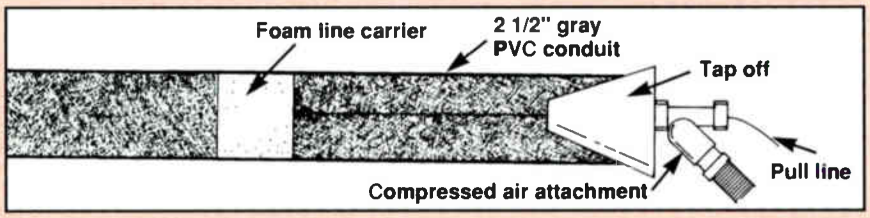
Figure 12: Clearing debris and blowing in a pull line with foam line carrier



Courtesy Jet Line Division/Thomas Industries Inc.

provides "a horizontal hole in the ground" for future system expansion or cable replacement. Second, it protects the coaxial cable from damage during and after installation. Third, it reduces the need for screening or for a sand cushion in rocky soil.

Level the bottom of the trench and remove all humps and loose soil. Dig the trench to the required depth and install the size of conduit suitable to the diameter(s) of the cable(s) to be pulled (Figure 10 on page 40). If future expansion is expected, add additional conduit as necessary (especially when going under major roadways).

Before cutting a length of the conduit for installing in a trench, place it alongside the trench as shown in Figure 11 on page 40 to be sure the conduit will be long enough and will not pull apart from the termination or splice couplings when backfilling the trench. When installing lengths of conduit greater than 100 feet, determine the amount of expansion and contraction of the conduit due to changes in temperature so it will not pull apart from the coupling or termination. This rate of expansion and contraction in plastic conduit is 1.5 inches per 100 feet for every 20° F change.

For example: 500 feet of plastic conduit is originally exposed to 70° F, but by morning the temperature is 50° F. The 20° change in temperature caused the conduit to contract 7.5 inches, or 1.5 inches for every 100 feet of conduit.

CAUTION!

When using a pulling compound or lubricant, use only approved products for CATV coaxial cables, because some lubricants can cause damage to the cable jacket. Two examples of approved pulling compounds are Polywater and Dyna-Lube.

Since conduit lengthens with an increase in temperature and shortens with a decrease in temperature, it is important to expose all plastic conduit and fittings to the same temperature for a reasonable amount of time before assembling. Glue or attach the conduit sections together and place them into the trench between the designed pedestal locations. If the conduit must pass through bores or under fences, install the conduit in the bore or under the fence, and glue or attach it to the conduit already in the trench. Backfill the trench in spots with a shovel to hold the conduit in place when pulling cable.

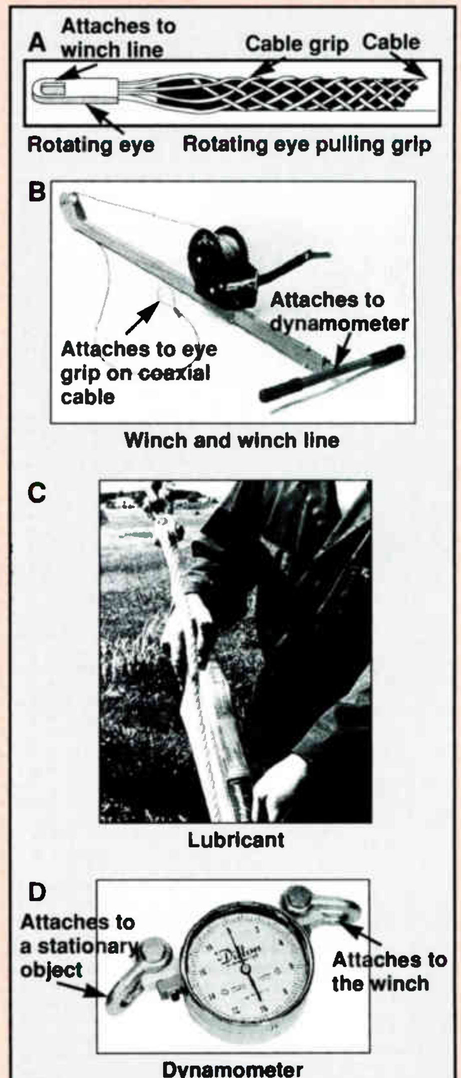
Widen the trench (if necessary) with a digging shovel to accommodate the proper placement of vaults and pedestals. If the coaxial cables are not to be pulled immediately, plug or tape all conduit ends at the designed pedestal or vault location to prevent water and debris from entering the conduit.

Pulling cable through conduit

When you are ready to install cable in the conduit, remove the tape or plugs from the ends of the conduit. Make sure there are no sharp edges on the conduit that may damage cable. Use a portable conduit fishing system to blow a pull line through the conduit (Figure 12). Then attach the pull line to a winch line and pull the winch line back through the conduit.

Put a rotating eye (Figure 13A) pulling grip over the end of the coaxial cable and attach the winch line (Figure 13B) to the eye of the pulling grip. The coaxial cable will begin to come off the bottom of the cable reel as the winch line is pulled back through the conduit. As the cable comes off the reel, apply an approved pulling compound or lubricant (Figure 13C) to the cable to reduce drag on the coaxial cable as it is pulled through the conduit. When

Figure 13: Pulling coaxial cable through conduit



E

P3 CABLE
MAXIMUM PULLING TENSION
0.412" = 150 lbs.
0.500" = 200 lbs.
0.625" = 295 lbs.
0.750" = 420 lbs.
0.875" = 435 lbs.
1.000" = 490 lbs.

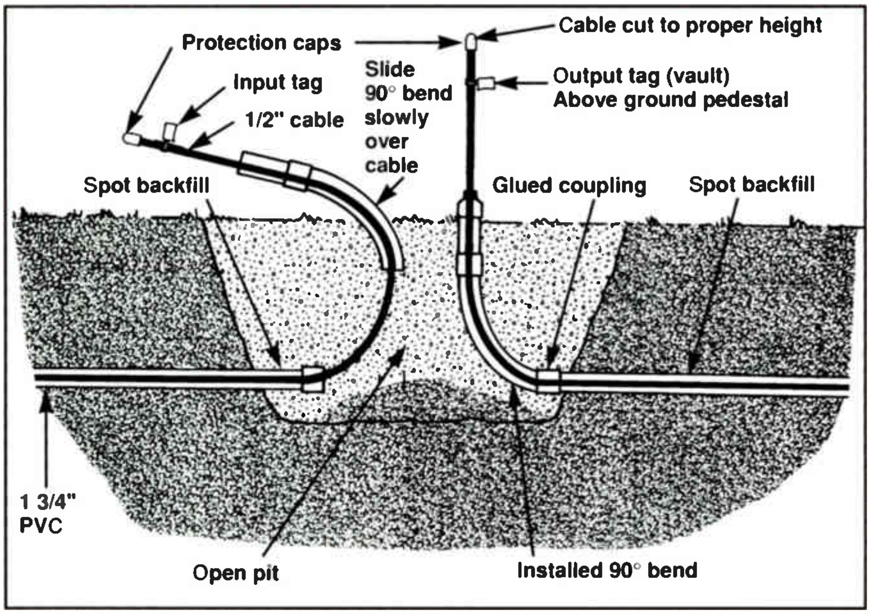
Cable pulling tension chart

Courtesy Jet Line Division/Thomas Industries Inc. and American Polywater Corp.

pulling coaxial cable through long and difficult conduit runs, use a dynamometer (Figure 13D) to ensure that the specified maximum pulling tension for that cable (Figure 13E) is not exceeded.

It is important to remember that any successful cable pull can be accomplished by the proper placement of the conduit, the firm attachment of the cable to the grip, a liberal use of an ap-

Figure 14: Cutting coaxial cable to correct height above ground and feeding it through 90° bend



proved pulling compound, the minimum number of 90° bends, and a continuous, steady pull on the cable with no interruptions during any length of the pull. If two or more cables are to be pulled into the same conduit, pull them simultaneously and not separately. In addition, place all trunk and feeder coaxial cable in separate conduits. This provides splice-free runs and much easier pulls on long runs.

Once enough coaxial cable has been pulled 2-3 feet above the ground level to reach the top of the designed pedestal or vault location at both ends of the conduit run, cut the cable and install protection caps. Carefully feed the cable ends through the 90° bend or flexible conduit and glue its coupling to the previously installed conduit (Figure 14). Install identification tags on the input/output cables. Use this same procedure between each pair of pedestals along the rest of the cable route.

The cable-pull step can be eliminated by using coaxial cable preassembled in a conduit. This conduit with pre-installed cable offers additional protection from damage to the coaxial cable during the installation process. When installing preassembled cable-in-conduit directly into an open trench, be aware that the coaxial cable will retract back into the conduit 25 feet for every 1,000 feet or 2.5 feet for every 100 feet of conduit at the pulled end. You'll need to cut off the conduit to expose the retracted end of the coaxial cable.

As well, the length of the conduit changes (expands or contracts) as the temperature changes. This change in conduit length is 1 foot per 1,000 feet (or 1.2 inches per 100 feet) for each 10° F change.

As shown in Figure 15, the total length of preassembled cable-in-conduit required for any particular trench is determined by the following factors:

1) The trench length
2) The pedestal (3-foot) or vault (2-foot) heights
3) The retraction allowance
4) The thermal expansion/contraction allowance

Also note that the minimum bending radius for cable-in-conduit is much larger than that of underground coaxial cables. This is because cable-in-conduit has a larger outer diameter than coaxial cable. Consequently, extra care is required to prevent kinking the cable-in-conduit when forming around corners or bringing it out of the trench at the pedestal or vault location. Check the manufacturer's specs for the proper bending radius.

Backfilling the trench

The final operation in trenching is backfilling. The trench must be backfilled after installing the cable, the conduit and any underground vaults. Promptness, compaction and cleanup are three primary considerations when backfilling the trench.

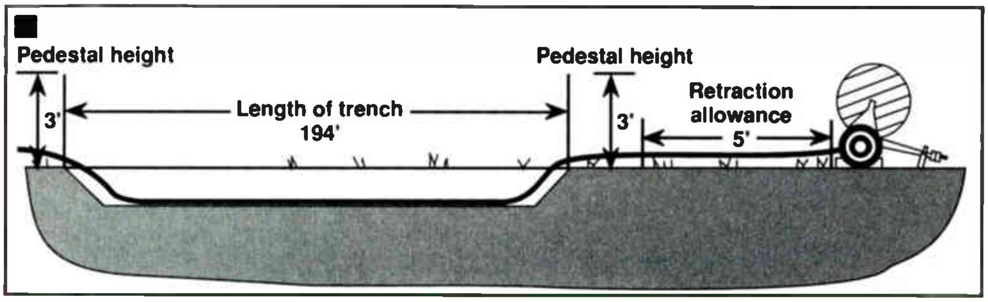
Promptly backfilling the trench avoids disturbing the cable, the conduit and underground vaults. It also prevents injury to people stepping into an open trench and permits the removal of barricades and traffic-warning devices.

Closing the trench before a heavy rainstorm avoids a multitude of problems. Examples of these problems include trench erosion, washing away of backfill material, and possible compaction problems. But perhaps the most important reason for promptness is to avoid that undue concern for property or injury on the part of property owners.

It is very important that the trench be filled with a material that will provide proper compaction. If this is not done, the material in the trench will settle several weeks or months after the trench is backfilled, resulting in bad public relations in addition to the expense of bringing crews back into an area for additional work at a much later time.

Certain soil conditions make it necessary to backfill with a different material than was removed from the trench. Gravel, a soil stabilizer or a slurry mixture is recommended under most conditions where it is difficult to obtain

Figure 15: Determinants of length of preassembled cable-in-conduit



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proper compaction by backfilling with the material removed from the trench. A soil stabilizer or slurry mixture usually is required when trenching on a steep incline since it is virtually impossible to obtain proper compaction by backfilling with soil on a steep slope. When backfilling a trench or a hole in street, it is extremely important to use materials that will result in an absolute minimum of settling or lateral movements after the initial backfilling, compacting and surfacing. If there is any question as to the adequacy of compaction, it is advisable to consult with the city engineer or a private testing laboratory. In cases of extremely unstable soil, a soil stabilizer or a slurry mixture is generally the best answer.

Frequently, the requirements for backfilling and the use of a soil stabilizer or slurry mixture, including the precise mix, will be specified by the city. Normally, a 95 percent compaction can be achieved with a one-sack slurry mix composed of one sack of concrete to one yard of sand. Add just a little water to mix the sand and cement. A two-sack slurry mix consists of two sacks of concrete to one yard of sand. Soil stabilizers require similar mixing quantities, but use the excavated material rather than sand.

Backfilling and tamping in different soil conditions with the same materials may require that the backfilling be done in 10- to 12-inch layers after the cable has been properly installed.

Many cable companies bury a warning tape above the buried cable and just below the earth's surface. This tape warns anyone digging in the area they are digging right above cable TV cables.

Cleanup also is very important and must be done promptly. Whenever possible, accomplish backfilling, seed planting and other gardening and cleanup on the same day. Experience has shown that property owners are highly sensitive to any mess or debris left behind after the trenching and backfilling operations are completed.

The thoroughness and promptness of cleanup operations cannot be overemphasized. After all, it does not make much sense to begin the process of selling a new service in a community by antagonizing the individual property owner in one of his or her most sensitive areas — the appearance of his or her residence before, during and after construction. Coordinate the watering of the sod with the property owner to ensure the restoration of the sod strips and to prevent having to return to the construction site and replacing these items later. **CT**

Technical consultation provided by: Lance K. Bolan, construction manager for ATC in Colorado Springs, Colo.; Paul Broeckert, construction manager for United Artists Cable; Bill Collins, plant manager for Tele-Communications Inc.; Jeff Geer, product manager for Alpha Technologies Inc.; Paul Kelly, construction supervisor of multiple dwelling units department for Continental Cablevision of St. Paul, Minn.; K. Charles Mogray, applications engineering manager for Comm/Scope Inc.; Jim Neil, plant manager for Multimedia Cablevision; Tom Prichard, MSO sales representative for Midwest CATV; Barry Smith, connector specialist for Times Fiber Communications Inc.; Joseph Thill, construction supervisor for Paragon Cable of Minnesota; Jerry Trautwein, consultant for Dynasty Communications Inc.; Gary Wesa, chief engineer for Green Bay Cablevision; and Frank Wiseman, technical communications coordinator, David Bazell, manager of technical training, and Dr. Gerald Stengl, new product research and development manager, The Charles Machine Works.

Figure 8: 550 MHz electronics/750 MHz analog spacing/headend splitting/49 dB C/N

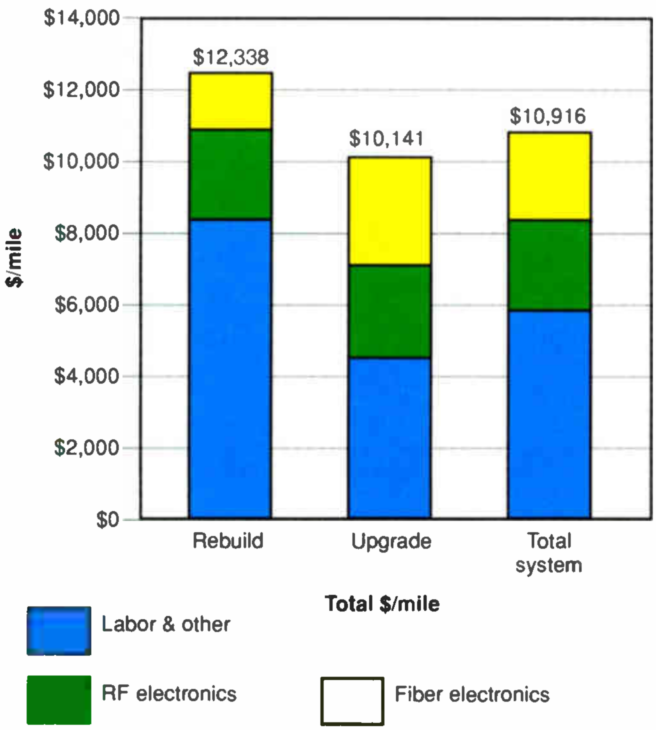
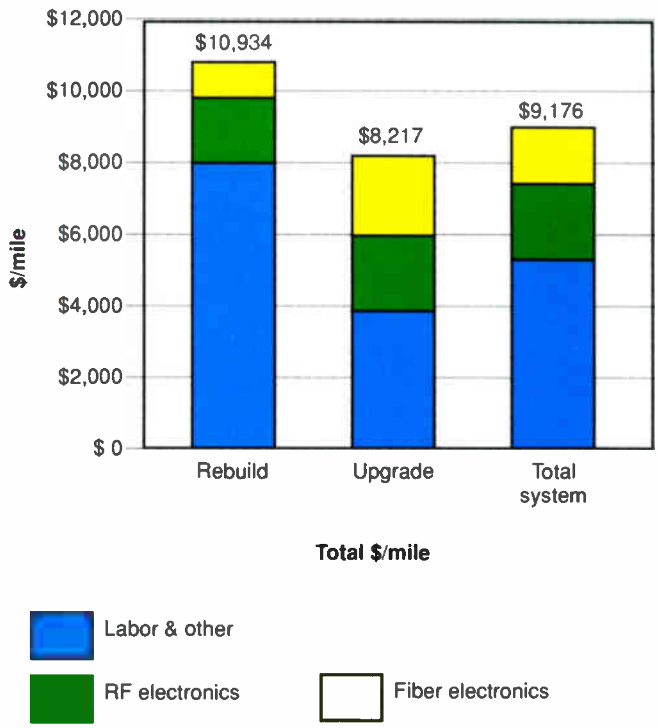


Figure 9: 550 MHz electronics/750 MHz digital spacing/headend splitting/49 dB C/N



Upgrade/rebuild

(Continued from page 23)

C/N performance means implementation of longer link budgets and, therefore, the fiber electronic requirements can be reduced by 10 percent. Further analysis reveals that the optoelectronic requirements in the rebuild portion of the system were significantly reduced (33 percent). This can be explained due to the splitting efficiencies associated with the FTF architecture. In the upgrade FBB architecture, however, the reduction in C/N performance only yielded a 6 percent reduction in optoelectronics, due to the less efficient utilization of fiber in a backbone architecture.

The next alternative given consideration was the use of a Cable Area Network (CAN) architecture for the upgrade area. Figure 6 on page 23 depicts the typical CAN architecture. This architecture provides a coaxial backup to the fiber nodes at the expense of a less efficient use of the optoelectronics. Field experience, however, has proven that coax cable is far more susceptible to breakage than fiber. Since most fiber cables will take the same paths as the coax trunk, the major benefit of a CAN architecture is believed to be in the speed of restoration rather than the overall reliability of the system. Figure 7 on page 23 shows that implementing this type of architecture will increase the overall system cost by approximately 10 percent. RF electronics are relatively unchanged but the optoelectronics expenses have increased by 30 percent. The balance of the increase is associated with labor, cable and other expenses.

Table 2: Total 750 MHz activation costs

Electronics	550 MHz	550 MHz	550 MHz	750 MHz
Spacing	550 MHz	750 MHz	750 MHz	750 MHz
Analog/digital	Analog	Analog	Digital	Digital
550 MHz activation	$6,643	$8,875	$7,460	—
750 MHz activation	$6,238	$3,420	$2,879	$9,214
Total cost	$12,881	$12,295	$10,339	$9,214

Notes: Dollars in thousands, headend splitting, 49 C/N.

750 MHz ready

Despite the 550 MHz franchise requirement, it was deemed prudent to analyze the impact of spacing the system for future bandwidth expansion. Figure 8 shows the impact of spacing the electronics for 750 MHz analog operation, thereby providing for a module upgrade from 77 to 110 channels. This alternative showed a sizable cost barrier of 34 percent ($10,917 per mile vs. $8,170 per mile). While fiber and RF electronics increase about equally for both the rebuild and upgrade portions of the plant (approximately 35 percent increase) the total cost increase in the rebuild area was only 15 percent. The upgrade area of the system, however, increased by 50 percent. This can be primarily explained due to the labor increasing only slightly in the rebuild section while the upgrade section's cable, labor and other expenditures doubled.

The next area of consideration was given to limiting the 750 MHz spacing cost impact by planning for digital channel carriage above 550 MHz. The benefit of digitally compressed signals on system performance comes from the fact that the picture quality of the

Figure 10: Architecture implemented

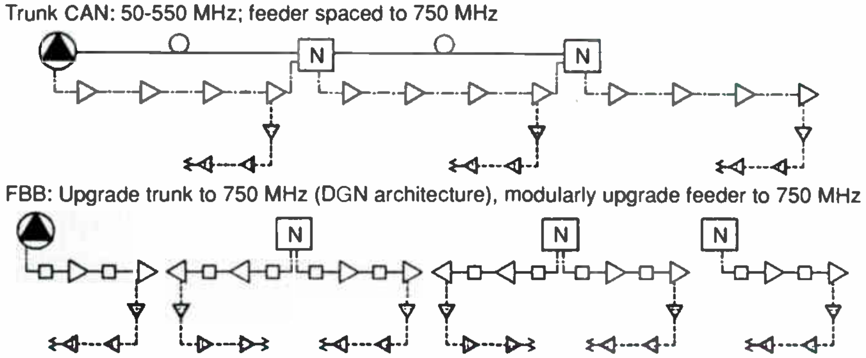


Table 3: Video-on-demand

Node size = 2,000 HPN

Penetration = 60 percent
(1,200 subscribers)

Video-on-demand (VOD) penetration = 25 percent
(300 subscribers)

Subs taking service at same time = 66 percent
(200 subscribers)

Using an 8:1 compression scheme, system requires:

25 analog channel space (150 MHz)

- 550 system = 400 MHz/52 analog channels
  50 compressed channels
  400 VOD programs

- 750 system = 450 MHz/60 analog channels
  25 compressed channels
  200 VOD programs

- 750 system = 550 MHz/77 analog channels
  33 compressed channels
  264 VOD programs

digital channels is not impacted by system noise and distortion, providing the C/N remains above the system threshold. As long as the carrier-to-noise plus distortion ratios exceed the threshold, the digital data is recovered accurately and the subscriber receives the picture with the same quality as is available at the headend.

Since the C/N requirements of the digital signals can be transmitted through the cable system at lower levels than the accompanying analog signals, the reduced loading results in improved amplifier performance for the analog channels. By taking this into consideration, it is possible to reduce the plant cost, compared to a full analog system.

This analysis assumed that the digital signals could be carried at a level 10 dB lower than the accompanying analog channels. This choice of level provides performance improvement while maintaining a fair amount of headroom for the digital signals.

Figure 9 on page 48 shows that the digital 750 MHz approach reduces the 750 MHz spacing cost penalty by 16 percent and leaves only a 12 percent increase over the 550 MHz spaced architecture of the initial system approach. Similar to the analog 750 MHz spacing approach, the biggest cost increase is in the upgrade portion of the plant, where cost increased by approximately 21 percent vs. only a 5 percent increase in cost per mile for the rebuild area.

A review of the 750 MHz options (see Table 2 on page 48) reveals that there is little difference in cost between a 550 MHz spaced channel expansion to 750 MHz vs. an analog 750 MHz spacing with a module upgrade to 110 channels. However, a 750 MHz digitally spaced system architecture will require only a 12 percent incremental up-front investment to yield an overall 20 percent savings to exercise the 750 MHz options.

Figure 11: Network chassis

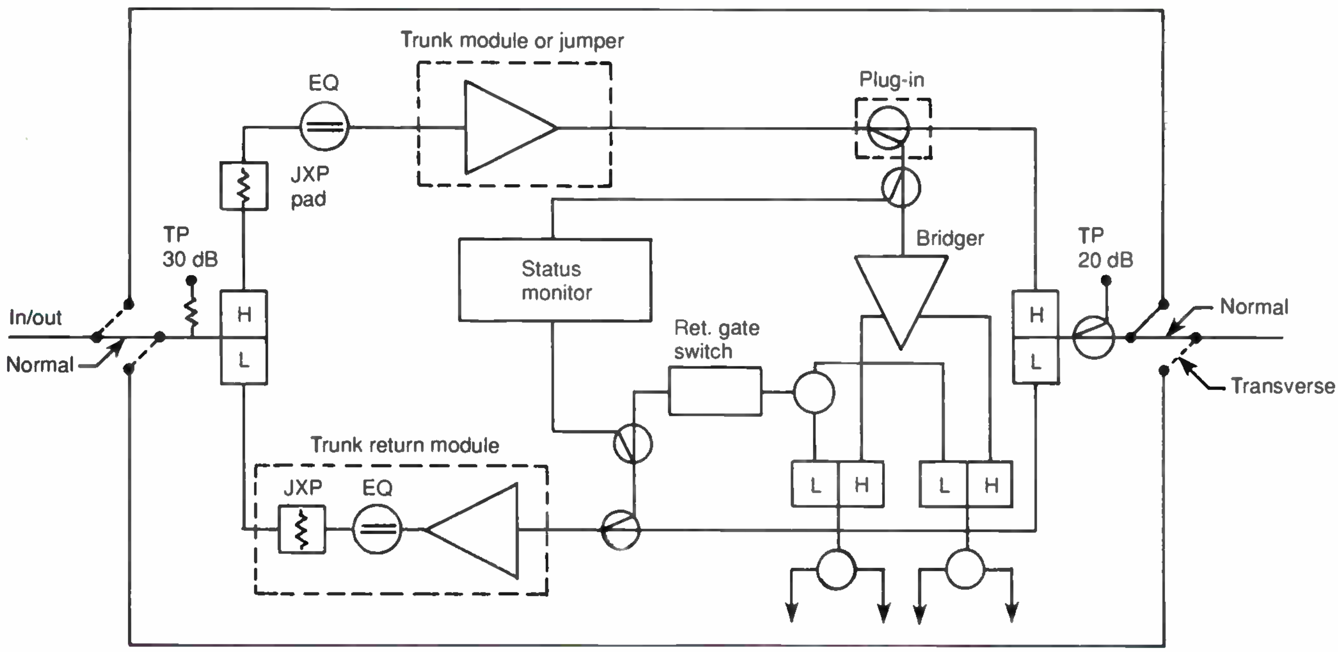
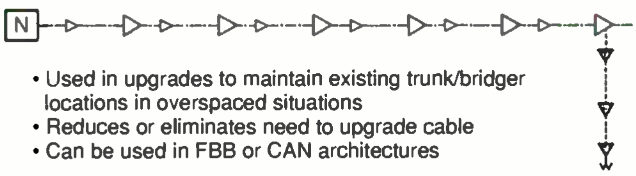


Figure 12: DGN (Cascader approach)



Additionally, the two-stage approach to the 750 MHz hybrid analog/digital capability is only 11 percent above the $9.2 million requirements initially to build and operate the system at 750 MHz. This approach also saves approximately $1.8 million in up-front expenditures, should the expenses for an additional 200 MHz of bandwidth prove to be not economically justifiable.

Architecture to be implemented

The system architecture selected for implementation was based on the cost trade-offs identified in the preceding analyses and gave consideration to other strategic issues. Figure 10 depicts the selected architecture that will be implemented. The trunk system will use modified CAN architecture, where cascades of three or four trunk amplifiers will be used, depending on system density. The trunk is to be spaced at 550 MHz while the feeder system will be spaced for 750 MHz operation. The CAN architecture was chosen to provide ease of restoration via coaxial backup, therefore allowing system personnel there to become comfortable with fiber restoration practices.

The eventual 750 MHz upgrade will require a FBB/distributed gain network (DGN) architecture for trunk with only module upgrades to the feeder network.

Because the 750 MHz trunk upgrade will require stations to reverse direction, a "network chassis" will be used in all 31 dB gain feedforward trunk stations. These chassis (see Figure 11) provide the ease of reversing station direction with chassis jumpers to transpose the station input and output cable ports.

Two alternatives exist for the implementation of the DGN architecture for the 750 MHz trunk system upgrade. The Cascader approach is shown in Figure 12 and uses a 22 dB gain power doubling trunk module in conjunction with a low gain trunk active device called a Cascader. The Cascader (see Figure 13) offers 14 dB of gain and acts essentially as a

Figure 13: Cascader

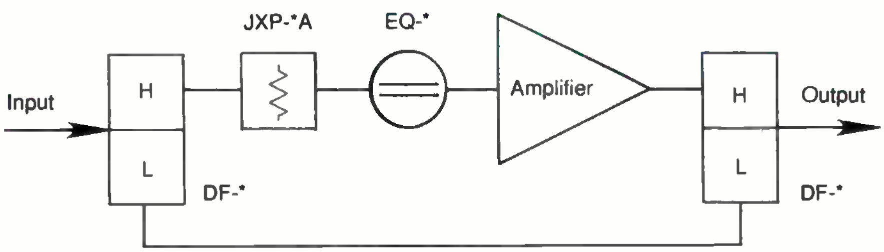
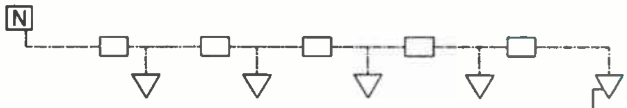


Figure 14: DGN (FITT approach)



- Used in upgrades to maintain existing trunk/bridger locations in overspaced situations
- Reduces or eliminates need to upgrade cable
- Can be used in FBB or CAN architectures
- Trunk station uses a trunk module jumper
- Bridgers are separated from main trunk path electronics
- Trunk stations are network-compatible — may reverse signal direction without resplicing housing

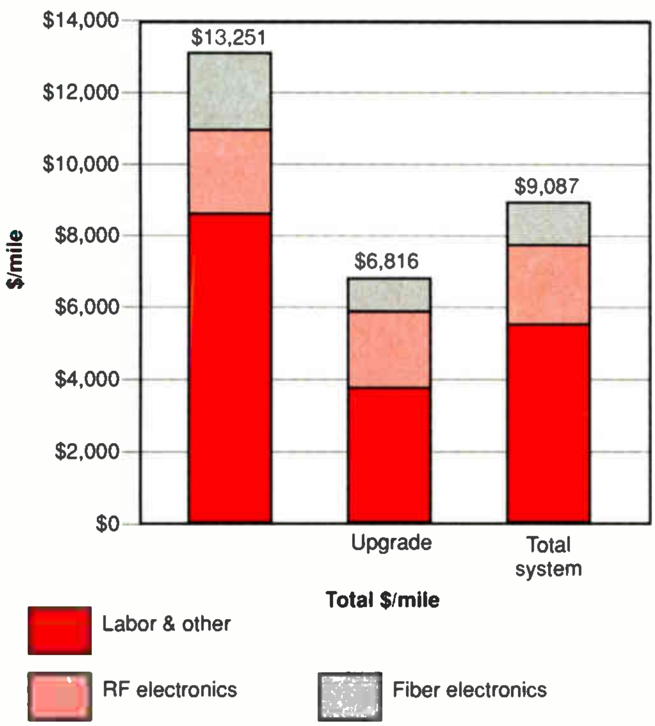
cable shortener. This alternative produces an extremely simple upgrade approach for the trunking network.

The second alternative in the DGN is a FITT approach shown in Figure 14. Although this is a slightly more complex upgrade alternative than the Cascader approach, it yields comparable costs and performance. In this approach the trunk module location in the trunk station is jumpered and an appropriate directional coupler is chosen to feed the bridger module. In addition, a Quadrapower Mini-Bridger is spliced into the trunk cable.

Besides the architectural changes of the final design, it was decided to reduce the system performance requirements to 48 dB C/N. Figure 15 depicts the cost per mile associated with the architecture that was selected for implementation. At $9,087 per mile, this approach offers a very attractive construction cost that is only 11 percent over the initial 550 MHz system that was first considered.

It was deemed that the 11 percent increase in up-front expenditures could be easily justified by the strategic value of this architecture. The CAN approach allows for ease of restoration in the case of a fiber cable cut. A 48 dB C/N is required to ensure customers receive high-quality pictures. Most importantly, however, headend splitting, a 2,000-home per node restriction and an easy 750 MHz expansion capability position the system to readily implement video-on-demand (VOD) services.

Figure 15: 550 MHz electronics and modular CAN trunk/750 MHz digital feeder/headend splitting/48 dB C/N



Video-on-demand

Table 3 on page 50 helps to clearly explain how easy VOD can be implemented on this system even at its initial 550 MHz bandwidth. Based on a node size of 2,000 homes and assuming a 60 percent penetration, the typical node serves approximately 1,200 subscribers in its micro cell. Further, assuming a 25 percent subscriber penetration for the VOD premium programming option, each node serves 300 VOD customers. Even if it is assumed that two-thirds of the VOD customers will want to select a different movie simultaneously, only 200 channels per node are required. By channel loading the system initially with 52 analog channels (a 50 percent increase in the number of channels currently available) and assuming the top 150 MHz is reserved for digitally compressed video (at eight channels per 6 MHz bandwidth), each node can comply with the 200-channel requirement for the VOD programming.

Table 3 also highlights how analog and digital bandwidth can be expanded by exercising the 750 MHz upgrade option to provide for even greater penetrations of the VOD services.

This discussion on VOD capabilities is not intended to gloss over the complexities that must be resolved at the headend to implement it. It is, however, important to understand that the proper system architecture can be implemented cost-effectively today that will support this high-potential program delivery system in the future.

Summary of findings

The following is a summary of the findings associated with the analyses on various rebuild/upgrade alternatives for the 800-mile system under consideration.

- Despite the cost savings for RF and optoelectronics, the cable and labor costs for a total rebuild make it over 50 percent more expensive to construct than a 300-to-500 MHz upgrade.
- The strategic value of headend splitting far outweighs the cost savings of field splitting of fiber cable.
- FTF architectures are more cost-sensitive to C/N requirements than FBB ones.
- CAN architectures are more costly than the FBB type, with the primary impact on fiber electronics costs. But the speed of restoration justifies the additional cost in many cases.
- Spacing for 750 MHz module upgrades has a much greater impact on upgrade costs than on rebuild costs.
- The costs associated with spacing for 750 MHz module upgrades can be significantly reduced if digitally compressed channels are considered for the 550-750 MHz passband.
- System architectures that can fully support VOD services can be economically constructed today. **CT**

The author wishes to express his thanks to Fred Slowik, Bill Beck and Tom Weldon for their assistance in preparing the many analyses that were used as the basis of this article.

Selecting a CAD system

(Continued from page 24)

system that they can take out of the box, plug into the wall, turn on and begin to use immediately with the help of a reference manual. Most CAE/CAD users want a computer system that is easy to use, maintain and train others to use. But a CAE/CAD system is made up of many pieces, such as the computer hardware and software, and both of these elements have different aspects that merit serious consideration. The first area that will be addressed is computer hardware.

Hardware

In the past, there were only a few stable computer companies that provided a reliable product. Now that the computer industry has entered into the age of the clone, it's possible to get a reliable computer from a small, secure company for a significantly smaller investment than offered by the larger companies. Doing business with a manufacturer or supplier with a healthy company track record definitely is advantageous and can reduce problems in the future.

It's a good idea to find out about the manufacturer's financial status. This will indicate whether or not the manufacturer will be around in the next few years. As with most major purchases, it's wise to examine the manufacturers warranty to determine how long the hardware will be covered and what is actually covered. It will normally carry at least a 90-day parts and labor warranty and the manufacturer will offer an extended warranty for an additional cost. These extended warranties are a good investment for those that don't have computer maintenance personnel.

As for compatibility, it has been a big issue for many companies in the past few years. A little research is usually required to ensure that the new computer hardware will be compatible with the hardware that is currently being used by other departments within your company — especially the departments or systems that you will be working with closely.

One of the major dilemmas with compatibility exists in deciding on an operating system. A lot of personal computers are using MS/DOS or PC/DOS, but there are a variety of operating systems that are being introduced into the computer marketplace. An operating system affects the productivity of the new users depending on how quickly they adapt to the computer. This will depend a lot on the CAE/CAD software chosen, but if another individual will be needed to train and maintain the new computer system because of its complexity, that particular configuration may not be worth the investment.

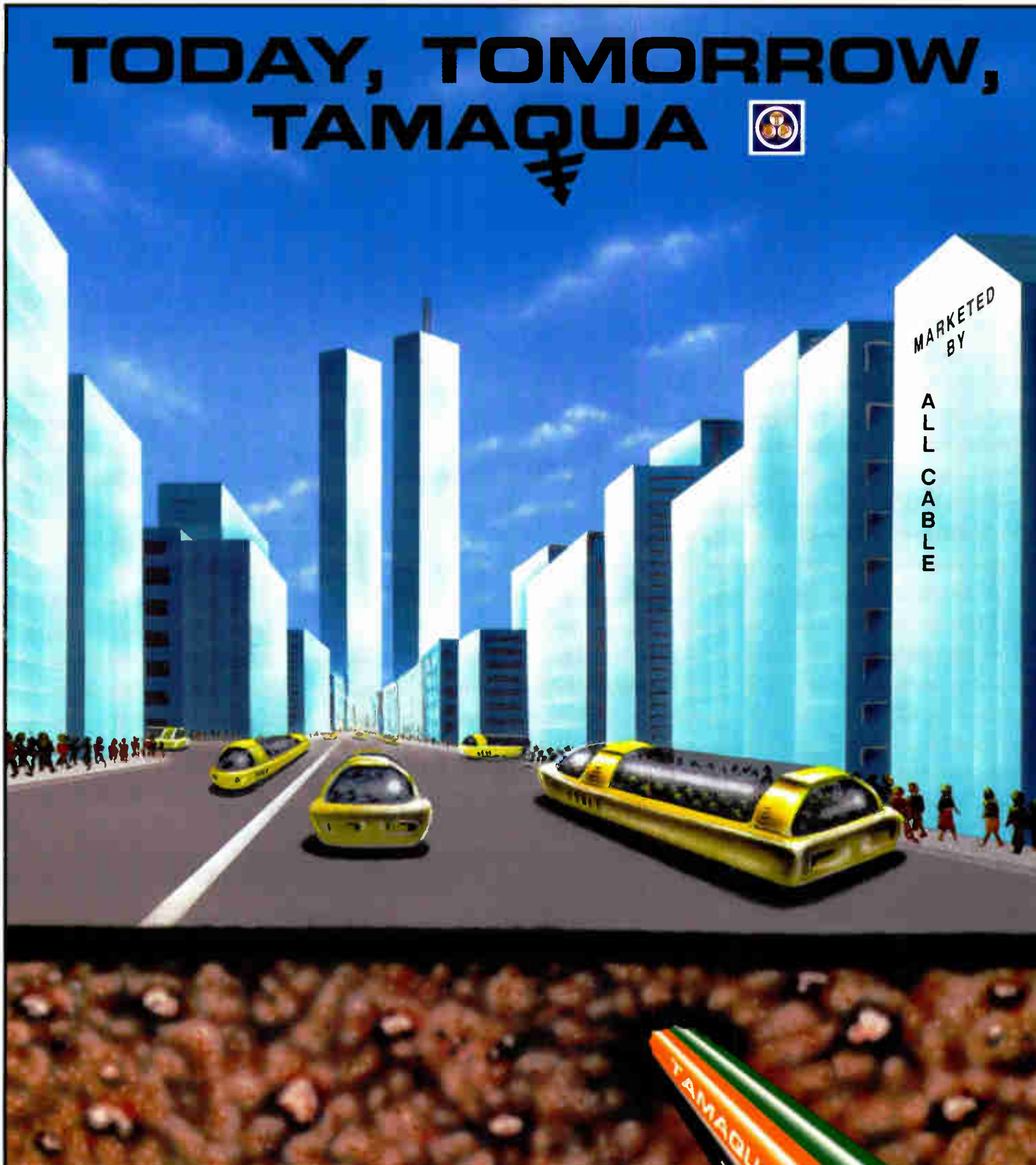
Regardless of what hardware/software configuration is decided upon, problems with the operation of the CAE/CAD system will arise. Some attention needs to be given to how the users will be trained on operating the equipment and how questions and problems will be addressed by the manufacturer or distributor.

In some instances, the company providing the hardware is not the manufacturer. This company should be able to provide a means of determining problems and servicing the computer hardware. Things to look for might be whether or not the company will provide a replacement computer while yours is being serviced to eliminate down time and loss of productivity. Determine if the computer will need to be taken into the shop or if the repairs will be done on-site. This may be something that can be negotiated when discussing the warranty.

Having touched on evaluating the future of the manufacturer and the equipment it provides, you need to anticipate the outlook or plans of your company. With the rapid changes that have taken place in the cable industry and as fast as the computer industry changes, it is necessary to consider how long the computer equipment will last before it needs upgrading. This would involve examining how old the technology of the computer is so you can be assured that it does not become outdated too quickly. When the system needs to be upgraded for engineering use, can it be done inexpensively? Perhaps the outdated equipment can be used elsewhere in the company. These issues should be considered before the purchase.

Software

Computer hardware is still only a part of the total CAE/CAD solution. The next area of consideration is in selecting the software. Probably one of the largest concerns when purchasing software is the price — which you should know doesn't always correlate to the capabilities of the software. →



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Reader Service Number 35

Features included in software packages

Package features	MAGIC	Lynx	SIGCOM
Land base drafting	■	■	■
Strand and route drafting	■	■	■
Design and equipment drafting	■	■	■
Amplifier schematic creation	■	■	■
Project management	■	□	
Vehicle locator	□		
Outage locator	□	■	
Inventory control	■		
Work order creation/tracking	■		
Integrated design/drafting database	■	■	
Fiber-optic design	■	■	■
Separate design/drafting database		■	■
Multiple equipment vendors	■	■	■
Integrated powering	■		■
Menu-driven	□	■	■
Redefine map grid	□	■	■
Map referencing	■	■	
Multiple sets of specifications	■	■	■
Plotter output (maps)	●	■	■
Printer output (maps)	●	■	■
Batch plot or print	●	■	■
Export to other CAD systems *	■	■	■
Import from other CAD systems *	■	■	■
Automated backup of database	■	■	
Automatic title block information	■	■	
Intelligent drafted symbols	■	■	■
Macro capability		■	■
User-customized menus		■	■
User-defined symbols	■	■	■
Search (user criteria)	□	■	
Search and replace symbols	■	■	■
User-customizable commands		■	■
Batch command execution	■	■	■
Distortion analysis	●		■
Customized user reports	□	■	■
Batch reports (BOM, legend)	●	■	■
Reports from graphic display		■	■
Export reports to spreadsheet	□	■	■

■ = functional feature
□ = available in future release/partially functional
● = functional feature can operate in background during other operations
* Exporting and importing does not guarantee compatibility with other CAD systems.

One of the most important elements of software is the documentation. Documentation for any software package should be helpful and probably include a reference manual and a sample session or tutorial. An attractive, well-arranged reference manual can actually improve productivity by making it easy for users to get help when problems or questions arise.

In most cases, if the documentation is easy to use then so is the software. The term "user-friendly" has been associated with a software package that does not irritate a user by demanding they remember numerous, cryptic commands. But later when the users have become familiar with the software, a user-friendly package can be irritating and slow.

Software that is menu-driven is usually a safe investment in regard to productivity and user-friendliness, but the program should be able to handle a sizeable amount of design information. If errors are constantly encountered when handling large amounts of data, it could be due to poor memory management by the software or limitations imposed by the developer to compel users to purchase additional modules or software potential.

Be careful of the modular approach. Some packages seem to meet the needs of most users but are unable to do every task you may need done because the appropriate module was not included in the original agreement. Modules acquired after the original purchase can cost more than when purchased with other modules. This approach can be very confusing and the facts should be clear before progressing with a software evaluation.

The ultimate goal in storing design and drafting information on a computer is to be able to see the effects changes have on the system and to report on how the system is currently performing. The manner in which a software package prepares and delivers reports can play a large part in the decision-making process. Although most software programs offer reporting capabilities of some sort, many lack the ability to customize or modify the way reports are delivered.

Another important element of reporting is the ability to create situations that may develop or test "what-if" scenarios. Some software packages allow this and are an asset when planning for rebuilds or upgrades.

In a CAD system, how the software can output information in a graphic format also is important. CAD packages allow changes and finished product to be accomplished in a shorter time frame than when done manually. Maps can be plotted out at different scales without the need for expensive reproduction houses or hours of drafting time or a section of a map can be plotted out at any scale in just a few minutes or seconds.

Even though these software packages accomplish the same things that were required before (only in a shorter time frame) other advantages come from being able to share information with the technical department, warehouse or construction department. Some companies are even offering users the ability to tie the design data base to the billing or marketing department or even pinpoint outages and maintenance vehicles.

In larger companies, many departments or divisions end up making their own decisions about CAE/CAD software. This poses new problems when a parent company wants access to the data of a division or vice versa. If a software package can import or export information, this can economize an otherwise disastrous situation. The growing standard for exchanging CAD information is called the data or drawing exchange format (DXF). Autodesk instituted this standard and many other software development companies are supporting this import/export standard.

Support and enhancements

Although support was mentioned earlier, there are some other related issues to consider with this subject. Additional costs for telephone and on-site

Descriptions of features in software packages

Package features	Feature description
Land base drafting	Drafting—Highways, roads, railroads, landmarks, rivers, lakes, etc.
Strand and route drafting	Drafting—Strand and trench route, poles, peds, house counts, poles, no., etc.
Design and equipment drafting	Drafting—Amps, taps, DCs, cable routing, amp info, power supplies, etc.
Amplifier schematic creation	Program creates amp schematic from design drafting at user specified scale
Project management	Color coding of maps based on drafting, design or construction status
Vehicle locator	Locates service vehicles in a real-time mode
Outage locator	Locates outages and helps determine possible problem
Inventory control	Tracks inventory in warehouse and service trucks
Work order creation/tracking	Creates WO for areas to be built and tracks use of the equipment supplied
Integrated design/drafting database	Design and drafting programs work together with same database
Fiber-optic design	Design program is capable of designing fiber-optic plant
Separate design/drafting database	Design and drafting programs work separately; can access same database
Multiple equipment vendors	Design program uses different vendors and equipment series in same system
Integrated powering	Calculate powering using design database
Menu-driven	Commands and input using menus not commands or codes
Redefine map grid	A cable systems map grid can be redefined or altered at any time
Map referencing	Maps referenced from other maps by poles, term points or map borders
Multiple sets of specifications	Different specifications can be applied to one database
Plotter output (maps)	Outputs maps to a plotter
Printer output (maps)	Outputs maps to a printer
Batch plot or print	Plot/print multiple maps specified by user unattended
Export to other CAD systems	Export drafting information to another CAD system
Import from other CAD systems	Import drafting information from other CAD systems
Automated backup of database	System automatically backs up database at specified intervals
Automatic title block information	Inserts title block information automatically each time maps are plotted
Intelligent drafted symbols	Drafted symbols contain info that can be retrieved or changed graphically
Macro capability	Multiple keystrokes can be saved and executed as one keystroke
User-customized menus	Menus can be customized to add commands created by user
User-defined symbols	User can create symbols for drafting
Search (user criteria)	User can perform a search for specific object in database
Search and replace symbols	Program can search for symbols on map and replace them
User-customizable commands	User can create a command to enhance productivity
Batch command execution	Batch file can be created to execute multiple commands
Distortion analysis	Distortions calculated based on design database
Customized user reports	Specific data can be selected and output to disk or printer
Batch reports (BOM, legend)	Same as batch plot except for bill of material and map legends
Reports from graphic display	Generate reports from user-specified area on screen
Export reports to spreadsheet	Reports can be exported to spreadsheet (i.e., Lotus, DBase, etc.)

support could be incurred if they are not discussed before the purchase. If it is agreed that these additional costs will be incurred, the customer service staff should be knowledgeable about the product as well as friendly and prompt in responding to the needs of the user.

One aspect of customer service that is often overlooked is the hours that the representatives are available. If a user is on the East Coast and the software company on the West Coast, the representatives should have flexible hours to accommodate the change in time zones. If not, there should be a local individual or support group that will answer your questions.

Many times a software manufacturer does not have the funds to keep a support staff going at convenient hours for all of their users, so an electronic bulletin board or computer support line is made available. In this way the support representative can connect directly to the user's computer via a modem, experience the problems firsthand and many times remedy them.

Another component of a software package to consider is its ability to be customized or how easy it is for the user to define new routines. This is a matter that is better left for open consideration. Some companies don't mind letting their employees develop skills in programming to increase productivity or make their job easier, while others would rather not have employees making additions to software that can complicate or confuse others within the company. Changes or additions to software packages can sometimes void the warranty offered by manufacturer and should be thoroughly investigated before proceeding.

In most cases, the manufacturer will be happy to hear from users about what features they would like added to new releases. This does not always ensure that these new features will show up. And if they do, they are usually accompanied by an additional cost. This should not discourage a user because this seems to be the standard within the computer software industry. Changes or additions are usually gathered over the course of a few months and the most-asked-for revisions are implemented into the next release. It is also common for software manufacturers to increase the price a little for each new release or to charge an upgrade fee to existing users to help defray the cost of programming.

Often a good way to let manufacturers know about changes and additions to software you'd like to see is through a users group. These groups seem to impact the software manufacturers the most and are usually made up of individuals who have already invested in a particular software package. Depending upon the success of the software, the users groups can be beneficial in keeping a software company on the road to success.

Within the cable industry, users groups have been voluntarily formed and have often been regarded by software manufacturers as virtually a firing squad. But software manufacturers are slowly realizing that these users groups hold the key to their success and continued growth. It is important to remember that a users group can only be effective if the locations of meetings can accommodate a majority of the users. The users groups also should be large enough to impact the software manufacturer.

Another source for additions or enhancements to software packages can be found in "third-party developers." These companies or individuals can add value to a software package and they usually have the software manufacturer's blessing. Third-party developers are not commonly found working with cable TV CAE/CAD packages now, but they may emerge in the near future as user demands outgrow software manufacturers capabilities.

Books and magazines are helpful in keeping up with the latest techniques and what's going on in the industry. Currently AutoCAD has a few magazines and quite a number of books to further assist the user but they deal with generic issues and don't really target the cable industry as a whole. Still, articles have been printed in these magazines observing the CAD enhancements for cable.

"The ultimate goal in storing design and drafting information on a computer is to be able to see the effects changes have on the system and to report how the system is currently performing."

No matter which solution is selected, the question that will always arise is, "Did I make the right choice?" If the product was introduced or demonstrated to you by a company other than the manufacturer, research its credentials. Find out why it deserves to represent this product and how much the representatives know about the needs of cable TV.

Researching the credentials of the software manufacturer is always a wise move. When viewing a demonstration provided by the supplier or manufacturer, take along a copy of a map or a DXF computer file of a drawing for the representative to use. This will provide an excellent idea of what problems may arise in your individual case.

Available packages

At this point, a brief overview of three popular packages available for the cable TV industry would be appropriate. Several design packages have been developed for the industry over the years, but few actually live up to the reputation of coming from a respectable, full-service company.

The companies whose packages are listed are very much in tune with the cable industry and have dedicated much of their time to the products they offer. They are no longer considered as companies that simply offer a design or drafting package. They are more concerned with providing complete engineering solutions that can actually pay for themselves and be used more as a tool to increase a cable system's revenue.

• *SECA Graphics' Magic* — This company has been around the cable industry for several years. Most of the revenue the company produces is from the cable TV industry, so it is not about to fold up and leave its customers in the cold.

Currently, it is the only communications software developer that has a national users group. The users group is headed by John Lewis of Oceanic Cablevision in Honolulu.

Alpha Micro and Digital Equipment are the hardware vendors used by the company and both of these companies also have a long track record in the computer industry. The use of these hardware platforms has allowed SECA to develop a product that is multitasking by taking advantage of the UNIX operating system. A considerable increase in the speed of the Magic system has been seen with the introduction of the DEC hardware, which this system badly needed.

The Magic system was the first product out as a bundled engineering package. It has set some of the standards and precedents that many cable systems and communications services firms implement.

• *ADS Inc.'s Lynx MIS* — This company also has been in the cable TV industry for a few years and has constantly realigned itself to try to best meet the needs of the cable industry. ADS built the

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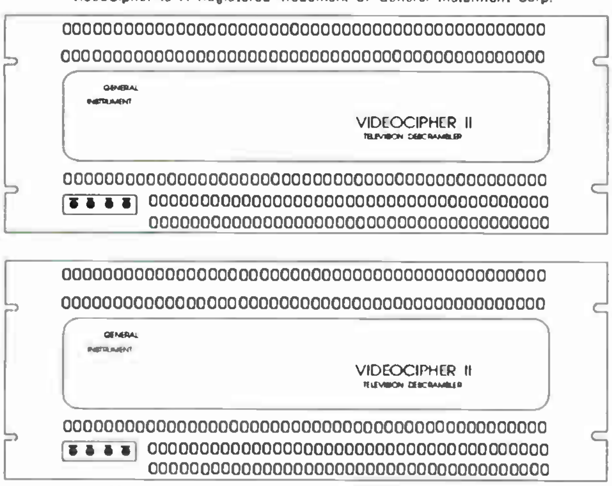

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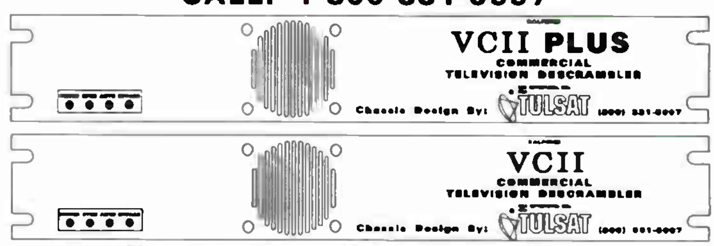

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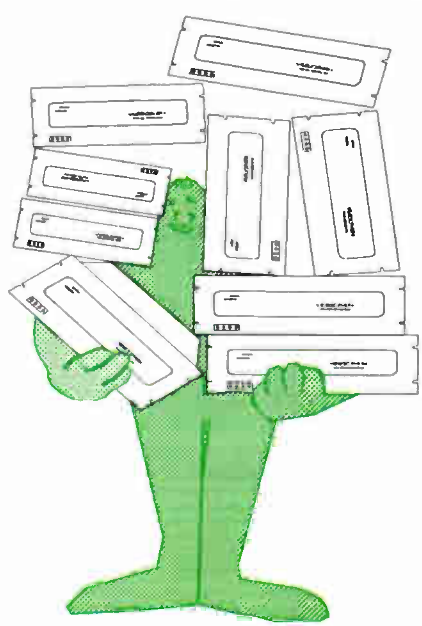

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graphics engine on a well-known and reliable CAD engine, InterGraph. This graphics engine was originally developed around a UNIX operating system but was ported to the MS-DOC and PC platform later on. ADS used the MDS-DOS platform, allowing users to implement their existing desktop computers for the Lynx product.

ADS is realizing the effects of a full GIS system and believes a user should be able to assign as much intelligence as possible to a graphic image to assist an entire cable TV system and not just the engineering department.

• *SIGCOM Inc.'s The SIGnal system* — SIGCOM's roots also are deeply embedded in the cable industry. This company has taken the approach that if the wheel already exists, don't reinvent it. This was shown by the fact that all of the program's graphics are managed by AutoCAD and its project management software is a result of third-party efforts. This has allowed SIGCOM to keep development time and cost down and offer a low-cost, high-powered solution to its users. SIGCOM also has put much effort into developing relationships with many computer equipment vendors so that it can offer a low-cost hardware solution as well.

The SIGnal system operates with MS-DOS on a desktop PC that is IBM-compatible. The use of AutoCAD as a graphics engine has shown to be a great asset to the software package due to the fact Autodesk controls more than 60 percent of the CAD software market and has set many CAD drafting standards within many industries. **CT**

Author's note: There is one engineering package that has been available for the past eight years that merits serious consideration, Load Data. This company is currently involved in developing an AutoCAD interface for its popular design program. It will take some time for a user to become familiar with this package but it's time well-spent. I felt it necessary to mention this company because it excels at supporting its customers. With the introduction of a CAD package, this company will be a serious contender with the packages reviewed in this article.

Readers wishing more information or to discuss the content of this article may contact the author at (303) 344-8271.

Fiber optics future

(Continued from page 26)

$7 million consolidation of its southern New Hampshire cable plant involving more than 20,000 subscribers and covering 547 miles (see accompanying figure on page 26). This far-reaching fiber upgrade will have the capability to tie in all the futuristic elements of the "next generation" of cable TV services. It also may provide some additional insights to cable operators contemplating fiber investments of their own.

"We think the consolidation of these New Hampshire systems is an excellent investment, both for economic and strategic positioning reasons," said Michael Stone, district engineer for Continental's northern district. "Short term, this project will allow for headend-to-headend video transport, internal communications, as well as data transport for on-line billing.

"In the long run, the network may evolve to include a broad range of communications services. As we look to the future, it's essential that our cable delivery system be capable of evolving with these new technologies, not obsoleted by them," Stone commented.

In addition, Continental will be maximizing the strategic advantages of fiber by linking its regional offices in Massachusetts and New Hampshire through the network. This interconnection will enable it to create a larger regional network, providing data communications and on-line billing. From there, the network can branch out into the delivery of future services.

Continental is no stranger to optical fiber, having previously managed a series of fiber upgrades for its systems in metropolitan Boston. To oversee its New Hampshire project, the MSO assigned a five-person staff, headed by Stone. The team — comprised of three design and two field engineers — realized that such a large-scale construction project would need to be completed over a number of stages.

Three-phase upgrade

Continental's upgrade strategy is predicated on a three-stage fiber deployment process. The "nerve center" of this emerging network will be its master headend, located in Exeter, N.H.

A 110-fiber count cable, believed to be one of the highest fiber count optical cables employed by an MSO, will

"As we look to the future, it's essential that our cable delivery system be capable of evolving with these new technologies, not obsoleted by them."

branch out from Exeter to serve 10 communities.

When the project is completed, this "fiber spur" will eliminate four headends at the furthest reaches of the network and, in combination with an innovative network design, provide significant savings in transmission equipment and electronics. The first stage of the upgrade, which is underway, will link the Exeter master hub with three nearby towns. Phase 1, which concludes early this year, is expected to affect approximately 8,000 subscribers and will cover more than 182 miles of cable plant.

Phase 2 gets underway in 1993, joining four communities and 8,000 subscribers over 201 miles. The final upgrade phase will occur in 1994, when the network expands by another 164 miles along the New Hampshire coast, connecting three more towns and 5,500 subs. Previously, the 300 MHz Exeter system delivered 37 channels. When the upgrade is completed, subscribers will have access to 80 channels.

Fiber deployment strategies

In planning its upgrade, Continental placed heavy emphasis on a design that would require the least change to its existing coaxial cable system, while allowing for improved reliability and performance. It was decided to employ a fiber-to-the-service area architecture that left 85 percent of its existing coaxial system intact. This design allows for the deferral of total cable replacement expenses as well as the elimination of some costly electronics.

Continental elected to establish a number of temporary nodes, outfitted with fiber-optic couplers, while the system upgrade continues. To save space within these nodes, while ensuring signal splitting reliability, the project's installation contractor devised a rack-mounted coupler enclosure that holds four 1x2 directional couplers. The optical performance of the couplers place minimal constraints on the laser transmitter.

The MSO's optical transmission plans call for an average of 16 fibers per cable throughout the trunk portion of the network to secondary hubs. An average of four fibers will be allocated to each optical node, broken out as follows:

- One main forward fiber, capable of carrying 70+ channels,
- One spare forward fiber, for future video transmission,
- One return fiber for route redundancy, and
- At least one spare return fiber for future services, such as data transmission.

The total number of "fiber miles" in the network — calculated by multiplying the number of fibers in each cable against the total mileage of the system — is 1,730, making it one of the cable TV industry's larger fiber upgrades.

Continental will "home run" fiber as part of its cable routing scheme. Rather than splitting its video signal from a single laser transmitter over a number of fiber links to a variety of optical nodes, the MSO will limit the signal splitting so that a transmitter serves one node. This point-to-point layout provides Continental with the capability to increase link margins while tailoring its channel offerings to the viewing interests or demographics of a particular service area. It also simplifies ongoing service and troubleshooting for the technical staff.

By breaking its system into a series of smaller, neighborhood-sized "mini-service" areas, Continental can provide advertisers with precisely targeted audiences. This infrastructure will provide a platform that facilitates interactive services. The layout also ensures that, should a signal outage occur, the inconvenience will be limited to a relatively small portion of the network's customer base.

The shape of things to come

In the not-too-distant future, cable TV communications may involve much more than *television*. When Continental Cablevision's communications network is completed, it will rely on optical fiber to deliver a host of new services on separate fibers in a common cable.

Is this development a harbinger of the "brave new world" of cable communications? Stay tuned. **CT**

March 1992

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.

Getting the drop on drops

Geri Saye

Table of Contents

Protecting underground service drops with conduit

By Steve Kerrigan
Maintenance Technician
Times Mirror Cable Television

Underground service drops are an important part of the cable system. New areas usually have underground utilities and now older communities are having their facilities moved underground as well. Improper placement of the underground service drop can lead to costly problems as the drop deteriorates. Placing drops directly in the ground should be avoided. The best quality underground drop cable, even if armored, becomes a maintenance headache if the drop deteriorates with age or becomes damaged. A direct buried drop is very susceptible to damage by rodents, tree roots, moisture ingress, excavation damage and obsolescence.

There are two ways to place service drops so that they are protected by conduit: cable pre-pulled in conduit (often called cable-in-conduit) is one method, and placing conduit in the ground and coming back later to pull in a service drop is another.

Working with cable-in-conduit

Pre-pulled drop has the advantage of not forcing the construction crew to visit the site twice. The drop is already in the conduit, so it is simply placed in a trench or plowed in. The drop-in-conduit comes on a reel not much larger than a standard reel of drop cable, so it can be transported easily. Common conduit sizes are 13 mm and 1/2 inch. Plans must be made to place the longest drop first while saving partial reels for shorter runs. Only continuous runs of cable-in-conduit should be used. Any cost savings vanishes if too much drop and conduit are thrown away.

The conduit can be spliced if damaged, but the drop must be replaced. Splicing damaged duct requires compression splices available from the manufacturer. Conduits that come on reels or spools are made of medium- or high-density polyethylene (often black, though other colors can be used for identification). Glue will not stick to polyethylene. Only use splices the manufacturer suggests.

Care must be taken when cutting cable-in-conduit. Scissor-type hack saw tools are available that have four blades to lightly cut on four points at one time. The extra conduit is removed to expose enough cable to work with. If the cable is not going to be used right away, the ends should be sealed by end caps or tape to prevent moisture being drawn down the braided shield by capillary action. The conduit diameter for pre-pulled drop cable is typically smaller than the ones placed in the ground where the cable is later pulled back through. The inside wall of the conduit is very smooth, or ribbed, to reduce friction. If a pre-pulled drop needs to be replaced, it often can simply be pushed in the conduit. Once a pedestal or vault is set over the conduit, caps should be placed over it to prevent dirt from plugging the ducts.

Installing empty conduit

A common drop installation method for empty conduit is to place it from the future tap location to the house. Two types of this kind of conduit are used: polyvinyl chloride (PVC) or polyethylene (often called "poly"). PVC comes in 10- or 20-foot pieces and is glued together. Bends are made using "sweeps" to negotiate corners and rise out of the trench next to a house or into a pedestal.

The disadvantages of PVC include the number of parts required to complete a job and it can be more expensive than poly conduits or cable-in-conduit. High-density polyethylene conduit has about 37 percent less coefficient of friction than PVC. The increase in friction of PVC is why a larger size conduit is used than with poly for the same size cable and distance. The larger PVC conduit size and labor of assembly of the pieces makes it more expensive.

"Using conduit for all service drops is the best and most cost-effective method of construction in the long run."

Poly conduit comes on large rolls — about 300 feet per roll. A crew carefully places the conduit to avoid kinking it, and then returns when needed to pull in a service drop. Drop poly conduit size is usually 3/4 or 1 inch. A carousel-style caddy dispenses the conduit into the trench. Since there is no cable in the conduit, it can be cut anywhere and easily re-spliced.

Compression splices are available to couple the conduit, but cost more than their crude but effective alternative, which is to use poly splices. These are available in about 16-inch lengths and 1/4 inch more in diameter than the conduit being used. You just slide the splice over both ends of the conduit and secure with duct tape or heat shrink. This simple splice does not have the strength of compression ones, and care must be observed so the splices are not pulled apart.

After the trench is back-filled, a compressor is used to blow in the drop or a jet-line, which is then used to pull in the drop. Lacking an air compressor, a fish tape can be used to pull in the drop. An advantage of using conduit is the ease of drop replacement due to damage or required in an upgrade. Like the cable-in-conduit, the duct should be protected in the pedestal or vault from debris falling into it.

Do it for the long run

Placing conduit in a trench or using cable-in-conduit both have their advantages and disadvantages. Conduit size and construction are considerations but the most important point is to use conduit for service drops. A shovel easily can cut a drop cable in two, while the conduit may deflect the blade and prevent a customer from losing service, not to mention then having to send someone out to repair the drop with a direct buried splice. Using conduit for all service drops is the best and most cost-effective method of construction in the long run. The advantage of simple replacement of a service drop can not be underestimated. **BTB**

Proper care and maintenance of cable preparation tools

By Deborah Morrow
President
And Eric Smith
National Sales Manager
Ben Hughes/Cable Prep

Today's CATV technician has access to hand tools that meet standards and recommendations set by member-groups of our industry. In addition to being made of materials that withstand vast environmental changes, these tools are manufactured as precision instruments to perform specific applications. Performance level of any particular tool is achieved through proper care and maintenance.

Although hand tools may not seem sophisticated, they do play an integral part in the connector/cable interface. Time and again, system operators have found that the tiny F-connector, improperly installed, has been the source of chronic problems.

Every technician likes to have a new tool when they begin a new installation or construction project. The manufacturer and distributor would like nothing more than to provide the technician with new tools. However, the current scenario of tougher financial constraints and budget cuts mean systems want even more out of their capital expense items, including the tools each technician uses. Better programs of maintenance will minimize recalls and maximize the life of each tool. Proper use or misuse of a particular tool can account for increases or decreases in an individual system's capital equipment costs. Tool care is a simple operation that each technician must apply in his or her everyday ritual.

Crimping tools

Regarding drop cable and connector applications — important pieces in fighting leakage problems — just how well the crimp tool will perform when an F-connector is crimped to the drop cable is important. Problems with connectorization can create signal leakage and outages. Procedures for crimp tool maintenance should be provided by the tool manufacturer. Considering that most technicians have three or four crimpers, it is imperative that the tools are kept in top condition at all times. The cost-effectiveness of the installer going to a site once is ensured by the proper crimp at the time of installation.

Misuse of crimp tools is one of the main reasons why a tool malfunctions. Misuse often occurs when a technician uses a crimp tool for something other than its designed application. The long standing joke among most technicians in the industry is that "the crimper makes a great hammer when pounding drive pins — it's the perfect tool." Some technicians have even used them to open compound cans. →

These applications can make for some very expensive hammers and can openers.

A basic understanding of tool care is determining when a crimp tool needs adjustment. Crimp tools usually need to be adjusted when the toggle or "spring action" of the tool is no longer evident when crimping an F-fitting, or if the connector pulls off or separates from the cable when using force of less that 50 pounds. Restoring toggle to the tool is usually done by readjusting the compression guide one notch. Details are provided in the instructions accompanying each tool. Or, call the manufacturer to assist you in the proper procedures.

When components in the tool wear, maintenance kits are available. These should include all the replacement pins, rings, spring washers, links, adjustment wheel and fasteners. The components all serve an important purpose in crimp tool maintenance and must be checked regularly for optimal performance.

The chief engineer or chief technician in every system should make his or her staff aware of the "how, what, where and when" regarding crimp tool care and maintenance. Acknowledgement of the do's and don'ts can be the difference between saving or wasting valuable time and money. Appreciating the tool as a valuable item, lubricating it occasionally and storing it in a dry place are small chores that pay off in the long run.

Coring tools

Just as important to the splicer is the coring tool. Coring tools and strip coring tools are essential in trunk cable preparation and proper maintenance can minimize downtime and rising labor costs.

Coring tools can be maintained with regular lubrication and cleaning. The blade in a coring tool must retain its sharpness; when it dulls replacement is necessary. Examine the blades and guide sleeves for signs of wear. Remove dielectric foam and aluminum chips that can clog the through hole of the coring bit. Knowledge of replacing parts such as blades and guide sleeves can offer a moderate cost savings. This same principle can apply to the strip coring tool that offers dielectric coring with the added feature of stripping the aluminum jacket on trunk cables. The same maintenance procedures as described for the coring tool will apply to this tool as well. Specific steps that are taken to maintain your coring tool will ensure the normal life span of one year or more.

As in any industry, trained personnel who are aware of their contribution toward the business in which they work are valuable assets. It is management's obligation to provide this training. In addition to the many fine training and certification programs available, don't forget the technical service departments of manufacturers; many are providing assistance to companies every day. **BTB**

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Reader Service Number 45

A fall arrest device for safety and reduced liability

By Keith A. Felder
Vice President, Engineering
Grassroots Cable Systems Inc.

In the 20th century, nearly every facet of technology has been improved upon by the industrial revolution. Engineers have redesigned and re-engineered nearly everything to utilize the new materials and knowledge that make today's products better than yesteryear's. Until recently, though, pole climbing methods hadn't changed in over 100 years.

The use of wooden utility poles and the need for workers to climb and work on these poles has spread worldwide over the last century. Unfortunately, the tools used for climbing didn't receive the same attention. In 1988, Scepter Manufacturing Co. gave climbing gear the high-tech upgrade it had been waiting for by introducing the Poleshark. I'd like to share my experience with this product.

The Poleshark is a fall arrest device designed to eliminate the deaths and serious injuries that can result from falls. Wooden utility poles range in size, shape, type of wood, treatment process and age. These factors make pole climbing a tricky business. Add to the equation all of the clutter that industries put on the poles and you have an obstacle course. The device is effective on utility poles ranging from 4 to 24 inches in diameter. I have had my Poleshark for a year now, and I have found that it allows me to safely climb all poles regardless of what man and Mother Nature have done to them.

The Poleshark provides hands-free safety.

Courtesy Scepter Manufacturing

As any experienced lineman knows, some utility poles are better than others. Some linemen are better than others, too. But even the best linemen sometimes take a shortcut to the ground. Table 1 shows statistics on falling accidents from various utility companies. They are published in their entirety so that you can draw your own conclusions. Due to the high number of injuries and fatalities resulting from falling accidents, the Ministry of Labor in Ontario just passed new safety guidelines that are outlined in Table 2.

These statistics give us an example of the dangers of climbing utility poles. Let's face it, as long as imperfect people are climbing imperfect utility poles, there are going to be falls. Why not arrest those falls with some modern technology?

Inexpensive insurance

Not only can we now greatly improve climber safety, we also can reduce accident liability. Climbing utility poles is a hazardous job. There have been numerous deaths and serious injuries from climber falls, as the statistics show. I personally know of one serious back injury from a 10-foot fall. I also have seen dozens of minor injuries from falls. Northwest Electrical Board, a large English utility with 300 lineman, recently learned the hard way. It settled a death suit from a fall for one unfortunate individual for the sum of $1.5 million. Northwest then purchased 300 Polesharks for $120,000 to prevent future accidents. (The units cost only 8 percent of the settlement cost, which sounds like pretty cheap insurance to me.)

I feel the industry and employers have a responsibility to provide fall protection to every lineman, now that it is available. If the company can't afford the cost, it should work with the employees to give them the option to purchase one themselves. The company can buy one unit for everyone to try, and offer to pay for Polesharks up front and deduct $10 a week from the employees' paycheck until they are repaid. Again this is very cheap insurance!

Table 1: Pole accident statistics

- **Trans-Alta Utilities Corp., Calgary, Alberta, Canada**
(10-year period includes all transmission, distribution lineman and contractors. Trans-Alta has approximately 450 climbers, not including outside contractors.)

Linemen climbing frequency
53%: 1-10 poles a week
32%: 11-20 poles a week

Linemen falls or slips frequency
81%: Up to 10 times
10%: 11-20 times
7%: 21-50 times
2%: Over 51 times

1984: Lineman in coma due to fall from pole
1986: Fatality (fall from pole)
1987: Five falls (One disabling, one requiring medical attention)

- **National Rural Electric Co-op Association, Washington, D.C.**
(Membership includes approximately 950 distribution co-ops with 3,800 climbers.)

1982 (typical year): 70 percent of membership reporting 65 injuries directly attributed to poles (no breakout of falls with poles/falls from poles).

Analysis of fatal accidents 1939-1968: 20 fatalities in other categories (falls with poles, falls from poles, etc.)

- **Sacramento Municipal Utility District, Sacramento, Calif.**
(This utility has 85 climbers.)

Falls from poles
1985: 13 falls resulting in medical treatment
1986: 16 falls resulting in medical treatment (Two were lost time: Eight were no injury)
1987: Four falls (One resulted in lost time of two weeks and permanent restricted duty)

Product evaluation

Let's start by answering the most often asked questions. Does it work, and is it easy to use?

After using the device for a year, I have found it extremely easy to use. As a matter of fact, I find it easier to climb with it than without it. The product allows me to stand more upright, keeping the angle of my gaffs where they should be. How many times have you climbed a fat utility pole and had to lean over so far you were uncomfortable about your gaff angle? This fall arrest device puts the handles in front of the pole, making climbing easier. Further, I can move around on the pole with both hands on my work because the device follows me around the pole. This is important when I am trying to keep a cable tail from bending up into power.

The only inconvenient part of the Poleshark is that when I am crossing an obstruction, I have to stop and belt above the obstruction, then move the unit above the obstruction and belt into it again. This is one minor inconvenience that is worth the fact that the product makes me feel safe 100 percent of the time. It wasn't a tough decision for me — 100 percent safety or possibly a lot of splinters.

The Poleshark is basically a pair of gaffs for your waist. When the gaffs on your feet cut out, the gaffs on your waist dig in. Directly behind the device's handles are two gaff wheels with eight angled gaffs each. As well, a strong torsion spring is employed that folds the gaffs inward at all times. The unit is spread around the pole and allowed to close in on it. The climber is then strapped through the handles. The spring tension that holds the device's gaffs against the utility pole during normal use is greatly increased when the climber's weight is applied. If the climber falls, the safety belt is pulled, drawing the handles and gaffs tighter around the utility pole. The farthest you can fall is the length of the strap. Unlike the gaffs on your feet, the gaffs on the Poleshark can't cut out. Their angled design forces them into the pole when weight is applied to the handles.

The manufacturer has a product videotape that shows two tests. One demonstrates the 40.2 kilovolts of dielectric insulation. The other shows a 400-pound weight being dropped from 5 feet above the Poleshark. The weight is stopped and the fall is arrested.

I remember that videotape every time I climb a pole. I have a bucket truck, but in rural New Hampshire there are a fair number of poles that have to be climbed. I am in the process of upgrading and sweeping 2,200 amplifiers. I weigh 195 pounds. Add in the climbing gear, amplifier guts, a selection of pads and equalizers, tools, and a sweep, and the equipment and I total over 300 pounds. I appreciate the 400-pound drop test. My company also appreciates the fact that my $13,000 sweep is protected from falls as well.

Who needs this device?

Anyone who ever has to climb utility poles needs this product, in my opinion. Bucket trucks and ladders work on many poles, but there is always going to be that one difficult pole that has to be climbed with hooks.

I have heard that some companies don't allow their chief technicians or engineers to climb poles. The companies don't want to risk having their best and brightest hurt. Unfortunately, these sharp guys are the ones who have to do the highly technical jobs in the field. They should be out there teaching the less experienced technicians how cable TV works and helping them fix those tough technical problems we run into. I can guarantee that there is going to be a pole that they can't reach with their bucket truck. If they aren't supposed to climb, they can't effectively do their jobs. Give them all a Poleshark and relax, knowing that they are safely maintaining your systems.

For more information on this product, contact: Scepter Manufacturing Co. Ltd., 170 Midwest Road, Scarborough, Ontario M1P 3A9; (416) 751-9445 (U.S.) or (800) 387-6018. **BTB**

Table 2: Guidelines for accessing work position on utility poles

(Set by Ministry of Labor, Ontario, Canada)

• General
The safest available means to access a work position shall be used.

• Climbing utility poles
Where climbing is used to access a work position above 10 feet:
1) The worker shall be prevented from falling more than 5 feet.
2) The worker shall be secured while at the work position.
3) Protective devices shall be properly maintained and used in such a manner that the requirements of 1 and 2 are met.

(These guidelines came into effect on March 1, 1991.)

All photos courtesy Corporate Communications, Lakewood, Colo.

Photo 1: The ground rod is inserted into the Sidewinder's jaws.

Photo 2: The jackhammer is placed on the Sidewinder's shank.

Photo 3: The release plate is positioned over the ground rod.

Photo 4: The entire assembly is lifted to a comfortable driving position, and the installation process begins.

Ground rod installation made easy

By Ron Hranac
Senior Technical Editor

Many of us have been faced with the usually unwieldy task of driving an 8-foot ground rod using one of a variety of common techniques. How many times have you found yourself perched precariously atop a step ladder trying to pound one into the ground with a sledgehammer? If you didn't use some means to protect the end of the rod while you were hammering away, it mushroomed, making difficult the later installation of the grounding clamp, or worse, presenting a safety hazard from chips of metal breaking away from the flattened end. (Of course, none of us have ever given up when the rod encountered hardened clay soil and taken a hacksaw to the four feet still sticking out of the ground.) I know I've missed the end of the ground rod a time or two with

Photo 5: The ground rod is driven into the soil until the Sidewinder reaches ground level and contacts the release plate.

Photo 6: The Sidewinder's jaws are released from the rod.

Photo 7: The Sidewinder is raised and re-attached to the rod, and the driving resumed.

Photo 8: As before, the rod is driven into the soil until the Sidewinder again reached ground level and contacts the release plate.

the hammer, landing instead on my other hand that was holding the rod steady.

Helpful products

There are a number of commercial products on the market that have been designed to simplify the ground rod installation process. From the simple protective driving cap that prevents the end of the rod from mushrooming when hammering it, to full-blown hydraulic equipment mounted on the back of a truck, all make the job easier and safer in varying degrees.

Foresight Products has developed a ground rod driving device called Sidewinder. Weighing in at less than 45 pounds, it is clamped around the rod, then is power-driven by any lightweight hydraulic, pneumatic or even gasoline jackhammer. In normal soil, an 8-foot rod can be installed in under two minutes — try that with a sledgehammer!

Photo 9: Steps 6 through 8 are repeated as necessary until about 1 foot of the rod remains above the ground. The Side-winder is then placed on the top of the rod for the final step.

The install process

The installation process is straightforward. The ground rod is inserted in the Sidewinder's jaws (Photo 1), then a jackhammer is placed on top of it (Photo 2). Next, the release plate is positioned over the ground rod (Photo 3) and the whole assembly is lifted to a comfortable driving position where the rod installation itself begins (Photo 4).

Photo 10: The ground rod is driven to the desired depth.

The rod is then driven into the soil until the Sidewinder reaches ground level and contacts the release plate (Photo 5). At this point, pressure on the jaws is released (Photo 6) and the device is raised, re-attached to the rod, and the driving process resumed (Photo 7). The Sidewinder is driven to ground level until it again contacts the release plate (Photo 8). The previous two steps are repeated as necessary until about one foot of the top of the rod remains above the surface. At this point, the Sidewinder is placed on *top* of the ground rod (Photo 9) and is driven until the desired 2 or 3 inches remains (Photo 10).

The Sidewinder can be used to drive both copper-clad and zinc-coated ground rods without leaving marks or scars on the rod's surface. As can be seen from the last photo, the end of the rod remains in the same condition as it was before the installation began. And since the Sidewinder has few parts, it can easily be serviced in the field.

For more information, contact Foresight Products, 6430 E. 49th Dr., Commerce City, Colo. 80222; (800) 325-5360 or (303) 286-8955. **BTB**

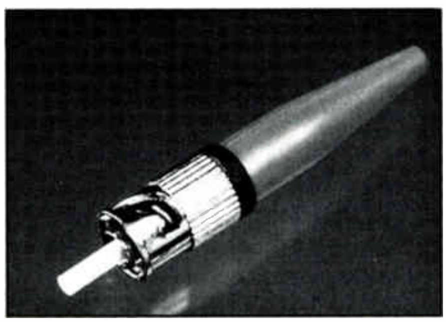
PRODUCT NEWS

Talk set

EXFO announced a new fiber-optic full duplex talk set over 1 fiber that has 38 dB of range over a single-mode fiber. The Model VCS-20A also functions as a 2 kHz tone generator, active fiber detector and stabilized source for attenuation testing.

The VCS-20A series is available for single- and multimode fibers and operates at 1,300 nm or 1,550 nm (LED or laser) to reach up to 120 km of range. It features the company's "3-Way Powering" capability, three-way communication and it provides hand-free operation through its head set.

Reader service #201

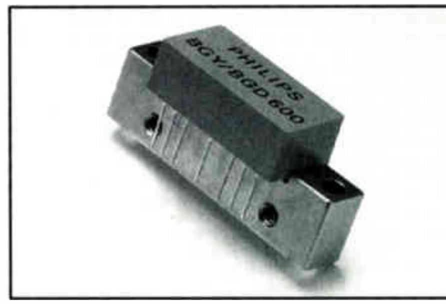


Fiber connector

Now available from AT&T Network Cable Systems is the ST II angled single-mode fiber connector for analog video transmissions in cable TV systems. An angled ceramic ferrule that uses the protruding fiber polisher ensures a higher return loss than that for standard ST connectors. Median maximum reflectance is -60 dB. Low insertion loss based on complete connection using 8.3/125 µm fiber and a dry connection is µm 0.5 dB; sigma 0.2 dB. The product is 2.14 x .375 inches and is said to be well-suited for dense panel arrangements.

The connector offers the higher mechanical stability needed for single-mode connections and resists transverse loads that may affect the cable. According to the company it is rugged enough to withstand unprotected environments. Connector plugs are available with either metallic or plastic hardware. Available separately are a field mounting kit (including necessary tools), mounting instructions, an angle polishing tool and a kit containing consumable materials to mount approximately 100 connectors.

Reader service #198



Amplifier modules

Philips Semiconductors introduced the BGY600 series of amplifier modules and BGD600 series of power doubler modules with sufficient bandwidth capable of carrying 85 U.S. standard channels. They have a bandwidth of 40 to 600 MHz. The BGY600 series offers six different power gains from 12.5 to 27 dB and the BGD600 series power doublers have a power gain of 12 or 18.5 dB.

Both amplifiers and power doublers have very low noise figures to ensure the maintenance of high signal-to-noise ratios over long cable lengths. The modules are constructed of thin-film material and are housed in SOT-115 packages that allow them to be used to upgrade existing equipment.

Reader service #197

Installation tool

The Gopher Pole from Crain Enterprises is a telescoping, rigid fiberglass pole used to install wire or cable. The hook/skid tip glides over rafters, suspended ceilings and otherwise inaccessible or restricted areas.

It collapses into a compact 4-foot base section and is lightweight. The tool is push-pull, non-conductive and extends to 22 feet in seconds, according to the company.

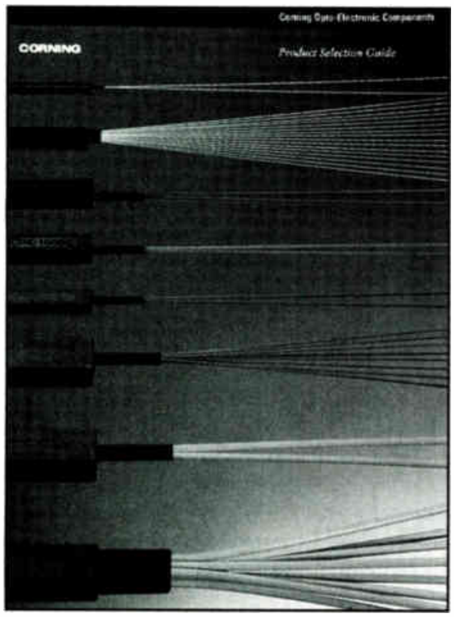
Reader service #196

Transmitter

RF Technology announced its RF-223GL wideband 10-watt portable transmitter. It provides up to 500 MHz of frequency agility combined with 10 watts minimum RF output.

The unit is available in frequency bands from 1.7 to 3.7 GHz including a U.S. domestic version that covers both 2 and 2.5 GHz in a single unit. The use of state-of-the-art GaAs FET devices is said to provide unparalleled efficiency combined with direct operation from 12 VDC and 115 VAC.

Reader service #195



Coupler guide

Corning made available its new product selection guide featuring a full line of optoelectronic components. It describes the company's family of fiber component products and helps identify the most appropriate product for a specific application (cable TV, telephony, instrumentation and sensors, and military, government and computer interconnects).

The family of products shown consists of a wide range of single-mode and multimode passive couplers, wavelength division multiplexers and optical gain modules for fiber amplifiers. The guide highlights several widespread coupler applications, the optoelectronic component used most frequently in each application, and important specifications.

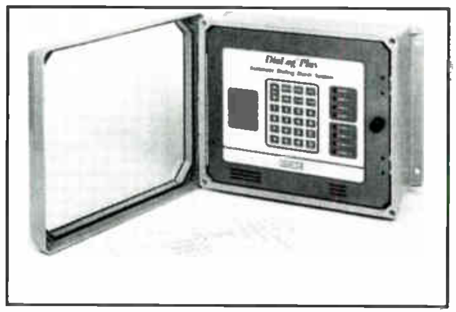
Reader service #194

Commercial insertion

TE Products introduced the Ad Vantage family of commercial insertion systems that has been designed to accommodate high definition video and stereo audio technology in program automation and commercial insertion. The initial basic unit features four-channel operation in a 2RU rack space profile and is either equipped with four or eight machine control ports. Expansion units are available to expand the system in steps of two or four channels and one to four machine controllers per channel.

Other features include operation from an ANSI or ASCII terminal or an IBM-compatible personal computer, remote up- and downloading of schedules and logs, and traffic and billing interfaces with all major software suppliers. Also, the systems have 50 MHz video with true vertical interval switching, automatic pre-roll averaging, internal black generator fall-back, stereo audio operation, internal SMPTE serial communications protocol, and keyboard selection of network cue tones.

Reader service #192



Monitoring system

The DiaLog Plus from Kaye Instruments is a new automatic dialing alarm system for monitoring CATV equipment that provides alarm monitoring and voice notification via dial-up telephone lines. For example, it monitors air conditioning of electronics in a headend station to prevent equipment overheating. Priority alarm calling and user-recorded voice messages provide advance warning of problems. When an alarm occurs, the auto-dialer telephones the appropriate personnel and delivers a recorded voice message. It continues to dial until one of its calls is answered and then identifies its location and existing alarms. The notified personnel must acknowledge the call or the unit will continue calling. It stores user messages in its solid-state memory, which eliminates the need to deal with tapes and mechanical parts or be limited to a factory-supplied vocabulary.

The product monitors up to eight separate alarm inputs and its own power and can sequentially call up to 16 different phone numbers when an

alarm occurs. It stores up to eight different lists of phone numbers and can call different lists of phone numbers for different alarms. Users can phone the unit at any time to find out what their equipment is doing and it can be programmed or reprogrammed from any location with a touch-tone phone. As well, the product features a serial port for documenting all alarm activity to a printer, providing a time- and date-stamped hard copy to trace the events at a particular location.
Reader service #193

Batteries

The Specialty Battery Division of Johnson Controls is manufacturing the Dynasty XL-2 series of lead acid batteries that are now constructed with blue flame retardant PVC containers and black PVC covers. The eight-battery series now has increased ampere hour capacity from 95-225 AH. The batteries have sealed, gelled electrolyte construction, are guaranteed not to leak, and require no electrolyte maintenance throughout their 20-year service life, according to the company. No water additions or specific gravity measurements are needed.

The PVC containers and covers have an oxygen index level of 33+, which means that a 33 percent or more oxygen pure atmosphere would be necessary to sustain flame on the PVC material itself. Gelled electrolyte ensures freeze protection to -90° F.
Reader service #191

Coax adapter

A 50 ohm coaxial adapter, the Model PE9344 UHF female to mini-UHF male coaxial adapter was announced by Pasternack Enterprises. It has low loss over the frequency range of DC to 2 GHz.

The adapter has a brass nickel-plated body and uses Teflon insulation. It also has a gold-plated contact and an operating temperature range of -65° to 165° C.
Reader service #190

COMMUNICATIONS TECHNOLOGY

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- ☐ 6. Microwave or Telephone Company
- ☐ 7. Commercial Television Broadcaster
- ☐ 8. Cable TV Component Manufacturer
- ☐ 9. Cable TV Investor
- ☐ 10. Financial Institution, Broker, Consultant
- ☐ 11. Law Firm or Government Agency
- ☐ 12. Program Producer or Distributor
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CT 3/92

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4	23	42	61	80	99	118	137	156	175	194
5	24	43	62	81	100	119	138	157	176	195
6	25	44	63	82	101	120	139	158	177	196
7	26	45	64	83	102	121	140	159	178	197
8	27	46	65	84	103	122	141	160	179	198
9	28	47	66	85	104	123	142	161	180	199
10	29	48	67	86	105	124	143	162	181	200
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13	32	51	70	89	108	127	146	165	184	203
14	33	52	71	90	109	128	147	166	185	204
15	34	53	72	91	110	129	148	167	186	205
16	35	54	73	92	111	130	149	168	187	206
17	36	55	74	93	112	131	150	169	188	207
18	37	56	75	94	113	132	151	170	189	208

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6	25	44	63	82	101	120	139	158	177	196
7	26	45	64	83	102	121	140	159	178	197
8	27	46	65	84	103	122	141	160	179	198
9	28	47	66	85	104	123	142	161	180	199
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11	30	49	68	87	106	125	144	163	182	201
12	31	50	69	88	107	126	145	164	183	202
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14	33	52	71	90	109	128	147	166	185	204
15	34	53	72	91	110	129	148	167	186	205
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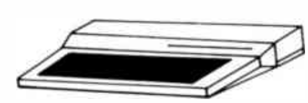

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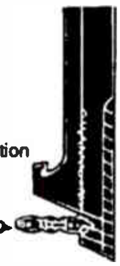

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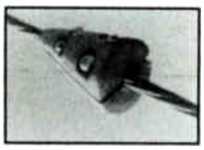

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Behind the scenes in the lab

By Ron Hranac
Senior Technical Editor

It's hard to believe that this column now is almost two years old. We introduced "CT's Lab Report" in the April 1990 issue of *Communications Technology* with a review of Tektronix's inexpensive TSG-100 video signal generator. Since that time we've evaluated a variety of CATV products, from coaxial cable to headend processors and most of what's in between. When I first suggested doing lab testing for the readers of *CT*, the idea raised an eyebrow or two. In general, though, it has been well-received.

I thought I'd do something a little different this time and give you an overview of the type of test equipment that we use to evaluate various products, as well as take a look ahead at what you can expect to see over the next few months.

Most of the product evaluations are done in Jones Intercable's corporate engineering lab. It's well-equipped with test instruments normally found only at a manufacturer's facility, and is located in the Denver, Colo., area, which is convenient for us. In a few cases I've performed some of the evaluations in other labs that had certain specialized test equipment not available in the Jones lab. Some of the equipment used in an evaluation environment will be familiar to you, but much of it is not normally found in a typical cable system.

Baseband measurements

Accurate and repeatable tests require automated measurements. Thanks to the advent of microprocessor-controlled equipment, it's now possible to quickly perform complex measurements that used to take several hours on manually operated equipment. For example, if you've ever measured video distortions on a vectorscope and waveform monitor, you know what I mean.

In nearly every case we use a Tektronix VM-700 automatic video measurement system for baseband video measurements. This instrument combines the functions of a waveform monitor, vectorscope and noise measurement test set. There is not too much in the video domain that can't be measured with the VM-700, and it's usually as easy as pressing one or two buttons. This luxury doesn't come cheap, though. A VM-700 will set you back around $20,000.

To provide high-quality video test signals, the lab has a Tektronix 1900 digital video signal generator. The 1900 has its various test patterns stored as 10-bit digital "words" that are converted to their analog counterpart for use. This results in extremely precise waveforms.

When performing baseband measurements on an RF signal — for example, a headend modulator's output — that signal must be converted from RF to baseband before the measurements can be made. This requires the use of a precision demodulator that won't introduce significant distortions of its own into the signal. We have two choices in the lab for this: a Tektronix 1450-1 and a Rohde & Schwarz EMFT demod. Both are frequency-agile, although the Tek tunes only to 300 MHz. Either of these can be considered essentially transparent to the signal, since they are both lab-grade instruments.

While we haven't yet tested any BTSC encoders for this column, the lab is equipped with a Modulation Sciences SRD-1 reference BTSC decoder. Like the demodulators, it is for the most part transparent to the signal being measured. Although the SRD-1 is a mature design, it still is considered by many to be a good reference instrument.

To simplify baseband audio tests such as signal-to-noise, frequency response, separation and THD, an automatic audio measurement system from Sound Technology is used. Certain tests are done using a Dorrough 40A loudness monitor.

RF measurements

Evaluating performance at RF requires more than the usual signal level meter (especially since we could be testing the SLM). Hewlett-Packard HP8558B and HP8590A, and Tektronix 7L14 spectrum analyzers are available, depending on the requirement. For extremely accurate unmodulated carrier amplitude measurements, a Hewlett-Packard HP435B power meter is used. Since this is a 50 ohm instrument, a precision H-P minimum loss pad converts between 50 and 75 ohms (it works both ways).

For accurate frequency measurements, a Philips PM 6676 counter is used. This particular one includes Philips' option 05, featuring a time base stability of about 5 parts in 10^{-10}. Even though the counter is completely solid-state, its rated specifications are valid only after it has warmed up for *48 hours*. This provides accuracy that is about two notches shy of a rubidium-based counter.

One of the toughest things to measure accurately is amplifier noise figure. For this we use a Hewlett-Packard HP8970B noise figure meter. It, too, is a 50 ohm instrument, requiring the careful use of appropriate impedance matching devices and very high-quality connectors and cables to provide good performance with 75 ohm equipment.

A favorite of mine is the Hewlett-Packard HP8753B network analyzer and companion 75 ohm S-parameter test set. This combination is a very fancy — and expensive — 300 kHz to 2 GHz bench sweep! Not only can it measure (automatically) such things as gain, loss, bandwidth, impedance, return loss, group delay and phase, it also includes an RF time domain reflectometer function as well as something called a time domain transmisometer. This particular network analyzer can use its control software to calibrate out the effects of cables and adapters, literally moving the measurement reference plane right to the device under test. The HP8753B is probably the most sophisticated instrument in the lab.

For amplifier distortion measurements, a Matrix 750 MHz 110-channel multiple carrier generator (sometimes referred to as a "Dix-Hill") and its companion R75 signal analyzer are used for CTB, CSO, C/N and XMOD. This is the same type of equipment that the major CATV electronics manufacturers use to characterize the performance of their actives.

The lab's RF measurement capabilities extend up into the microwave region as well. A complete Harris satellite link simulator is used for receiver testing. It includes the 8012 combination 70 MHz FM modulator/exciter and 6 GHz upconverter, along with the Harris 2110 loop test translator. This setup allows evaluations of satellite receivers under controlled conditions using reference test signal sources (such as the Tektronix 1900) to avoid the uncertainties that occur when trying to use live satellite programming for receiver evaluations.

RF shielding measurements are done in a custom-built untuned RFI chamber. The special post-amplifier used with the chamber limits measurement bandwidth to 450 MHz, but the combination has a noise floor over that frequency range that is 130 dB down. The chamber is often used in conjunction with the network analyzer.

Odds & ends

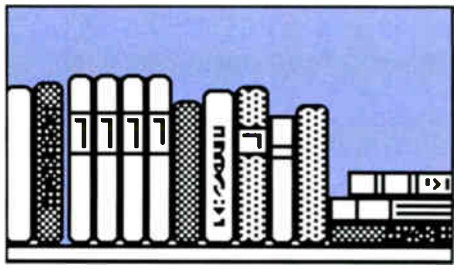
A recent addition to the lab is an Associated Environmental Systems Model SK-3105/8 temperature chamber. This allows controlled measurements of device performance over some incredible temperature ranges. (Expect to see future evaluations of certain products that have been cycled through the temperature chamber.)

Of course, a modern lab wouldn't be complete without fiber-optic test equipment. Hewlett-Packard's HP8153A lightwave multimeter (combination dual-laser source and power sensor) is available for accurate optical power measurements. In the past, we've also used an HP8152A optical average power meter and its companion instruments for product testing.

There is a variety of other less specialized equipment such as RMS AC power and voltmeters, a power supply load simulator, and the usual oscilloscopes, bench power supplies, etc. For certain types of tests such as ozone susceptibility and corrosion testing, products are sent to outside facilities.

Access to this lab (and occasionally others) has provided *CT* an opportunity to share with you the evaluations of products that you may not otherwise have the ability or time to test. During the next few months we plan to take a look at products such as ComSonics' new WindowLite hand-held SLM, CaLan's STAR 2010 signal level measurement system, Trilithic's power interference locator system, Riser Bond's CATV time domain reflectometer, and a new IRD receiver from DX Communications. I'll still occasionally present a review of current technical publications, too. (McGraw-Hill's *Cable Television Technology & Operations* by Eugene Bartlett is now in my briefcase.) Planned but not yet scheduled are some of the new 1 GHz line passives that have just been introduced, and possibly some of the 150-channel active equipment. **CT**

BOOKSHELF



The following videotapes are currently available by mail order through the Society of Cable Television Engineers. Prices listed are for SCTE members; non-members must add 20 percent when ordering.

☛ *Cable Preparation and Connector Installation* — This three-part presentation, produced by Augat/LRC Electronics, discusses recommended practices for preparing the ends of coax and proper methods for the installation of cable connectors. (30 min.) Order #T-1028, $35.

☛ *Video and Audio Signals and Systems (BCT/E Review Course)* — Category II Curriculum Committee Chairman Paul Beeman presents this overview of Category II of the Broadband Communications Technician/Engineer Certification Program. Emphasis is placed on audio and video terminology, plus test and measurement procedures. From Cable-Tec Expo '86. (1-1/2 hrs.) T-1029, $55. **B-II**

Note: The appearance of the symbol **B-** indicates a videotape relating to a certain Category (noted by Roman numerals **I-VII**) of the BCT/E Certification Program. These tapes have been discounted to aid candidates for certification in their studies.

All SCTE videotapes are in color and are available in the 1/2-inch VHS format only. Videotapes are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

Shipping: Videotapes are shipped UPS. No post office boxes, please. SCTE pays surface shipping charges within the continental U.S. only. Orders to Canada or Mexico: Please add $5 (U.S.) for each book or videotape. Orders to Europe, Africa, Asia or South America: SCTE will invoice the recipient for additional air or surface shipping charges (please specify). "Rush" orders: A $15 surcharge will be collected on all such orders. The surcharge and air shipping cost can be charged to a Visa or MasterCard.

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A complete listing of SCTE publications and videotapes appears in this month's edition of the SCTE newsletter, "Interval."

March

2: SCTE Satellite Tele-Seminar Program. To air from 1 to 2 p.m. ET on Transponder 6 of Galaxy 1. Contact (215) 363-6888.

2-6: ONI Fiberworks '92 seminar, ONI Training and Product Development Center, Englewood, Colo. Contact Ray Reynard (800) FIBER ME.

6-7: SCTE West Virginia Mountaineer Meeting Group, installer certification exams (March 6) and BCTE exams (March 7) to be administered, ATC Training Center, Charleston, W.V. Contact Ken Gabehart, (304) 965-7026.

10: SCTE Cascade Range Chapter seminar. Contact Cynthia Stokes, (503) 230-2099.

10: SCTE Central Illinois Chapter seminar, FCC-CLI, Holiday Inn, Brandywine, Ill. Contact John Heck, (309) 353-8777.

10: SCTE Desert Chapter, BCT/E exams to be administered. Contact Chris Middleton, (619) 340-1312, ext. 258.

10: SCTE New York Chapter seminar, alternate access, Time Warner, Flushing, N.Y. Contact Richard Fevola, (516) 678-7200.

10: Scientific-Atlanta seminar (part 1), headend and earth station systems, Airport Holiday Inn, Pittsburgh. Contact Dan Pruitt, (404) 903-5183.

11: SCTE Oklahoma Chapter seminar. Contact Arturo Amaton, (405) 353-2250.

11: SCTE Oahu Meeting Group seminar, signal level meters, headend switching and swept frequency analysis, Kahikapu, Honolulu. Contact Michael Goodish, (800) 836-2888.

11: Scientific-Atlanta seminar (part 2), distribution systems, Airport Holiday Inn, Pittsburgh. Contact Dan Pruitt (404) 903-5183.

12: SCTE Penn-Ohio Chapter seminar on maintenance and construction standards, Sheraton Hotel, Warrendale, Pa. Contact Bernie Czarnecki, (814) 838-1466.

12: SCTE Wheat State Chapter seminar, FCC rules and regulations and system standards, Holiday Inn, Salina, Kan. Contact Mark Wilson, (316) 262-4270.

12: Scientific-Atlanta seminar (part 3), fiber-optic systems, Airport Holiday Inn, Pittsburgh. Contact Dan Pruitt, (404) 903-5183.

12-13: SCTE Dakota Territories Chapter consecutive seminars, Ramkota Inn in Pierre, S.D. (March 12), Radisson Inn in Bismarck, N.D. (March 13), FCC technical performance standards and testing. Contact Kent Binkerd, (605) 339-3339.

14: SCTE Chaparral Chapter seminar on fiber fundamentals and BCT/E Category III, "Transportation Systems", Albuquerque, N.M. Contact Joe Roney, (505) 761-6224.

14: SCTE Wyoming Chapter, Casper, Wyo. Contact Stan Olson Sr., (307) 347-3244.

15-16: SCTE Old Dominion Chapter second annual vendor show and training sessions, Holiday Inn, Richmond, Va. Contact Margaret Davison, (703) 248-3400.

16-18: North Central Cable Television Association trade show and convention, Hyatt Regency Hotel, Minneapolis. Contact (612) 641-0268.

16-20: ONI Fiberworks '92 seminar, ONI Training and Product Development Center, Englewood, Colo. Contact Ray Reynard, (800) FIBER ME.

17: SCTE North Country Chapter seminar (in conjunction with North Central Show), Hyatt Regency Hotel, St. Paul, Minn. Contact Bill Davis, (612) 646-8755.

18: SCTE Appalachian Mid-Atlantic Chapter seminar, digital and analog fiber, and BCT/E exams to be administered, Holiday Inn, Chambersburg, Pa. Contact Richard Ginter, (814) 672-5393.

18: SCTE Bluegrass Chapter seminar, BCT/E Category III, "Transportation Systems." Contact Liz Robinson, (606) 299-6288.

18: SCTE Central California Chapter seminar, data networking, Almond Tree Inn, Turlock, Calif. Contact Deborah Abate, (408) 578-1790.

18: SCTE Dixie Chapter, Montgomery, Ala. Contact Scott Peden, (904) 968-6959.

18: SCTE Golden Gate Chapter seminar. Contact Mark Harrigan, (415) 358-6950.

18: SCTE Michiana Chapter, Turners American, South Bend, Ind. Contact Russ Stickney, (219) 259-8015.

18: SCTE Snake River Chapter seminar on CATV system design and powering, Weston Plaza, Twin Falls, Idaho. Contact Ron Kline, (208) 376-0230.

Planning ahead

May 3-6: National Show, Dallas. Contact (202) 775-3550.

June 14-17: SCTE Cable-Tec Expo, San Antonio, Texas. Contact (215) 363-6888.

Sept. 8-10 (tentative): Eastern Cable Show, Atlanta. Contact (404) 252-2454.

Oct. 13-14: Atlantic Cable Show, Atlantic City, N.J. Contact (609) 848-1000.

SCTE escaping to the Alamo

By Wendell Woody
President, Society of Cable Television Engineers

In the year of 1836 there was no *escaping from* the Alamo and on March 6 the Mexican army stormed it, killing all the defenders. *Davey* Crockett, using his rifle as a club, *fell* to the attackers.

Now, *escaping to* the Alamo 156 years later, *Davey* Willis, *Davey* Fellows, *Davey* Spallinger, *Davey* Robinson and *Davey* Franklin also will *fall* into the active lines. Using their SCTE (club) membership cards, they will *fall* in line and rifle their way into the opening session of the annual SCTE Engineering Conference on June 14, 1992. At that time, they will face Antonio, Fernando and Lopez with armies of Mexican CATV technicians and engineers who also will be seeking to share in this excellent training.

We extend a most hearty special welcome "con mucho gusto" to all Mexican CATV technicians and engineers who plan to attend this year's Cable-Tec Expo and Engineering Conference in San Antonio, Texas. This special welcome includes all countries in Central America as well as South America. Many of you have joined our Society and are striving to organize something local in your area. Attending our expo gives you the greatest and fastest exposure to our Society. If requested, we could hold an Español meeting during the expo. Last year we met with a group of Japanese expo attendees and, with the assistance of their interpreter, shared a good meeting.

The number of international members joining our Society continues to grow. These members support our Society by attending our fiber-optic seminar and the Cable-Tec Expo as well as by purchasing SCTE training materials. Our Canadian neighbors certainly account for a large segment of this group. We appreciate our members from all over the world including those from: Argentina, Australia, Belgium, Brazil, Canada, Caribbean Islands, Chile, Costa Rica, Denmark, England, Finland, France, Guam, Guatemala, Hong Kong, Ireland, Israel, Italy, Japan, Mexico, New Zealand, Norway, Paraguay, Puerto Rico, Scotland, Spain, Switzerland, Taiwan, and more.

Election deadline

The final day for SCTE voting is approaching. To vote in the 1992 national SCTE election, your ballot (in the specially provided envelope) must be postmarked no later than March 15, 1992. Every national member is eligible to vote for the at-large director and the referendum item. Those members in Regions 3, 4, 5, 7, 8, 10 and 12 also have their respective regional director vote to cast.

Happy birthday

The monthly membership newsletter of the Society, *Interval*, just started its second year in January as a separate publication (from *Communications Technology*) mailed only to national members. The January 1991 issue was 8 pages; the year ended with the December issue's having 12 pages. The January 1992 *Interval* kicked off the year with 16 pages (which will be the minimum for the year).

A "job well done" acknowledgment is due to Howard Whitman, the editor of *Interval*. He has not only developed great content for the publication but has continued to expand its size at the same time. We also thank Paul Levine for publishing expanded SCTE pages within his *CT* magazine, as part of the contract as the official trade journal of the Society.

Senior membership

With a special "thank you" for a superbly revised program, we acknowledge the Senior Member Subcommittee: Ron Hranac, Dan Pike, Fred Rogers and Dave Willis. They recently completed a review of the requirements for SCTE senior member grade. A number of changes to the Society's policies and procedures were recommended to and subsequently approved by the board of directors.

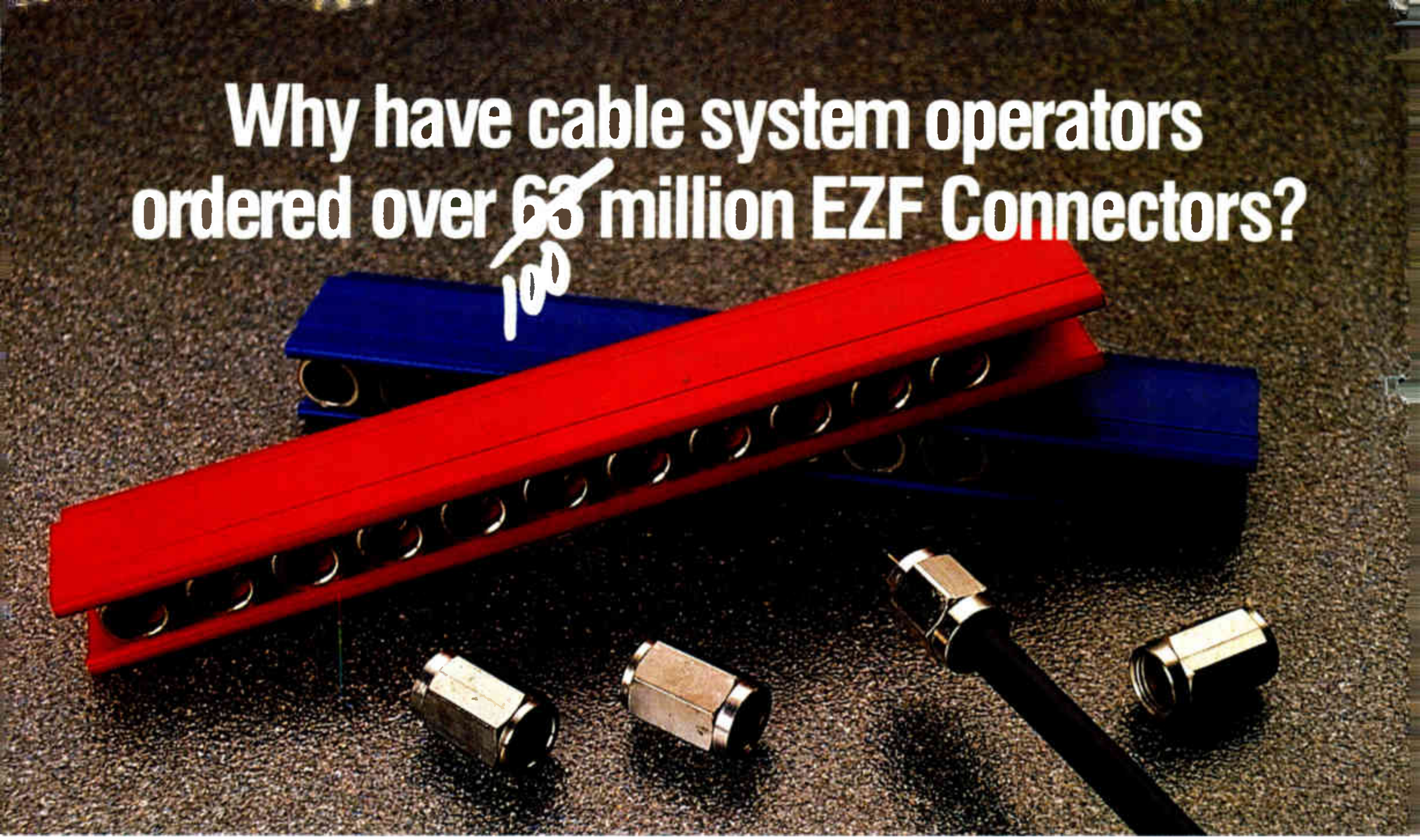
Senior member is the highest mem-

ber grade in SCTE for which application may be made. This level of membership recognizes an individual's seniority in the industry, in addition to professionalism, significant performance and technical competence. If you are eligible but are not yet a senior member, we encourage you to consider applying for an upgrade. You also may nominate another person who you know is a potential candidate for elevation. We hope to have a group to elevate at the Cable-Tec Expo.

Meeting the members

I was very pleased to see the large attendance at the Ohio Chapter meeting in Columbus along with a good program including Broadband Communications Technician/Engineer testing. Chapter officers present were: Jon Ludi, Jim Brown, Gil Nichols, Jon Schatz, Frank Adams and Bill Ricker. From the New York City Chapter was guest speaker, Richard Pfister.

The Dakota Territories Chapter combined its Bismarck, N.D., and Pierre, S.D., meetings for a joint annual meeting held in Aberdeen, S.D., recently. This chapter always has long distance attendees. Officers present were: Tony Gauer, A.J. Van de Kamp, Tom Heir, Kent Binkerd, Pete Ehresman, Jay Chapman, Larry Dodd, Tim Holdahl and Bob Spilde. Their regional director, Rich Henkemeyer, also was present along with Steven Baker from the North Country Chapter in Minneapolis. **CT**



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