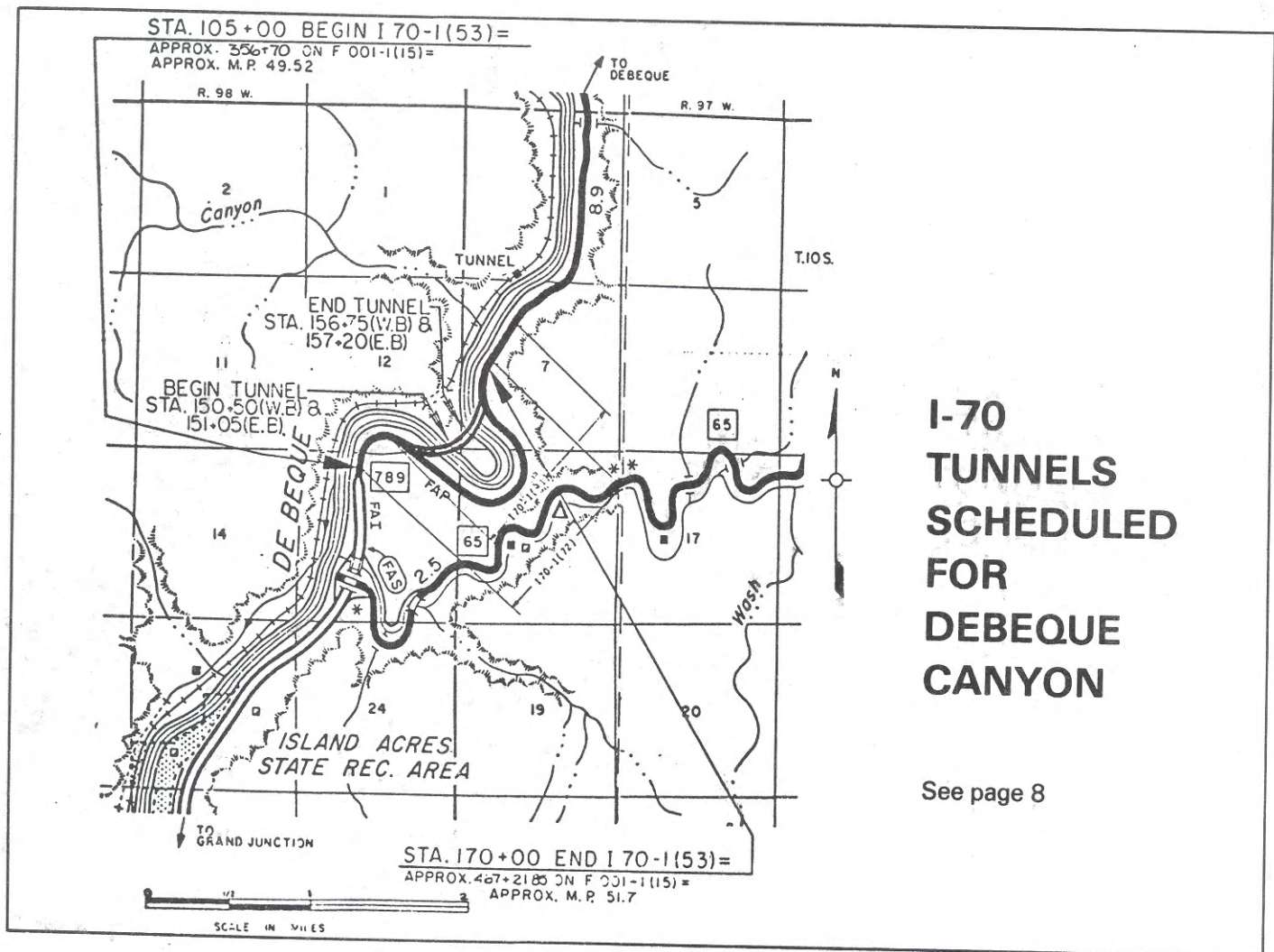


western engineer

Volume 68, Number 11

November 1984



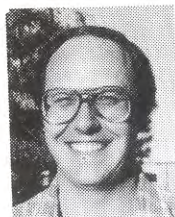
1884 1984
A CENTURY OF ELECTRICAL PROGRESS

Rockwell Overlook

See Page 10

PRESIDENT'S MESSAGE

James M. Dougan
President — Colorado Society of Engineers



Bravo for our program team — Howard McGregor and John Boring! We had 29 members attend our first meeting. We'll try to keep the programs interesting to keep your interest high. We need and enjoy your company. See you at our November 13th LUNCH meeting.

Our calling committee is growing. Lloyd Weide, John Preister, Fred Dumler and Ron Akerlow have volunteered to help. Thanks. Fred Dagel is our Chairman. He can still use some help if you have a few minutes a month. We inducted one new member at our September meeting, Ray Fenster. Ray gra-

ciously volunteered to work on the calling committee. Welcome, Ray.

Al Cook has taken the membership chairman's job. Thanks, Al. We're looking forward to a successful year with your leadership. John Kreiling and Walt Howat have volunteered to host our mid-holiday get together. Details will be forthcoming as soon as John tells Walt he's volunteered.

Heard from Harold Seely this month. He's well and says hello. Other members who wish to correspond with the society are encouraged to do so. Harold's address may be obtained from

me. I'm sure he would love hearing from you.

Our 1984 CSE Roster will be out before October 31, come hell or high water says Roberta.

Our Engineers Fun Night is set for Thursday, February 21. It will be a great party for CSE and all engineers. More details in December. Plan to come.

SHARING RISKS IN THE CONSTRUCTION INDUSTRY

The following letter appeared in the September 20, 1984 issue of ENR magazine.

The construction industry has some serious problems. Increases in litigation, cost overruns, delayed and even abandoned projects have to be addressed if our industry is to continue to grow.

Your recent Viewpoint article should be the starting point of an ongoing discussion on contract formation and risk-sharing. I continue to be amazed at how many large owners who take enormous risks in their day-to-day operations (i.e., drill oil wells, build nuclear plants, self-insure entire fleets) try to put all of their construction risks in the hands of the contractor through the use of exculpatory clauses (i.e., borings provided are for information only, time extension only/no damage for delay, etc.) The wide use of exculpatory clauses has resulted in less responsive project management on the part of the owner and designer, as well as general increase in protracted claims and litigation.

Our industry needs more discussion on how risks should be divided between the owner, designer and contractor. We need to start talking and acting like a construction team.

ABOUT THE COVER

Tunnel and bridge construction will carry four lanes of Interstate 70 through the Beavertail area in DeBeque Canyon. The map also shows State Highway 65 and Plateau Creek in Mesa county at their junctions with I-70 and the Colorado River.

ON THE WRITE SIDE

By Susan R. Quinn

— 'SHUN WORDS' —

Do you feel obligated to sound "formal" when you write? Do you think "formal" writing is the same as "professional" writing? If that's your thinking, you're wrong; formal writing generally sounds awkward and pompous, and inhibits rather than creates rapport with your readers.

When we are not comfortable with our writing, we tend to rely on words that end with "tion," what I call formalized verbs, or "shun" words. For example, some people write, "I would like to voice an objection," when they could simply say, "I object." There is nothing grammatically wrong with "shun" words; the problem is that we overuse them:

"Due to the ramifications of the dissemination of the objections to the qualifications of the definitions . . ."

The reader has to wonder if that sentence ever came to an end. This example of "shun" words is an exaggeration—to most people—I hope. But you can see that overuse of them can make the reader wonder just what the writer is trying to say.

The key is that if you use those words

ask yourself if it wouldn't be better substituted with a verb (or made part of the predicate). For example:

"Determination of the source of the problem was made."

Sounds a little awkward, doesn't it? The sentence reads much better as, "We determined the source of the problem," or "The source of the problem was determined," or depending on the context, "We found the problem." (Always keep in mind that you never want to revise to the point that you change your true meaning.)

Another example is:

"Organization of the energy group was organized?"

Sometimes a "shun" word is used at the beginning of a sentence to emphasize the actions of "organizing" or "determining"; this can be effective. The point is, do not overuse the words. They clutter our writing, tend to make us sound pompous, and do not contribute to the conciseness and clarity of what we are trying to say.

Susan R. Quinn is a business/technical writing trainer and consultant with S R K, 10432 N. Dartmoor Ct., Parker, Colo. 80134; phone 841-5673.



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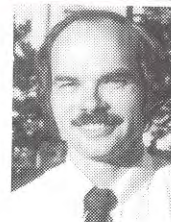
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CHAIRMAN'S MESSAGE

By John B. Richards, Chairman IEEE Denver Section



The WESTERN ENGINEER would like to publish your articles. If you have an article you have already written that you feel would be of interest to other engineers, we are very receptive to reviewing it for publication. We ask that you obtain all necessary copyright approvals prior to submission to us. If your article has appeared in another publication, it is important that you secure approval for reprinting in the WESTERN ENGINEER. If copyright approvals have been obtained from outside sources, please include a photocopy of it.

If photographs are part of your article, black and white glossy finishes reproduce the best. Please include photographs you do not need to have

returned. If the article includes illustrations, please make sure they are of reproducible quality.

We will attempt to return all materials you submit for publication. However, there is no guarantee that something won't get lost in the mail. Please send duplicate photographs when possible. Photocopies of pictures do not produce quality reproductions. Please send your articles to me. Thank you.

Student Paper Contests

Wayne VonFeldt has written a schedule of the Student Paper Contests for the next eleven years. He has already scheduled next year's contest for March 1, 1985. His article is included in the RockIEEE Overlook section of this issue.

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SEMINAR ON
ACCESSING AND USING THE COLORADO WATER DATA BANK
November 9, 1984

AGENDA

8:30-9:00 Registration — Coffee
9:00-9:20 Introduction — Leonard Rice, CEC/C. Need for access, history, potential uses and users
9:20-10:00 Colorado Water Data Bank — Dr. Jeris A. Danielson, State Engineer. Background, evaluation and purpose
10:00-10:15 Break
10:15-11:00 Structure and Content of Data Bases — Walter I. Knudsen, State Engineer's Office. Data dictionary, data management
11:00-11:45 Status of Data Bank — Walter I. Knudsen, State Engineer's Office. Diversion years for Districts in data base, verification and updates, water rights tabulation, water data base
12:00-1:30 Lunch
1:30-2:30 Access Procedures and Administration — Michael J. Moravan, C.S.U. Hardware requirements to communicate with CSU, personnel availability, manuals and newsletter, user accounts, passwords, overview of system 2000 data base man-

2:45-3:30

agement, CSU use charges
Use of the Data Base — Walter I. Knudsen, State Engineer's Office. Options in obtaining information (string, card, standard reports, reduced reports), example of applications, cautions in using the data base, state use charges
3:30-4:30 Questions and Answers

SEMINAR SPEAKERS

JERIS A. DANIELSON was appointed State Engineer and Director, Colorado Division of Water Resources in December 1979, after serving in the Division since 1970 as Chief of Planning and Deputy State Engineer.

WALTER I. KNUDSEN, JR. is presently Chief of the Information Services Branch, State Engineer's Office.

MICHAEL J. MORAVAN has been with the Colorado State University Computer Center for the past 8 years and was the team leader of the group that redesigned and implemented the Water Data Bank utilizing System 2000 as the data base management system.

**COLORADO WATER DATA BANK
BACKGROUND**

The Colorado Water Data Bank was authorized in 1972 by the state legislature to store

technical water resources data. Colorado State University was selected as consultant for the project. Computer programs and data are located in Ft. Collins and are accessible by the Division of Water Resources through their remote facilities.

The principal objectives for creating the Water Data Bank were to improve access to water resources data by state and federal agencies, consultants and members of the public as well as to improve the administration and management of the state's water resources, through establishment of a central facility for compilation, organization, storage and dissemination of water resource data. These objectives can be achieved by enhancing the public's access to the Data Bank by direct connection with user computer facilities.

REGISTRATION INFORMATION

Before October 26: \$40.00. After October 26: \$50.00

Registration includes a copy of the CSU user's manual and supplemental materials prepared by the speakers, plus lunch and breaks. Registrants will also receive a sample copy of the CSU monthly newsletter, *Vector*.

Make checks payable to: CEC/C

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Attendance will be limited to the first 40 registrations received.



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Public Service

National Institute of Education, Washington, D.C.

In the past two years, about a dozen reports have been issued by commissions and committees of prestigious individuals on the state of U.S. secondary education. They have all reached a common conclusion: that American high school students are not learning enough math or science to satisfy the Nation's needs for its economy or defense. As a group, the reports are based on four premises regarding the quality and extent of education. It will be enlightening to explore some of the data for these assertions.

Scores on the College Board's Scholastic Achievement Tests (SAT), which were presented graphically in a previous issue of *Impact*,* have declined substantially from 1963 to 1983. Performance in mathematics decreased from 502 to 467 during that period, and average test scores of verbal ability dropped from 478 to 425. One result is that enrollments in remedial (high school level) courses in universities and four-year colleges rose 72 percent between 1975 and 1980, a period when undergraduate enrollments increased only seven percent. Remedial courses, including arithmetic and general mathematics, now account for one-quarter of all mathematics courses taught in four-year institutions and 42 percent of all mathematics enrollments in two-year colleges.

assessing knowledge of content, inquiry and use of scientific methodology, and the application of science in everyday life, have declined in the last set of assessments.

$\sqrt{48} \cdot \sqrt{12} + \sqrt{43}$
 $\sqrt{16 \cdot 3} \cdot \sqrt{4 \cdot 3} + \sqrt{43}$
 $\sqrt{16 \cdot 3} \cdot \sqrt{12 \cdot 9} + \sqrt{43}$
 $4\sqrt{3} \cdot \sqrt{12 \cdot 9} + 2\sqrt{3}$
 $4\sqrt{3} \cdot 2\sqrt{12 \cdot 3} + 2\sqrt{3}$
 $4\sqrt{3} \cdot 6\sqrt{3} + 2\sqrt{3} = 24 \cdot 3 + 2\sqrt{3} = 72 + 2\sqrt{3}$

In a series of assessments of mathematics learning conducted in 12 industrialized countries in 1960-64, the United States was the last or almost last in each of the population groupings measured. As noted in Fig. 2, this included both 13-year olds and high school seniors. A second international assessment of mathematics achievement has recently been conducted. Although the results will not be released until late 1984, preliminary data indicate that the scores for U.S. students have remained about the same as in 1964, while those for other industrialized nations, most notably the Japanese, have increased.

the participating nations, U.S. students not only scored in the lower half of the developed nations as measured by the composite science scores, but also in separate physics. Fig. 3 compares the scores of U.S. students in their last year of secondary schooling with those of France, Germany, Japan, and the United Kingdom, our chief economic competitors.

Overall, on 19 academic tests that were conducted in the period of 1960 to the early 1970s, which provide international comparisons in several subject areas in addition to math and science, American students were never first or second and, in comparison with other industrialized nations, were last seven times.

Assertion #3: The problems of math and science education result from a general laxity in educational standards and from a shortage of qualified math and science teachers.

In *A Nation at Risk*, the National Commission on Excellence in Education recommended a basic curriculum for all high school students that, among other requirements, prescribed three years of mathematics and three years of science. As noted in Fig. 4, as of April 1984, eight states approved and five states proposed raising high school graduation requirements to include three years of mathematics; and five states approved and an additional two states proposed requiring three years of science. Although the number of states with these requirements is a minority, it is a significant increase from 1982, when only Louisiana required three years of math and no state required three years of science.

With regard to college admissions, in the fall of 1982 only nine states required three years of high school math for admission to their state universities, and none required three years of science. Further, only 11 states required even two years of science. By early this year, however, standards have been raised so that 13 states

WESTERN ENGINEER

UNCLE JOHN'S FILE

by John C. Kreiling, P.E.



Quite a surprise, recall last month I wrote of losing my camera at the adjourned golf tournament? At the evening September membership meeting, the Society presented me a replacement camera — Thank you all. The meeting with Neil Kelley, of SERI speaking on Wind Turbines and 29 members and guests pleased President Jim Dougan. The next two meetings will be at noon at the Landmark. Fred Nagel's calling committee will be contacting you all.

NEW MEMBER

Ray Fenster

Walt Howat and I have volunteered as hosts for the December-January meeting to occur between Christmas and New Years — an early evening affair, just a party, exact date later — so mark the calendar and be there — the Society Board Room. There are so many things going on before Christmas and after the New Year let down from the myriad of football games just led the Board to the idea to try something else.

Many of you may remember Gene Lindberg, he was a reporter with the Denver Post before retirement. He was usually assigned the news topics relative to engineering and for years wrote metrical composition for the Empire section of the Sunday edition. He is moving to Deer Isle, Maine. Gene was among the late teen classmates at the

College of Engineering in the University at Boulder. His eyes weren't up to the strain, so he switched to Journalism and with the knowledgeable basics as an Engineer, his talents were readily pounced on by "Big Brother" — a great friend of Lawrence Robertson and Marcellus Merrill. Be sure you read and keep the serialized article "The Birth and Growth of Electricity in Colorado" by Lawrence Robertson — so much history is available, never to be known because it isn't recorded. As Hal Roach, the Irish Comedian says "Write it down."

A nice letter from Harold Seely of Colorado Springs — he was pleased with the appeal to participate in the Society activities. April 27, 1984 a general mailing to all the members asking for help to revitalize the organization was sent. How many of you have responded? Harold, you are a Life Member, dues are no longer required of you. However, a professional donation of any amount will be appreciated — you are entitled to all the privileges of the Society with the Life Membership. Are you still receiving the Western Engineer?

Several deaths have been reported since last month. Frank V. Wedlick, a Life Member is gone. He joined the Society in 1937 and became a Life Member in 1967. After graduation from what is now CSU at Fort Collins, he

began his engineering career working for his father gaining further experience with California-Edison, Stearns-Roger and the Sunflower Ordnance Depot, in Kansas. Frank established The Killam Gas Burner Co. and was President of the Company until his retirement. He served as chairman of the Rocky Mountain Gas Association, and was active in the Society. Harold F. Silver, the founder of Silver Engineering Co., a design and heavy equipment manufacturing plant, North City Limits of Denver. Harold donated the furnishings for the Board Room for the Engineers Building on South Santa Fe Avenue when it was opened in 1959. Today, the large table, chairs, bookcases and lounge are in the Society Offices at 7000 Broadway. Mrs. Augusta Zietz Whiteside the step-mother of Frederick K. Whiteside and the wife of former president of the Society F.W. Whiteside (1926) also passed away. They shall all be missed.

Perusing the dictionary is something I do often because spelling is often a problem for me. An interesting thing noticed a few minutes ago is with the letter "Q", other than acronyms and rare proper names all words start with Qu---, I am sure you all have known the oddity for sometime. However, should your dictionary have other than what I have written please let me know. Bernadine and I are off to the Western Mediterrean — will be back for our 50th Anniversary.

Dan Harrington sent us tickets for the CU Football game scheduled for Saturday after Labor Day, postmarked the 3rd, the tickets arrived Saturday the 8th at 3:30 PM — 5 days from Edgewater to Englewood, some fun. Shall see you at the November meeting. No word from Jeannie.

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CSU COURSE TO TRAIN STUDENTS ON CAR EMISSIONS

In the future, students at many of the nation's 17,000 high schools will get the facts on automobile emission control and the effects of tampering, thanks to a short course developed recently by the National Center for Vehicle Emissions Control and Safety.

"The attitudes and habits that they form now could have a direct effect on their future behavior," said project director Terry Wohlers, a Colorado State University research associate.

Wohlers and colleague Joe Beebe developed the three-hour short course so it can be included in drivers' education, environmental science and industrial education classes. They hope to reach most high schools in the country within a few years.

The course, titled "Tampering, Your Car, and the Air You Breathe," assumes that automobile emissions control are not high priority interests among students. Students receive a nontechnical overview of emissions control, and they

learn why federal programs have been designed to reduce vehicular pollution.

The emissions center also conducts workshops to show high school instructors how to incorporate vehicle emission control awareness into their classes.

Wohlers believes the short course will help reduce vehicular emissions in the United States. While automobiles still are a major contributor to air pollution, some studies suggest that the amount of vehicle-generated hydrocarbons, carbon monoxide and nitrogen oxide in the country is less than half what it was in the 1960s he said.

"Tampering with emission controls, contrary to popular belief, usually increases maintenance costs and decreases engine performance. This hurts motorists' wallets and the environment because emissions tampering can add seven to 10 times the amount of vehicular pollutants to the air," he pointed out.

Many of today's misconceptions and misinformation regarding emissions control emerged more than 10 years ago when automobile manufacturers redesigned engine parts to meet air quality standards imposed by the Environmental Protection Agency.

"There was a lot of trial-and-error in the car makers' early efforts, and that created much of the misunderstandings about emissions control efficiency and effectiveness," Wohlers said.

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I-70 TUNNELS SCHEDULED FOR DEBEQUE CANYON

By Carl Sorrentino
Department of Highways

Colorado's 916 miles of Interstate highway open to traffic represent 10 percent of the state's total highway network. But the Interstate routes contribute to the growth of the state, carrying 37 percent of the vehicle miles traveled. Residents, truckers and tourists alike are happy to see that each year's edition of the Colorado Travel Map shows a little more of the Interstate system completed.

There are three gaps: U.S. 6 in DeBeque and Glenwood Canyons, and the Interstate 76 segment along Clear Creek north of Denver which will continue I-76 from its current I-25 junction farther southwest on a diagonal route to I-70 near Wadsworth Blvd.

In the mountains and canyons on Colorado's western slope, each four-lane mile is a safer mile. As Interstate construction continues in both canyons, a tunnel project in DeBeque Canyon should provide another measure of safety at the Beavertail area about 20 miles east of Grand Junction.

Originally funded in fiscal year 1983/84, the Beavertail Tunnels project was postponed last January after state legislators took \$9 million from the Highway Users Tax Fund to help bail out Colorado's sagging General Fund. The project is reinstated in the FY 1984/85 construction budget with a total amount of \$14,658,000 in federal and state money.

The Colorado Division of Highways intends to advertise the project for bids during October. A bid opening in November should determine which con-

tractor will perform the work.

Bidders will all be prequalified, in a process similar to that used for the Hanging Lake pilot bore project in Glenwood Canyon. Prospective bidders must have 10 years experience in major tunnel construction, including at least one project exceeding two million dollars. Requirements call for technical experience on the part of the company

"As Interstate construction continues . . . a tunnel project in DeBeque Canyon should provide another measure of safety at the Beavertail area about 20 miles east of Grand Junction."

and its key staff personnel, along with bonding ability. This process prequalified 27 contracting firms for the Interstate 70 pilot bore near Glenwood Canyon's Hanging Lake area, and on bid opening day 15 highly competitive bids were turned in. Prequalification for the Beavertail tunnels project has been published twice.

Construction (see map on cover) calls for two 34-foot by 48-foot tunnels, each about 600 feet long. A temporary tunnel support system will use rib and post type steel sets, and a final support system

will encase those with a reinforced concrete final lining. The Division of Highways advertisement will call for portal construction and portal slope stabilization, rock mechanics instrumentation, grouting, concrete pavement, guardrail, tunnel lighting and drainage, and other detailed work. The contract will require completion within about 15 months.

Motorists will use the new four-lane roadway from the Colorado River, Plateau Creek junction to a point a quarter of a mile northeast of the tunnels. (On the map, State Highway 65 follows Plateau Creek toward its Interstate 70 interchange). At the eastern end of this project, impact attenuators will be provided for eastbound motorists where U.S. 6 narrows to one lane in each direction. The system will cushion the effect of potential crashes, for vehicles which stray from the traveled way.

Four bridges and retaining walls at the Beavertail area are currently under construction. On July 19 the Argee Corporation of Denver bid \$8,022,310 on the project, and a contract was awarded four days later. Work began August 31. By the end of January this project is to have its river work completed (caissons poured), with concrete deck pouring scheduled for next spring.

Each of the three Interstate gaps has its tentative scheduling and phased construction, based upon the federal funding allocated each fiscal year.

But if federal apportionments continue and state matching funds are available, all three Interstate gaps should be opened to traffic in 1991.

SIX NDT LEADERS HONORED BY ASNT

Six leaders in nondestructive testing (NDT) were honored by the American Society for Nondestructive Testing (ASNT) during the Society's Annual Awards Brunch, Oct. 2, in Cincinnati, OH, during QualTest-3.

Those honored were: Edward L. Cri-

suolo, retired from Naval Surface Weapons Center, Silver Springs, MD, and Donald T. O'Connor, retired from Magnaflux Corporation, Chicago, IL, 1984 ASNT Honorary Member Award; Carl B. Shaw, Portland General Gas & Electric Co., Portland, OR, 1984 ASNT Gold

Medal; John L. Summers, Rockwell International, Golden, CO, 1984 ASNT Tutorial Citation Award; William Lord and Nathan Ida, Colorado State University, Ft. Collins, CO, and Ramasamy Palanisamy, The Timken Company, Canton, OH, 1984 ASNT Achievement Award; and Donald J. Hagemaiyer, Douglas Aircraft Co., Longbeach, CA, presenter of the 1984 ASNT Lester Honor Lecture.

THE BIRTH AND GROWTH OF ELECTRICITY IN COLORADO

By Lawrence M. Robertson
Vice President of Engineering and Construction,
Retired Public Service Company of Colorado

Public Service Company of Colorado-Valmont Plant

The Denver Gas and Electric Light Company and the adjacent Western Light and Power Company needed additional generating capacity but existing plants could not be enlarged. The companies were merged into the Public Service Company of Colorado to build a steam-electric generating plant in 1923 and 100 kv (later 115 kv) 28-mile line to Denver and eight miles to a hydroelectric plant in Boulder Canyon, west of Boulder and three miles of double-circuit to the 44 kv loop.

The Platte River could not provide circulating water for more than 25,000 k.w. A small lake at Valmont, five miles east of Boulder, had good geology and an area of 120 acres. It could be, and was, increased to 540 acres for a development of at least 400 m.w. and is supplied by both South and Middle Boulder Creeks. This site is near the lignite coal fields of southern Colorado and railroad facilities were available. Construction was started in 1923 and completed in December 1924.

A five story brick building was built to house boiler, generator, controls, 13 kv switch gear and accessories. A separate brick building was built to house coal preparation equipment. The lake was immediately adjacent to the plant and 100 k.v. and 44 k.v. substations were adjacent to the building. A 20,000 k.w. turbine generator was installed. Since that time, the machine has been rebuilt, increasing the capacity to 32,500 k.w. and four additional units have been added to make a total of 314,000 k.w.

Valmont plant was the largest and most modern coal-powered generating station between the Missouri River and the Pacific coast when it started operation in December of 1924.

Cabin Creek Pumped Storage The Cabin Creek Pumped Storage

THE RECENT YEARS — THE ADVANCEMENT OF POWER GENERATION TECHNOLOGY AND INDUSTRY RESEARCH

Hydroelectric Project was built in 1964 through 1967 near Georgetown in the mountains 35 miles west of Denver. It has an upper reservoir at an altitude of 11,202 feet with a 4,300-foot power, water tunnel from the upper reservoir to two reversible pump turbines in a powerhouse in the lower reservoir. They can operate in one direction to pump water from the lower reservoir to the higher one or reverse and receive water from

the upper reservoir to generate power with the water going into the lower reservoir. The generation capacity is 324,000 k.w. and during the pumping cycle 275,000 k.w. is required for the two as pumps.

The system load is down at night and efficient steam generation is running idle and can be used to pump the water to the upper reservoir where it will be ready for generating power. This is storing water or energy for peak load or emergencies. This was the highest head of water (1200 feet) and highest altitude of a pumped storage plant in the United States (Figure 16).

The project is located in a valley on South Clear Creek, five miles south of Georgetown and is connected by a 35-mile double-circuit 230 k.v. line to the

Continued on page 16



Figure 16. Cabin Creek Pumped Storage Hydroelectric Project near Georgetown. It is 35 miles west of Denver on South Clear Creek.



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RockIEEE Overlook

CHAPTER'S COLUMN

By Mike Foley, Group's Chairman, Denver Section

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NOVEMBER CHAPTER ANNOUNCEMENTS

IEEE DENVER SECTION MEETING NEW MEMBER RECOGNITION NIGHT

The November meeting will be New Member Recognition Night. The Denver Section will honor our new 1985 IEEE Members. Any person who joins IEEE at the November meeting will receive a free dinner. Introduce your professional associates to IEEE at the November dinner meeting.

DATE: Second Tuesday in November . . .
November 13, 1984
PLACE: Quality Inn Downtown
(I-25 and Speer Blvd. Exit West)
TIME: Social 6:00 pm; dinner 6:30 pm; Meeting 7:30 pm.
PANEL: Telecommunications consultant, Mountain Bell representative, Data Communications Consultant
PROGRAM: JUST HOW FAST ARE WE ENTERING THE AGE OF INFORMATION/COMMUNICATIONS. Hear about the many changes we have all experienced in our telephone service since the separation of the Bell System. Topics will include the many optional services now available since the FCC allowed for privately-owned and interconnected telephone equipment, the multitude of players that now deliver the equipment and services, their position in the domestic telecommunications consumer marketplace, and what we can expect in the next 10 to 25 years. Bring the whole family, including those who now have (or should have) their own telephone/computer.
RSVP: The pre-meeting Social & Dinner will require reservations. Call Bill Whipkey at 427-2411 on or

before Friday, November 9, 1984. Dinner will be Braised Swiss Steak at \$10.00 per person. Dinner is not required to attend the meeting at 7:30 pm. Section meetings are open to all IEEE Society members, their guests, and friends of the Engineering profession. NEW MEMBERS WELCOME!

Joint COMPUTER/ITS Computer/Information Theory Society

DATE: Third Tuesday in November . . .
November 20, 1984
TIME: 7:30 P.M.
PLACE: AT&T Information Systems
11900 North Pecos Street
Denver, CO
Take I-25 to 120th and turn west to Pecos. Turn left on Pecos and then take second left into parking lot. Meet in Lobby.
PROGRAM: Bringing Artificial Intelligence Products and Technology to Market
SPEAKER: Roger Ison, Project Manager, Hewlett Packard
TOPIC: Overview of State of the Art Research and Development for Fifth Generation Computers
RSVP: Dan Michaels at 939-5139

Joint PES/IAS Power Engineering Society/Industry Applications Society

DATE: November 15, 1984
TIME: 6:00 P.M. Social Hour

CONTINUED ON NEXT PAGE

6:30 P.M. Dinner (Optional - \$10.00)
7:30 P.M. Meeting
PLACE: Landmark Inn Hotel
455 South Colorado Blvd. at Cherry Creek North Drive. (Free parking available underneath rear tower)
TOPIC: Solar I and Medicine Bow — Two Operating Alternative Energy Sources
SPEAKER: Jerry Harris, Stearns Catalytic Corporation. Mr. Harris served as the Lead Electrical Engineer for Stearns Catalytic during construction of the Solar I 10 MWe Pilot Plan in Barstow, California, and for the 4 MW wind turbine at Medicine Bow, Wyoming. Mr. Harris will show slides and a short film of the construction phases of both projects. Design considerations and the general background of both of these alternative energy projects will be discussed.
RSVP: Gary Petersen, Stearns Catalytic, 692-4140. By November 12, 1984

Joint VTS/COMSOC Vehicular Technology Society/Communications Society

DATE: Third Thursday in November . . .
November 15, 1984
TIME: Social 6:00 pm, Dinner 6:30 pm,
Meeting 7:30 pm.
PLACE: STEAK and ALE, S.E. corner, Westminster Mall (Route 36 to Boulder. Take Sheridan Blvd. Exit South)
SPEAKER: John Dawson, Director of Engineering, Mile Hi Cablevision
TOPIC: TELEVISION PIRACY. The speaker will discuss who are TV pirates, why this *is* an illegal act, and what the cable industry is doing about it. This should be another spirited meeting with lots of questions and comments, especially from those with home brew HBO receivers.
RSVP: The pre-meeting Social & Dinner will require reservations. *Please call John Hardzinski at 360-4178 on or before noon, Tuesday, November 13, 1984.* Dinner is not required to attend the meeting at 7:30 pm.
ALL IEEE MEMBERS AND GUESTS ARE WELCOME!

DECEMBER HOLIDAY SOCIAL IEEE DENVER SECTION JOINT MEETING WITH VTS/COMSOC ADVANCE & ONLY MEETING NOTICE

DATE: Second Wednesday in December . . .
December 12, 1984
TIME: Social 6:00 pm, Buffet 6:45 pm, Barnstormers 8:00 pm, Curtain 8:30 pm.
PLACE: Country Dinner Playhouse
(I-25 and Arapahoe Exit East — Turn south on Clinton)
PROGRAM: "SEVEN BRIDES FOR SEVEN BROTHERS"
A tremendously enjoyable and entertaining musical set in Oregon in pioneer days. The oldest of seven bachelor brothers comes home to the farm one day with a beautiful and spirited bride, who

succeeds in transforming their home, life and habits, but unwittingly inspires them to invade her village and kidnap six unwilling maidens as their prospective brides. The resulting madcap of confusion and courtship, spiced with lively music and brilliant dancing, all leads to a six fold happy ending.

RSVP: To obtain tickets, make check payable to "Country Dinner Playhouse" in the amount of \$14.95 per person and send to Bill Whipkey, 8069 Meade Street, Westminster, CO 80030. Seats will be assigned as checks are received. Tickets will be sent by return mail. As usual, tickets are limited and will be gone before next month's RockIEEE Overlook.

This will be the only meeting notice for this December Holiday Special!

EMC (Littleton) Electro Magnetic Compatibility

For meeting contact Robert O. Loveland at 977-6578

AES Aerospace and Electronic Systems

For meeting information contact Henry Rackley at 977-7621.

CS Control Systems

For meeting information contact Dan Zwego at 497-2682

EMB Engineering in Medicine and Biology

For meeting information contact K.C. Rock at 394-8351.

RELIABILITY

For meeting information contact Mike Jinnette at 538-3447.

Joint APS/MTTS/GRS Antennas and Propagation/Microwave Theory and Techniques/Geoscience and Remote Sensing

IEEE Denver-Boulder Joint Chapter Meeting

PROGRAM: Thermal Infrared Geophysics

SPEAKER: Dr. Kenneth Watson, U.S. Geological Survey

Joint EMC/IM Electro Magnetic Compatibility/ Instrumentation and Measurement

For meeting information contact Paul Hardy at 499-6655.

AREA A STUDENT PAPER CONTEST SCHEDULE

1985 University of Southern Colorado in Pueblo
1986 University of Texas at El Paso
1987 University of Colorado at Colorado Springs
1988 Metropolitan State College in Denver
1989 South Dakota School of Mines & Technology

ENGINEERING SALARIES DOWN RELATIVE TO CONSUMER PRICE INDEX

By Gary A. Peterson

A recent comparison of engineering salaries shows that engineers' salaries have actually decreased over the past 20 years relative to the Consumer Price Index. The salary survey was prepared on behalf of the Manpower Committee of the United States Activities Board of IEEE. The salaries included in the survey are average salaries of entry level engineers (Engineer 1), engineers with 5 to 10 years of experience (Engineer 4), and engineers with the Ph.D. degree. Salary data was provided by the U.S. Bureau of Labor Statistics.

The Consumer Price Index (CPI) is a U.S. Bureau of Labor Statistics "Cost of Living" index which tracks the comparative cost of household consumer goods over a period of time. The CPI includes such items as food, clothing, housing, automobiles and medical costs. The CPI uses 1967 as a base equal to 100. As shown in Table I, the CPI has increased to 298.4 in 1983. It should also be noted that the CPI does not reflect progressive income tax and FICA tax rates. Thus, the actual "spendable" income is even lower for the 1983 salary level compared to the 1967 salary level than is indicated by the curves.

As an example, the curves indicate that in 1967 the average salary for an Engineer 4 (engineer with 5 to 10 years of experience) was \$12,424. In 1980, an Engineer 4's average salary was \$28,486 in current dollars, but was only \$11,542 when adjusted for the 1980 CPI of 246.8. The Engineer 4's 1980 salary was effectively 7 percent less in 1980 than in 1967 in terms of the CPI. And, as noted earlier, this example does not reflect the higher tax rates applicable to the \$28,486 salary which would further reduce the spendable income for the 1980 salary level.

One conclusion that can be drawn from this survey is that, on average, there has been a sufficient supply of engineers to meet the requirements of U.S. firms over the past 20 years. The laws of supply and demand would suggest that if a shortage of engineers existed, salaries would be increasing in order to attract the additional engineers necessary to fulfill the demand.

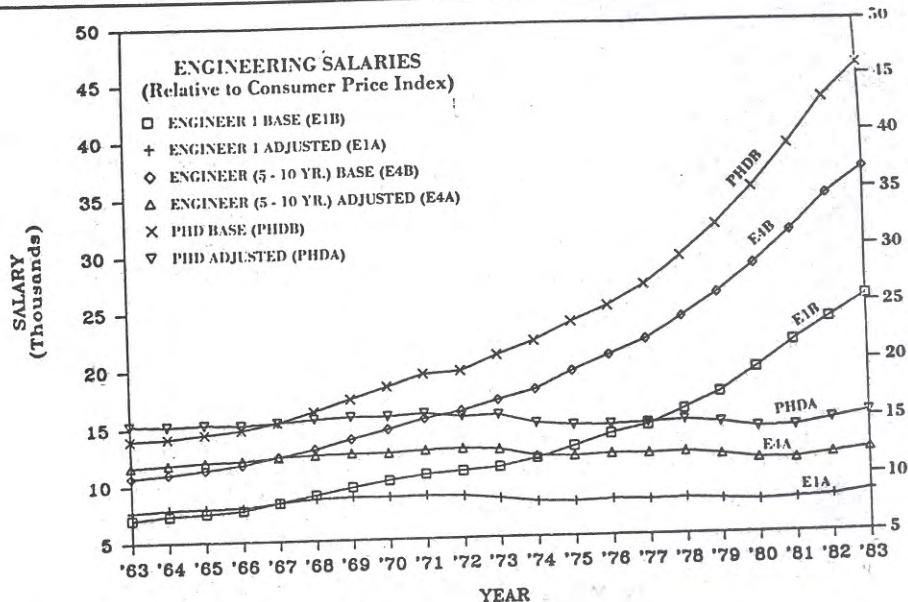
Mr. Peterson has been a member of IEEE since 1968 and currently holds the grade of Senior Member. He is a Principal Engineer with Stearns Catalytic Corporation, Denver, Colorado.

Year	CPI	Engineer 1		Engineer 4		P. H. D.	
		BASE	ADJ.	BASE	ADJ.	BASE	ADJ.
1963	91.7	7056	7694	10728	11699	14012	15280
1964	92.9	7344	7905	11016	11857	14117	15195
1965	94.5	7512	7949	11367	12028	14447	15287
1966	97.2	7764	7987	11784	12123	14782	15207
(1) 1967	100	8388	8388	12424	12424	15423	15423
1968	104.2	9023	8659	13095	12567	16335	15676
1969	109.8	9662	8799	13893	12653	17366	15816
1970	116.3	10209	8778	14695	12635	18368	15793
1971	121.3	10677	8802	15535	12807	19418	16008
1972	125.3	10921	8715	16159	12896	19635	15670
1973	133.1	11203	8416	17030	12794	20947	15737
1974	147.7	11901	8057	17927	12137	22106	14966
1975	161.2	12917	8013	19443	12061	23720	14714
1976	170.5	13918	8163	20749	12169	25047	14690
1977	181.5	14613	8051	22072	12160	26817	14775
1978	195.4	15928	8151	23972	12268	29245	14966
1979	217.4	17345	7978	25989	11954	31966	14703
1980	246.8	19411	7865	28486	11542	35180	14254
1981	272.4	21712	7970	31352	11509	38876	14271
1982	289.1	23622	8170	34443	11913	42881	14832
1983	298.4	25556	8564	36726	12307	45907	15384

NOTE 1: Notes 2 & 4
 NOTES:
 (1) Consumer Price Index, 1963 through 1983, using a base of 1967 equal to 100%
 (2) Source: Bureau of Labor Statistics Data
 (3) Source: Mechanical Engineering, July 1983
 (4) Engineer 1: Average Starting Salary For Entry Level Engineers
 (5) Engineer 4: Average Salary for Engineers With 5 to 10 Years Experience

Prepared By: Gary A. Petersen, IEEE/USAB
 Manpower Task Force, June 1, 1984

TABLE I



CONTEST SCHEDULE

Continued from page 11

1990 University of Colorado at Boulder
1991 University of Wyoming at Laramie
1992 Colorado State University
1993 New Mexico State University
1994 United States Air Force Academy
1995 University of Colorado at Denver

As shown in the above schedule, the University of Southern Colorado in Pueblo, Colorado, is hosting the next Area A Student Paper Contest, tentatively scheduled for March 1, 1985. As last year, the awards will be in the form of cash grants as follows:

1st Place Winner — \$200.00; 1st Place School — \$200.00; 2nd Place Winner — \$125.00; 2nd Place School — \$125.00; 3rd Place Winner — \$75.00; 3rd Place School — \$75.00.

The Denver Section encourages students to participate in the upcoming contest.

Wayne VonFeldt
Denver Section
Student Activities Chairman
Student Fund Chairman

NOVEMBER 1984

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	5	6	7	8	9	10
11	12	13 DENVER SECTION	14 EMC (Littleton)	15 PES/IAS VTS/COMSOC	16	17
18	19	20 COMPUTER/ ITS	21	22	23	24
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Denver, CO 80207
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Westminster, CO 80030
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SECRETARY

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Aurora, CO 80013
690-3879

TREASURER

Gary Swoboda
Stearns Catalytic
4500 Cherry Creek Drive
Denver, CO 80217
692-2748

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Ron Schroer
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4714 Lariat Drive
Castle Rock, CO 80104
977-1734/688-5912

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P.O. Box 1900 59Z/025-1
Boulder, CO 80302
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Charles R. Wright, 720 Everett St., Lakewood, CO 80215, 233-5553.

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ROCKIEEE OVERLOOK EDITOR

Craig Hartman, Westinghouse Electric Corp., 3900 S. Wadsworth Blvd., Lakewood, CO 80235, 987-4256

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Professional Activities — Bill Whipkey, 8069 Meade St., Westminster, CO 80030, 427-2411
Awards — Tom Bassett, Power Equipment Specialists, 423-2741
Membership — Ezra Larsen, National Bureau of Standards, 497-3540
Colo. Engr. Council Rep. — John Nelson, Nelson Engineering Inc., 431-7895
Colo. Engr. Council Alternate — James Hart, Hartec Inc., 795-2813

MEMBERS-AT-LARGE

K. C. Rock, University of Colorado Health Sciences Center, 394-8351

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Control Systems — Dan Zwego, Rockwell International, 497-2682
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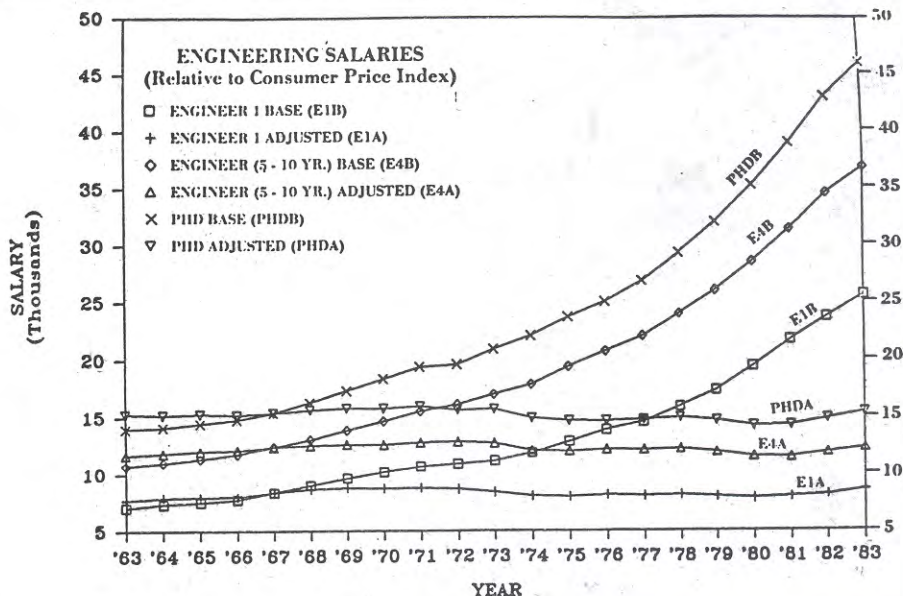
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ENGINEER'S CALENDAR — NOVEMBER 1984

ACM

Association for Computing Machinery.
Boulder Chapter: Monthly meeting, November 28th, 7:30 p.m. To be held at the University of Colorado Computing Center Auditorium, 3645 Marine Street, Boulder. The speaker will be Dr. Poma Diszkocs, Special Assistant for Research and Development at the National Library of Medicine in Bethesda, Maryland. The topic will be "Informational Retrieval - State of the Art." For information, call Joe Lachman at 538-3872.

Denver Chapter: Monthly meeting, November 7th. Cocktails at 6:00, dinner at 7:00, and program at 8:00 p.m. The topic will be "Software Metrics." Speaker and location to be announced. For more information, call 988-4265.

Professional Development Seminar on ADA, November 14th, 8:30-4:30. To be held at the Auraria Higher Education Center, 955 Lawrence. Registration fee of \$70-\$90 includes Handouts, lunch and snacks. Advanced registration required. For information, call 988-4265.

ACSM

American Congress of
Surveying and Mapping.

November 13 - 1:00-5:00 p.m. Public Land Survey Workshop at the Colorado State Office of BLM. Joint meeting with ACSM, ASP, and URISA. For further information, contact Homer Gilson at 294-7586.

AEG

Association of Engineering Geologists.
Monthly meeting, November 5th. For more information, contact Mike West at 972-2706 or Susan Steele at 623-2500 ext. 547.

AIME/SPE

Society of Petroleum Engineers
of the American Institute of
Mining, Metallurgical and
Petroleum Engineers.

Breakfast meeting November 14, Heritage Hotel, Bellevue at I-25. Speaker will be Fred Morrow, Company - Fiberflex, Topic "Beam Pumping with Fiberglass Rods."

Luncheon Meeting November 28, Downtown Marriott. Speaker will be Jim Harshorne with Gerry Williams Oil Producers, topic "Micellar Polymer Flooding at the Bell Creek Unit."

For further information, call Jim Mack at 832-0989.

AIPE

American Institute of Plant Engineers.
Monthly meeting, November 14th. Cocktails at 5:30, dinner at 6:00, and program at 7:00 p.m. To be held at the Holiday Inn North. The speaker will be George Moffat, Director of Market Development at Colorado Interstate Gas. His topic will be "A Natural Gas Update - The Gas Bubble or Ballon." For information, contact Dick Deyoe at 534-8181.

AICHE

American Institute of
Chemical Engineers.

Dinner meeting November 20 - Marathon Oil - Speaker Dr. W. B. Gogarty, Associate Research Director. Contact Wayne D. Roszelle at 794-2601, Extension 478, for further information.

AIME/SME

Society of Mining Engineers
of the American Institute of
Mining, Metallurgical and
Petroleum Engineers.

Meeting will be held at Writers Manner on November 15. For further information, contact Gregory Chlumsky at 279-2581, Extension 3104.

AIPG

American Institute of
Professional Geologists.

Monthly luncheon meeting, November 19th at the Denver Press Club. For reservations, call 534-3667 by Thursday, October 15th.

ASCE

American Society of
Civil Engineers.

Colorado Springs Chapter: Monthly meeting, November 15th. Cocktails 6:00, dinner 6:30, and program to follow. To be held at the Windsong Restaurant. The speaker will be Rollo Jacobs with the Van Guilder Agency. His topic will be "Loss Prevention." For information, contact Jane at 471-9960.

Western Chapter:

Environmental Group: November 9th, 11:30 a.m. To be held at the Viscount Hotel. For reservations, call Doug Manigold at 236-9404 or 234-4061 by **Wednesday**, November 7th.

Geotechnical Group: November 8th. Cocktails at 6:00, dinner at 6:30, and program at 7:30 p.m. to be held at Marlowe's Restaurant. For reservations, call Joni or Al Gipson at 694-2770 by November 6th.

for information on other group meetings, contact Dave Sorenson at 320-6400.

ASHRAE

American Society of Heating,
Refrigeration and Air Conditioning
Engineers.

Student Night, November 7th. Cocktails at 5:30, dinner at 6:30, and program at 7:30. To be held at Rossi's, 4301 Brighton Blvd. - Denver. The topic will be "Solid State Controls." Speaker to be announced. The cost will be \$11.00. For information, contact Gary Shaffer at 232-6200.

ASSE

American Society of Safety Engineers.

No information available at press time. Contact John Mayerle at 740-1680.

ASPE

American Society of
Professional Estimators.

November 13th - Holiday Inn North (I-25 and 48th) 6:00 p.m. social, 7:00 p.m. dinner with program to follow. Ted Dougherty, contractor for **Christos Surrounded Islands** which were completed in May 1983, along a 6-1/2 mile North-South line in North Biscayne Bay, Florida, will present a slide show with descriptions of the many activities and involvements in construction and installation of this outstandingly beautiful art project. For reservations contact the ASPE Office, 458-0465.

ASME

American Society of
Refrigerating and Air-Conditioning
Mechanical Engineers.

For information, contact Rob Hampel at 797-2455.

CCEA

Colorado Chinese
Engineers Association.

Co-sponsoring a meeting with the Colorado Chinese Club and the Organization of Chinese Americans - A China Night on November 10 at the Colorado University Medical Center. For further information, contact Dr. Paul Cheng at 977-1871.

CECC

Consulting Engineers
Council of Colorado.

Board of Directors meeting, November 27th at 3:30 p.m. To be held at the DAC. General meeting to be held on November 27th. Cocktails at 5:30, dinner at 6:30, and meeting at 7:30 p.m. For information, call the DAC office at 757-3379.

CSA

Colorado Safety Association.

Events for November include:

1st-2nd — Occupational Safety Management (NSC)

7th-8th — Defensive Driving Course — Open to the public. Evening classes 5:30-9:30 p.m.

15th — Motor Fleet Accident Investigation Workshop.

27th — Managing Motivations, Decisions and Communications (4th of Four) IV. Being Right is Not Good Enough (Communications)

28th — DDC - 8:00 a.m.-5:00 p.m.; Open to the public.

29th — Drinking, Driving & You, 8:00-10:00 a.m.; Open to the public.

30th — DDC II - 8:00 a.m.-12:00 noon; Open to the public.

28-29th — DDC Instructor Development Course.

30th — DDC II Instructor Development Course.

For more information, contact Rodney Williams at 629-6255.

CEC

Colorado Engineering Council.

Monthly meeting, November 14th. Cocktails at 6:00, dinner at 6:30, and program at 7:30. To be held at the Landmark Inn. For more information, contact Chris Sheats at 1-330-8008 or 1-330-6158.

CSE

Colorado Society of Engineers.

Monthly meeting, November 13th, 11:30 luncheon. To be held at the Landmark Inn. The speaker will be Major Edwin A. Holme, NORAD Briefing Officer. His topic will be "NORAD." For reservations, call the CSE office at 426-5228 by November 9th.

CSNHR

Colorado Society of

Natural Hazards Research.

No information available at press time. Contact Roy Spitzer at 744-7105.

DFCPEG

Denver Federal Center

Professional Engineers Group.

General meeting, November 21st. Cocktails at 11:30. To be held at the Denver Federal Center, Bldg. 56, Room 2017. The speaker will be Dennis Polhill, P.E., of PMS. His topic will be "Infrastructure." For more information, contact Floyd Summers at 231-1147.

Extractive Metallurgy

Chapter of Denver

November 15 - Dinner meeting, Holiday Inn Denver West, 14707 West Colfax, Speaker Judy A. Eisele,

Research Supervisor at Reno, Nevada, U.S. Bureau of Mines. Cocktails 6:30, dinner at 7:00. For reservations call Tom Grey, 771-3120, prior to noon on Tuesday, November 13. Professionals \$10.00, Students \$5.00.

IEEE

Institute of Electrical and Electronics Engineers.

November 15 - Dinner meeting at 6:00 p.m., Landmark Inn Hotel, 455 South Colorado Boulevard, topic "Solar I and Medicine Bow - Two Operating Alternative Energy Sources." Contact Gary Peterson at Stearns Catalytic, 692-4140. See RockIEEE Overlook beginning on page 10 for additional meeting notices.

IES

Illuminating Engineering Society.

No information at press time. Contact Charlott Synecki at 750-6982.

ISA

Instrument Society of America.

November 1 meeting at Quality Inn, 1 block west of I-25 and Speer Social hour at 5:30, dinner at 6:30 p.m., followed by the program "Preparation and Presentation of Technical Papers" - Oren Moore Manager of Marketing Services, Stearns Catalytic Corporation. For dinner reservations, call 296-1790 by October 29..

PEC

Professional Engineers of Colorado.

Boulder Chapter

November ??th - University Memorial Center (UMC), Broadway and Euclid in Boulder. Social Hour at 6:30 pm, dinner at 7:00 with program to

follow. Cost is \$8.00 or \$5.50 for students. For reservations and information contact Dallas Fowler at 494-4943 or Robert Patterson at 494-7707.

Comanche Chapter

November 10th - Details to be announced. For further information, contact Charles Tucker at 384-7787 (days), or 384-6613 (evenings).

Jefferson Chapter

November 8th - Bernard's Restaurant, 5390 Wadsworth By-Pass. Cocktails at 6:15 p.m., dinner at 6:45 p.m. with program to follow. For further information & reservations, call the PEC office at 458-0465.

Metro Chapter

November 14th - Quality Inn Central, Denver, 2601 Zuni St. Executive Committee meets at 5:00 pm. Cocktails at 6:30, dinner and program to follow. Roy Scott, Manager of Systems Engineering and Analysis at Ball Aerospace will discuss "The Engineer's Role in Future Space Operations." For information and reservations, call the PEC office at 458-0465.

Northern Chapter

November 15th - Either a tour of the Engineering Research Laboratory at Colorado State University, or a joint with the ASME Northern Chapter. For details and reservations, contact Mike Ketterling at 351-0550.

Pikes Peak Chapter

November 16th - Joint meeting with the Professional Engineers in Government. A speaker will be announced. For details and reservations, contact Gregory Smith at 473-2300 x774.

San Juan Chapter

November 15th - Contact Gerald Zink for information and reservations at 259-2869.

Southern Chapter

November 4th - At LaRennaissance in Pueblo. Social hour at 6:30pm, dinner at 7:00 with program to follow. Frank Cordova and Fred Adams of the State Board of Registration will discuss PE-LS licensing requirements. The student Chapter from the University of Southern Colorado will be in attendance. For reservations and further information, contact Mark White at 545-5660.

Ute Chapter

For information, call Bryant Rose at 242-5202.

PES

Pueblo Engineers of Colorado.

Monthly meeting, November 14th. Cocktails at 6:30, dinner at 7:00. For more information, contact Bob Erickson at 544-2791.

PI/USA

Packaging Institute of America.

December 5 meeting - Tour of Rocky Mountain Delta Petroleum Products. January 24 - Foil and Foil Laminates. For reservations call Carole Cantor at 373-4860.

PLSC

Professional Land

Surveyors of Colorado.

Three workshops to be held November 30th thru December 1st, from 9:00-3:30 p.m. To be held at the Green Center, Colorado School of Mines. For information, contact Robert Chichester at 756-3695.



COLORADO SOCIETY OF ENGINEERS

Lunch Meeting November 13, 1984

Landmark Inn 455 South Colorado Boulevard

Cocktails 11:30 Lunch 12:00 Program 12:30

Speaker:

Major Edwin A. Holme, NORAD Briefing Officer

Topic: NORAD

Cost: Regular Members \$9.50

Junior Members \$6.00

For reservations call the CSE office, 426-5228, by November 9

Continued on page 18

ELECTRICITY IN COLORADO

Continued from page 9

Denver area and a single circuit line to the west to Dillon and 115 k.v. to Henderson Molybdenum Mine in the Clear Creek area. Because of the rough terrain, the 230 k.v. towers were aluminum and the line connection was aided by the use of helicopters.

Fort St. Vrain Nuclear Generating Station

The Fort St. Vrain Plant is 35 miles north of Denver near Platteville, at the

generator has a capacity of 330,000 k.w. (Figure 17). The initial fuel load was placed in the reactor on December 27, 1973 to January 16, 1974 and the self-supporting chain reaction was first started on February 9, 1974. This plant feeds power into the power system through 230 k.v. lines.

Research Lightning Investigations at High Altitudes in Colorado

The operation of transmission and dis-

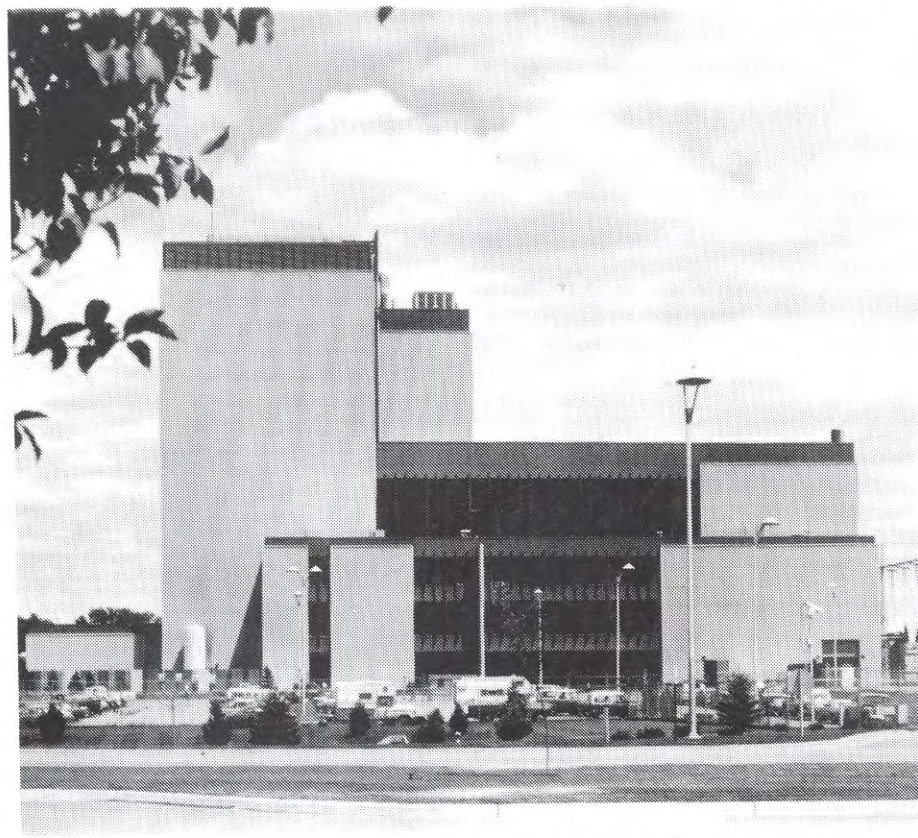


Figure 17. Fort St. Vrain Nuclear Generation Station. Located 35 miles north of Denver, it is the first commercial high temperature, gas-cooled reactor.

junction of the South Platte River and St. Vrain Creek. It is the first commercial size, high efficiency, gas cooled reactor with high steam temperature (1,000 degrees F, 1,000 degrees F reheat), high pressure (2,400 p.s.i.), gas cooled (helium) with a fuel of enriched uranium and thorium. The thorium is converted to a fissionable isotope of uranium, thus it produces fuel during operation which in turn reduces the cost of fuel.

The reactor has a graphite core for the fuel and a large, prestressed concrete containment vessel. The steam, turbine

tribution lines in high altitudes of the Rocky Mountain region had indicated that lightning strokes were not as severe as at lower altitudes. Glow discharges, or corona current from the earth have been observed at high altitudes from pointed objects and rocks.

This investigation was made to determine the probable lightning current at altitudes from 6,000 feet to 13,500 feet and to measure corona current. Air temperature was recorded and correlated with the strikes at the various altitudes.

The Shoshone-Denver 100 k.v. transmission line was constructed in 1908 and 1909 on steel towers and did not have overhead ground wires. A ground-fault neutralizer or Peterson Coil had been installed at Shoshone Plant. Tower-footing resistance measurements from elevations from 6,000 to 13,500 feet, were made for the dry year of 1934 and the wet year of 1935 to study this condition and effect on tower-top voltage with stroke current and the causes of multiple phase faults. The results showed a substantial increase in resistance in a dry year and increase in resistance with an increase in altitude; not because of altitude itself but the character of the earth, rocks versus soil, and probable leaching of salts and minerals out over the years. The resistance range was 40 k.w. to 950 ohms.

A continuous counterpoise, tower to tower, had been installed from Denver to Leadville over Argentine and Hagerman Passes. They were buried about one foot where possible. The altitude at Denver is 5,280 feet, and rises to 13,500 feet on Argentine Pass.

Surge-crest ammeter links (small sheet of steel in a plastic tube) were installed on wood brackets on tower legs

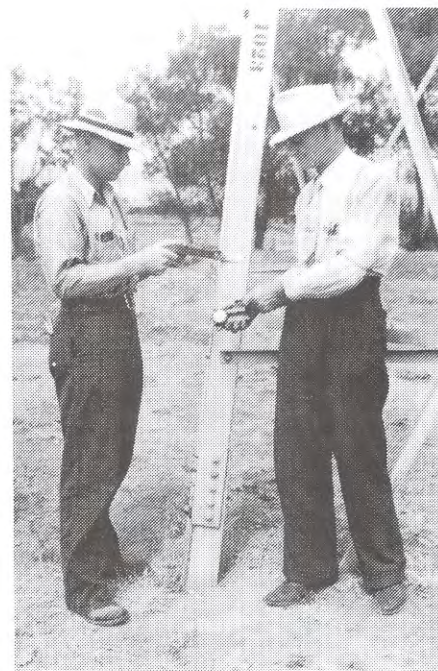


Figure 18. Wood bracket and magnetic links for measuring maximum crest lightning stroke current and direction of flow in tower members and buried counterpoise conduction on Shoshone-Denver line.

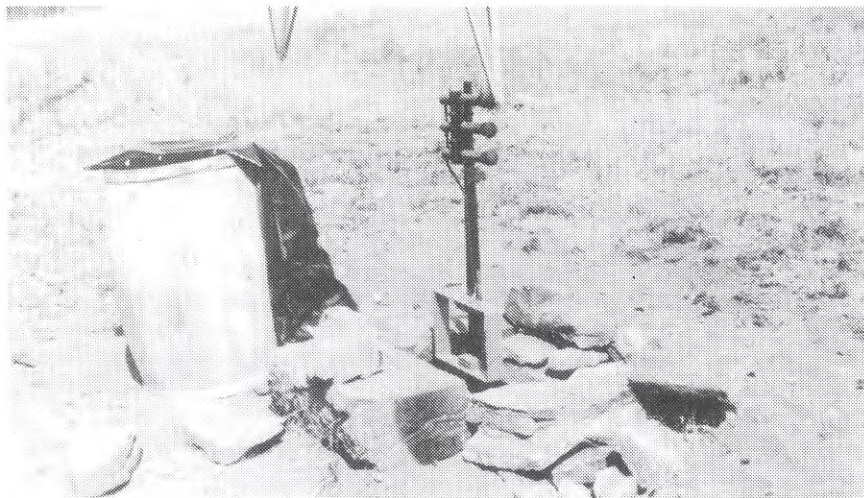


Figure 19. A recorder to rate rise of lightning stroke current in buried counterpoise conductor continuously connected tower to tower on Lookout Mountain.

(Figure 18) and on the counterpoise on each side of the towers to indicate maximum or crest current and direction or polarity. This was done from Denver to the top of Argentine Pass.

A rate of rise recorder was installed on Lookout Mountain where lightning seemed to be active. The maximum measured stroke current was here at 96,800 amperes. Also, the counterpoise wires carried at an altitude of about 7,800 feet practically all the current flowing in the towers into the stroke with little in tower footings. Fig. 19.



Figure 20. Installation on Argentine Pass, 13,400 ft., to record earth corona current or discharge, lightning stroke currents, and air temperature and estimate of cloud-field voltage gradients as indicated by corona currents.

Minimum readable current with surge-crest ammeter links is 1,500 amperes. It was found that the length at which values of current were observed, increases directly with increase of tower current. With the tower current of 96,800 amperes, the distance in feet to minimum readable current was 8,000 feet. This was the maximum tower current observed on this project.

Work started in 1937 and completed in 1940. There were 145 stroke currents measured, ranging from 2,000 to 96,800 amperes, 64% negative and 36% positive, compared with low altitude figures of 95% negative and 5% positive. The observed stroke current decreased with altitude from sea level to 13,500 feet.

Three stations were installed to record the earth discharge or corona current, air temperature, stroke current and surge voltages. These consisted of two steel boxes for instruments connected to a copper lightning rod supported by a wood pole. The tip of the rod was 18 feet above the ground (Figure 20). Three towers were installed in an equilateral triangle of about one-quarter mile on each side; Argentine tower at 13,500 feet, Argentine Pass at 13,500 feet, and Argentine peak at an altitude of 13,700 feet. The microammeter showed corona current, positive and negative, and recorded 51 different storms of 51 to 480 microamperes and potential gradients up to 94 k.v. per foot. The records showed discharges lasting for an hour and going from negative to positive polarity.

The line passes over an area of differing geology, but except for resistivity, these differing formations do not appear to influence location of strokes or the value of the current.

The information has proved valuable in design and operation of transmission lines, substations and equipment at high altitudes.

Leadville-500 k.v. High Voltage, High Altitude Test Line-Corona, R.I. Structures

As early as 1925, measurements of corona loss on lines of the Public Service Company of Colorado on 110 k.v. lines at high altitudes indicated that the losses were less than those predicted by Peek or Peterson's formula for corona loss, and actual tests showed appreciably lower than calculated values. RI (Radio Influence) and TVI had not been tested, therefore, it was not known what should be the design factors for lines above 115 k.v. which were contemplated.

Tests had been made near sea level at Tidd Station of American Electric Power Company in Ohio at 500 k.v. and a test line was built in 1957 at Leadville, Colo-

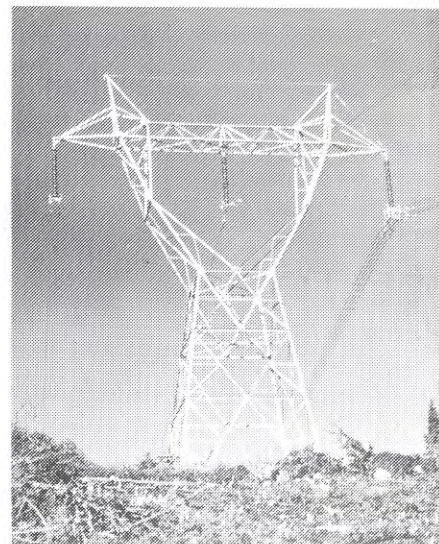


Figure 21. Steel tower on Leadville high-altitude, high-voltage 500 k.v. testline with two-conductor bundle, single conductor, and four-conductor bundle. Altitude is 10,500 feet.

rado at an altitude of 10,500 feet to extend data taken at Tidd to high altitudes.

The line consisted of 10 structures of various designs; steel towers, steel H-frames, wood pole frames, guyed V towers and deadends. Conductors included

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ELECTRICITY IN COLORADO

Continued from page 17

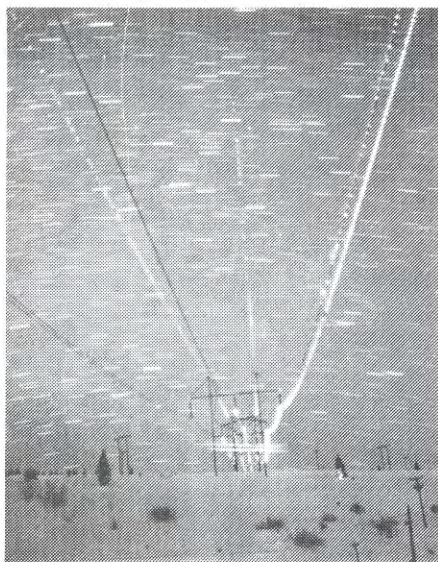


Figure 22. Steel H-frame and wood H-frames with corona present.

a single, expanded 1.65 inch ACSR and a two-conductor bundle of .92 inch ACSR conductors, identical to Tidd tests for comparison. A bundle of four 1.4 inch expanded conductors was used for the proper voltage tested. It was reduced to a three-conductor bundle and to a two-conductor bundle.

A transformer was brought to Leadville, and testing was conducted for a number of years. In order to get variables of weather, aging, surface conditions and on corona loss, critical voltage; performance of variable designs of struc-

tures were completed over a period of four years. Figure 21 shows the tower with conductors and hardware tested. Figure 22 shows corona on the conductors on the steel H frame and the wood frame.

Influence of Air Density on Electrical Strength of Transmission Line Insulation

Flashover tests were conducted at the Leadville EHV Test Facility of the Public Service Company of Colorado and at Project EHV at Pittsfield, Massachusetts

to evaluate influence of air density (altitude) on flashover strength of transmission line insulation. This included switching surge and impulse voltages.

A transportable impulse generator rated 3,600 k.v. was taken to Leadville to test the length of insulator assemblies, lengths of air gap, influences of nearby ground plains, wet and dry conditions, and switching surge and impulse wave shapes. This involved cap and pin insulators, suspension insulators and guyed V structures. These tests were made in 1965 and 1966 and have attracted international attention. Figure 23 shows test setup at Leadville.

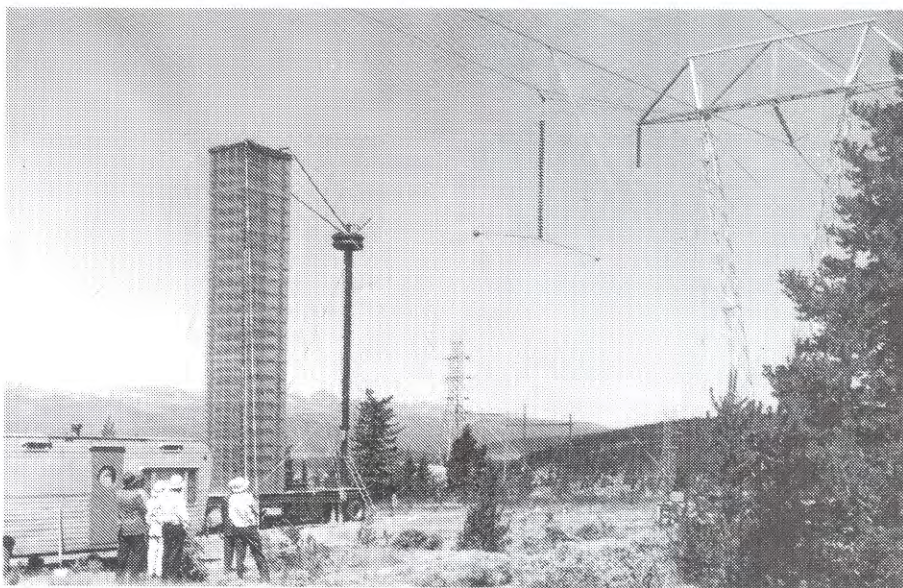


Figure 23. Surge generator of 3,600 k.v. for making impulse and switching surge voltage tests in insulators, air gaps, and guyed V aluminum tower. It also tests the proximity effect of the tower as a grounded object on insulator flashover.

CALENDAR

Continued from page 15

RMAG

Rocky Mountain Association of Geologists.

Meeting dates for September include:

2nd — Edwin K. Maughn, of U.S.G.S., Denver. His topic will be "Tyler Formation and Associated Rocks in Montana and Adjacent Areas."

9th — David W. Rich, of Sabine Production Co., Denver. His topic will be "Porosity types in Goltic Limestones."

16th — John Kaldi, of Shell Ltd. of Canada, Calgary, Canada. His topic will be "Reservoir Properties, Depositional Environments and Diagenesis of the Mississippian Midgale Beds, Midale Field, Southeastern Saskatchewan."

23rd — Thanksgiving — no meeting.

30th — (Tentative) Thomas J. Schull, of Chevron U.S.A. Inc., Concord, California. His topic will be "Oil Exploration in Nonmarine Basins of Interior Sudan."

For more information, contact Lorna Porter at 526-0613.

SAME

Society of American Military Engineers.

Dinner meeting, November 14th. Cocktails at 6:00, dinner at 7:00, and program at 8:00. To be held at Dragon Palace - Denver Tech Center. The speaker will be Col. David Swint, Head of the Engineering Dept., U.S.A.F. Academy. His topic will be "Service Academies and Engineering Education." For more information, Contact Dave Sprengle at 751-0741.

SSS

System Safety Society.

For information, contact Rich Tower at 977-9292.

SAE

Society of Automotive Engineers.

November 14 - Tour of the Warren Village Training Center. For further information, call Cathy Sherepita at 744-4647.

SWE

Society of Women Engineers.

For information contact Pam Tarquin at 333-4505.

WIM

Women In Mining.

Industry Appreciation Night, November 14th. Cocktails at 6:00. To be held at the Green Center, Colorado School of Mines. The speaker will be Dr. George C. Ansell, President of Colorado School of Mines. For more information, call Martha at 844-4481.

DIMENSIONS OF THE PROBLEM

Continued from page 5

require or have proposed requiring three years of math for admission to their state universities and four states have proposed three years of science.

In addition to the math and science requirements, the Commission on Excellence also recommended four years of English and three years of social sciences. A survey indicated that only 13.4 percent of 1982 high school graduates met the recommendations in these four areas. When two years of a foreign language were added to the recommendations, the number of graduates who completed the suggested curriculum dropped to 2.6

school seniors intending to major in education have taken 20 percent fewer math courses and 35 percent fewer science courses than college-bound students intending to pursue other fields. Further, these future education majors scored 80 points below the national average in their combined verbal and math scores on the SAT, had lower high school grade point averages, and took a smaller percentage of their high school curriculum in academic subjects.

Not only are education majors less well prepared to teach math and science, but there are fewer of them. As shown in Fig. 5, there is a rapidly

Association showed that in 1982 50 percent of the newly employed high school math and science teachers were not qualified in the subjects. The percentages are high for all parts of the country, but reach a staggering 94 percent for the Pacific states, which paradoxically is an area rich in high-technology industries.

Assertion #4: The U.S. appears to have more lower-skilled manpower and less higher-skilled manpower than an information-based, high-technology nation requires for its future.

Advances in computers, robotics and other technologies, as well as the demands of competition in an international marketplace, are swiftly changing skill requirements in health

TABLE 1: The Twenty Fastest Growing Occupations, 1982-1995

Occupation	Percent Change	Employment Change
Computer service technicians	97	53
Legal assistants	94	43
Computer systems analysts	85	217
Computer programmers	77	205
Computer operators	76	160
Office machine repairers	72	40
Physical therapy assistants	68	26
Electrical engineers	65	209
Civil engineering technicians	64	23
Peripheral electronic data-processing equipment operators	64	31
Insurance clerks, medical	62	53
Electrical & electronics technicians	61	222
Occupational therapists	60	15
Surveyor helpers	59	23
Credit clerks, banking & insurance	54	27
Physical therapists	54	25
Employment interviewers	53	30
Mechanical engineers	52	109
Mechanical engineering technicians	52	25
Compression and ignition mold machine operators, plastics	50	47

TABLE 2: Twenty-five Occupations that will account for forty percent of all new jobs created, 1982-1995

Occupation	Employment Change	Percent Change
Building custodians	780	28
Cashiers	740	47
Secretaries	720	30
General clerks, office	700	30
Sales clerks	690	24
Nurses, registered	640	49
Waiters and waitresses	560	34
Teachers, kindergarten & elementary	510	37
Truck drivers	430	27
Nursing aids and orderlies	420	35
Sales representatives, technical	390	29
Accountants and auditors	340	40
Automotive mechanics	320	38
Supervisors of blue-collar workers	320	27
Kitchen helpers	300	36
Guards and doorkeepers	300	47
Food preparation & service workers, fast food restaurants	300	37
Managers, store	290	30
Carpenters	250	29
Electrical & electronics technicians	220	61
Licensed practical nurses	220	37
Computer systems analysts	220	85
Electrical engineers	210	65
Computer programmers	210	77
Maintenance repairers, general utility	190	28

percent. Thus, only about one in 40 of the current high school graduates has taken a course of study that was common 25 years ago for those intending to go to college.

Students planning to major in education, however, are even less well prepared in science and math. A 1982 survey by the National Center for Education Statistics indicates that high

shrinking supply of secondary school teachers qualified in math and science. Further, only about half of those graduating actually enter teaching, and one in four of these people intend to leave the field in the near future. The result is that there is a very large number of unqualified people teaching math and science. A survey conducted by the National Science Teachers

care, energy production, insurance, banking, food processing, construction and many other occupations. Of the twenty job areas projected to grow the fastest between now and 1995, as shown in Table 1, almost all are high-technology related. While there still will be large demands for low-level service jobs, as indicated in Table 2, most of

Continued on page 21

DIMENSIONS OF THE PROBLEM

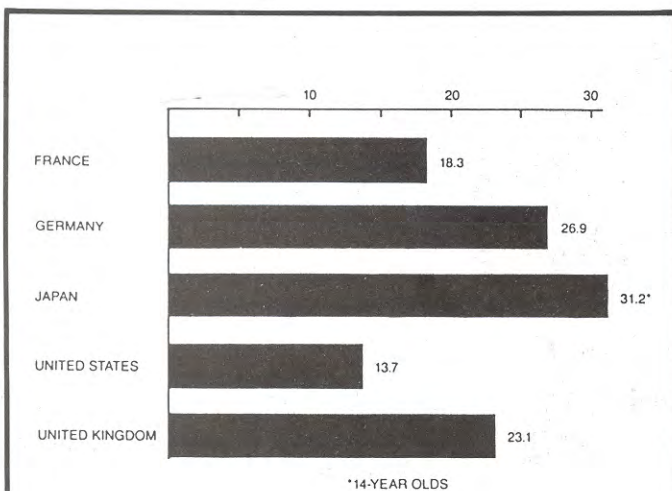
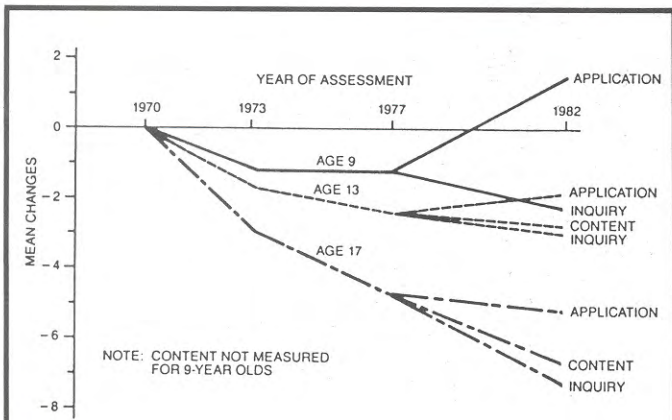


Figure 3: International Assessment in Science of Students in Last Year of Secondary School, 1970-72

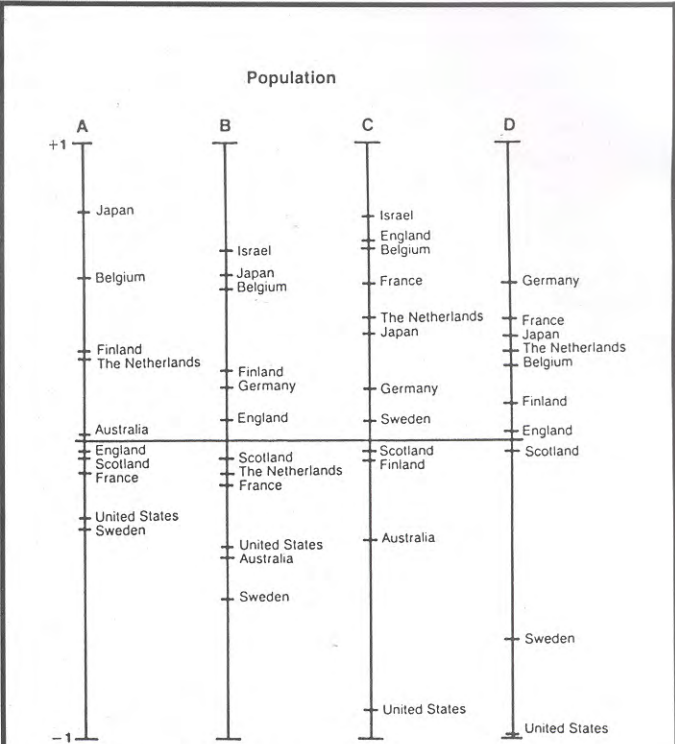


Figure 2: Distribution of student scores by country for the first international assessment of achievement in mathematics, 1964. Population A—13-year olds; B—grade containing most 13-year olds; C—students in last year of secondary school intending to major in engineering or science; D—students in last year of secondary school not intending to major in engineering or science.

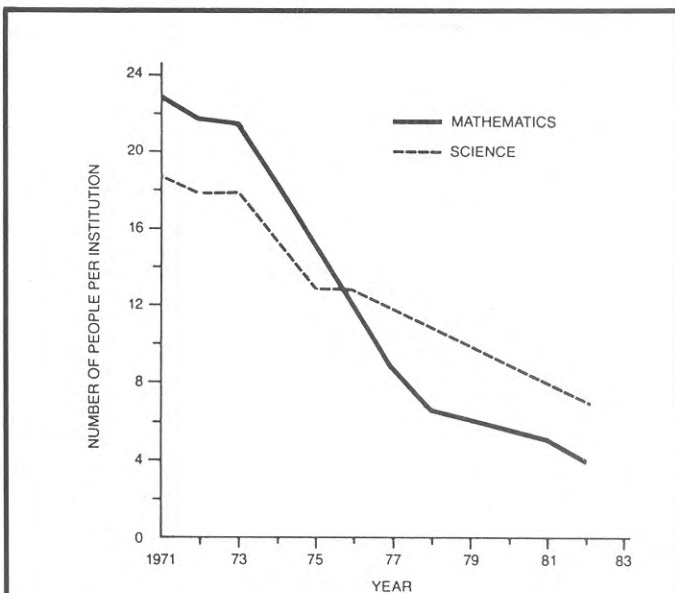


Figure 5: Average number of people per institution completing student teaching by year

DIMENSIONS OF THE PROBLEM

these require certain skills in mathematics and science.

Students not intending to go to college may not need advanced or theoretical courses in math and science, but they do need a working knowledge of these subjects to perform

their jobs correctly, with precision and, most importantly, with understanding. Lab technicians, nurses aids and surveying technicians must be familiar with equipment and procedures used in laboratories. Dental hygienists, aircraft mechanics and instrument repair

technicians must know basic concepts of biology, chemistry or physics. Accounting helpers, stock clerks and automotive mechanics must know how to estimate costs and keep accurate records. Basic skills in measuring, estimating and calculating, as well as in the methods of scientific inquiry and measurement are necessary in a

Continued on page 22

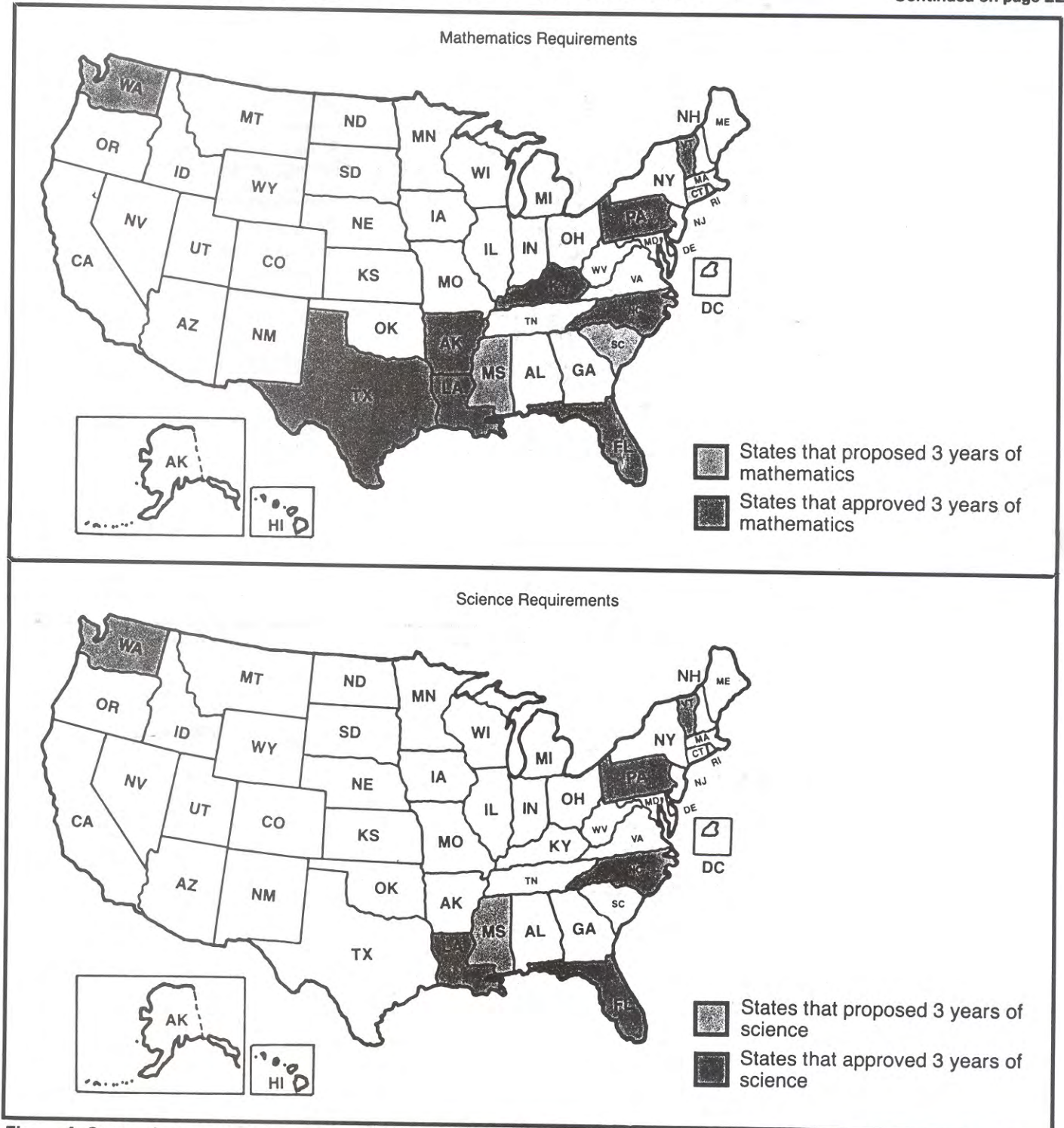


Figure 4. States that approved or proposed requirements of 3 years of mathematics and 3 years of science for high school graduation.

November, 1984

DIMENSIONS OF THE PROBLEM

Continued from page 21

growing number of jobs functions. Further, an understanding of probability, risk and other mathematical concepts, and of the elementary principles of the physical and life sciences and their implications for social and environmental issues, are necessary for all persons if they are to function as responsible citizens.

Professionals need an even deeper understanding of math and science. These include not only engineers and scientists, but doctors, lawyers, accountants, and professionals in production, sales and marketing of

technology-related products. Yet, high schools currently are not providing a solid education in these and other areas.

Although the current problems are serious, the situation is not hopeless. America has a basically sound educational system, in spite of the present difficulties. The system, however, must be improved and revitalized so that our schools can effectively educate our young citizens to live, work, participate in, understand and enjoy the fruits of our high-technology society. American education needs more and better prepared

teachers, updated curricula and teaching materials, and increased academic standards. To achieve this will require a national resolve to solve the problems of our schools, a strong commitment to excellence in education, and action by all concerned—our educational institutions, government at all levels, federal, state and local, business and industry, professional societies and individuals. The IEEE can take a leadership role in this effort. President Gowen and other Institute officials have issued the call. Now it is up to the members to take action.

****Leadership, Not Stagnation!****
IMPACT, May 1984, pp. 1-3., Grayson

CSU ENGINEERING BUILDING DEDICATED

Colorado State University will double the teaching laboratory space of its engineering college with renovation of CSU's old veterinary hospital. Since 1974 the engineering college's enrollment has nearly doubled causing cramped laboratory conditions," said Frederick Smith, acting dean of CSU's engineering college.

The new facilities will give CSU engineering students access to state-of-the-art equipment and more lab space, Smith said. Major features of the project include the Center for Computer-Assisted Engineering (CCAIE), a geotechnical laboratory and chemical engineering laboratories.

"The development of the CCAIE and the geotechnical laboratory represent

cooperative ventures between CSU faculty and industry to increase the strength of our educational programs," Smith said. The \$5.5 million renovation was funded by state and private sources.

The CCAIE lab was funded with approximately \$2 million in cash gifts and hardware from Rockwell International, Martin Marietta, Eastman Kodack, Peter Kiewit & Sons, Digital Equipment Corporation, Storage Technology, and Evans & Sutherland.

The lab is nationally unique because it exposes engineering students to some of industry's most sophisticated computer-assisted engineering technology, Smith added. "It was Rockwell International's contribution to the

CCAIE, which paved the way for the other industries to support the project," Smith said.

Robert Anderson, a CSU alumnus who is Rockwell's chairman and chief executive officer, was instrumental in securing his company's contribution. To honor Anderson, the CCAIE's interactive computing laboratory will be named for him.

CSU's geotechnical engineering program involves the study of geotechnical properties of soils related to such civil engineering projects as building foundation construction. The geotechnical lab will be named after Fu Hua Chen, president of a Denver engineering firm and CSU affiliate faculty member. Chen and representatives of other contributing industries were present at the building's Oct. 4 dedication ceremony.

How To Know You're Growing Older

1. Everything hurts, and what doesn't hurt, doesn't work.
2. The gleam in your eye is from the sun hitting your bifocals.
3. You feel like the night before, and you haven't been anywhere.
4. Your little black book contains only names ending in M.D.
5. You get winded playing chess.
6. Your children begin to look middle-aged.
7. You finally reach the top of the ladder, and find it is leaning against the wrong wall.
8. You join a health club and don't go.
9. You begin to outlive enthusiasm.
10. You decide to procrastinate, but never get around to it.
11. You're still chasing women, but can't remember why.
12. Your mind makes contracts your body can't meet.
13. You know all the answers, but nobody asks you the questions.
14. You look forward to a dull evening.
15. You walk with your head held high trying to get used to your bifocals.

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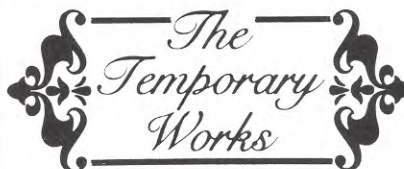
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