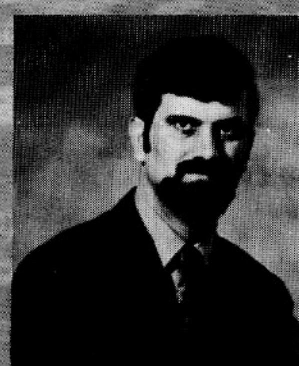
IEEE Council on

OCEANIC ENGINEERING

NEWSLETTER

EDITOR: HAROLD A. SABBAGH MARCH 1982 (USPS 420-910)

EDITOR'S COMMENTS



We apologize for the delay in getting the December issue to you. In making the transition to a new printer, there were delays in postal handling. The problems have been solved, and we can expect resumption of our regular schedule (as long as your editor gets his material to the printer on time).

This issue's feature article, which deals with the numerical modeling of corrosion, is typical of those that we wish to print from time to time; it's timely and of considerable importance and general interest. My own professional interests are in the areas of modeling and numerical analysis of engineering problems, so I jumped at the opportunity to publish the article. If you have an article of general interest that you would like to share with our readers, please send it to me, and we'll see about publishing it. Of course, the more specialized technical papers that undergo a review process will not be published in the Newsletter; they should be submitted to the Journal editor.

Best wishes for a pleasant Spring; see you at OTC in Houston.

Harold A. Sabbagh
Analytics, Inc.
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Council on Oceanic Engineering Roster

COUNCIL ON OCEANIC ENGINEERING

IEEE JOURNAL OF OCEANIC ENGINEERING

Contents

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COMPUTER TECHNIQUES FOR OFFSHORE CORROSION PROTECTION

Gene DeCarlo
Senior Corrosion Engineer, Lockheed Marine Services
Lockheed Aircraft Service Company

The offshore oil industry has experienced extraordinary technological development in recent years. Significant breakthroughs have been made in almost every technical area. For example, there have been notable advances in: exploration, drilling and recovery methods, offshore structural designs and design techniques, and in construction and installation methods.

Much of this progress is attributable to the application of modern computer techniques. The application of computerized systems analyses and design methods has enabled the installation and operation of massive deep-water structures to become almost a commonplace occurrence. One of the newest areas of offshore technology development is corrosion protection. Here again the computer plays a major role.

LOCKHEED MARINE SERVICES

Lockheed's involvement in marine-related fields is generally well known. However, many people are not aware that Lockheed is in the business of marine corrosion protection. Actually, Lockheed Marine Services (LMS) has been providing Cathodic Protection (CP) hardware and engineering services to the marine industry for 20 years. During this time, LMS, in line with corporate philosophy, has been committed to the development of high-technology products and services. Lockheed's high-output platinum/niobium anodes and pulse regulated power supplies are examples of the results from this commitment. Most recently, LMS has directed its development efforts to the improvement of existing CP design methods.

COMPUTER DESIGN TECHNIQUE

Cathodic protection is often thought of more as an art than a science. Because of the many variables that can affect the distribution of cathodic protection current, design techniques have often involved "rules-of-thumb" and unsubstantiated assumptions. By using mathematical models and computer methods developed by the aerospace industry to handle these variables, LMS has developed a sophisticated design program which eliminates reliance on sometimes dangerous assumptions and conservative "rules-of-thumb."

The Lockheed Computerized Current Density (CCD) program represents a significant advancement in the current state-of-the-art of corrosion protection. It offers offshore operators an alternative to outmoded design techniques and puts cathodic protection on an equal technical level with other areas of the rapidly advancing offshore oil industry technology.

The computer design method provides some notable benefits to offshore operators over conventional techniques. For example, the program will predict the level of protection that will be achieved on every member of a complex structure for a given design. Thus, the design is verified or modified before the CP system is installed. Another advantage is the ability to vary critical parameters and observe the effects. In this way the design can be based on "worse case" conditions if test data are limited.

For the first time, essential data needed to optimize new, expensive CP systems are available. A computer analysis can also be used in designing "retrofit" CP systems for existing structures and for locating critical areas for periodic underwater inspections. Most importantly, the use of the Lockheed CCD technique gives the offshore operator increased confidence that his structure is well protected.

MARINE CORROSION PROTECTION

Corrosion of man-made steel structures has always been a serious matter for concern, especially for structures in the marine environment. The technique commonly used to prevent the natural corrosion of steel in seawater is called cathodic protection. Described simply, cathodic protection is a technique whereby the tendency for iron, in a high-energy state (steel), to revert back (corrode) to its natural, low-energy state (iron oxide) is suppressed by the addition of energy from an independent source. Since corrosion is an electrochemical process, energy added to the system in the form of electric current (electrons) prevents the natural corrosion reaction from proceeding.

Electrons or electrical energy can be added to a freely corroding system in two ways. First, the addition can be accomplished by connecting a more active metal (higher energy state) to the structure below the waterline. Metals commonly used for this purpose are magnesium, zinc, or aluminum. Second, electrons can be supplied by an independent direct-current (DC) power source.

The active metal used in the first method, which is called sacrificial cathodic protection, gives up its electrons to the steel and is itself sacrificed or consumed in the process. The sacrificial metal is oxidized and becomes the anode in the electrochemical (corrosion) cell. Corrosion only occurs at the anode.

The second method, where electrons are provided by a DC generator or rectifier, is known as impressed current cathodic protection. In this method the circuit in the electrolyte (seawater) is completed by nonconsumable anodes. In both methods, the steel or structure becomes the cathode in the reaction and is protected—thus, the term "cathodic" protection. The principle of cathodic protection is illustrated in Figure 1.

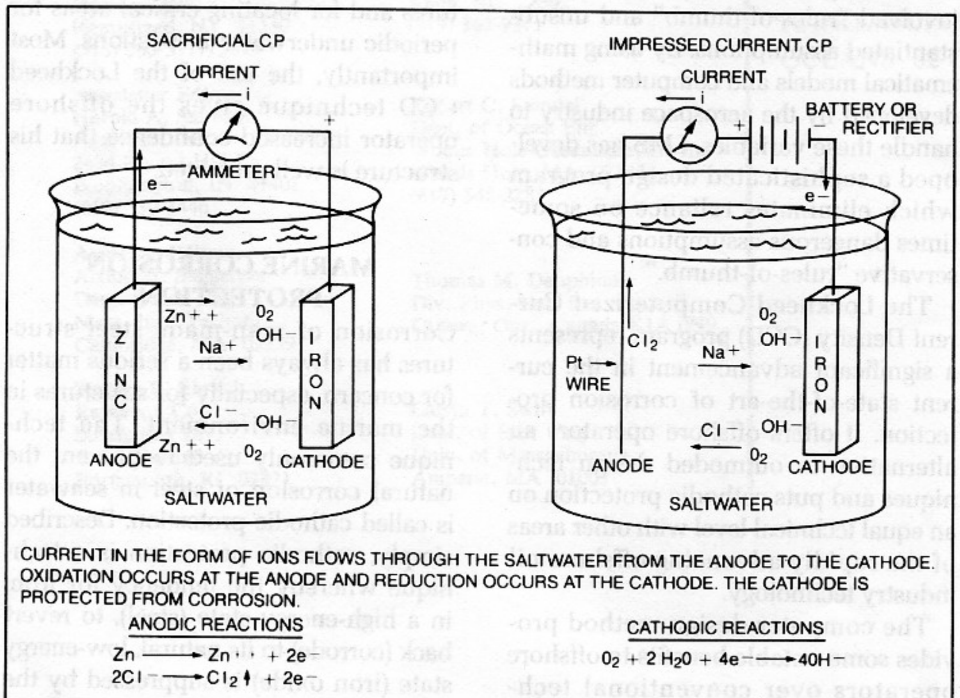


FIGURE 1 Cathodic Protection Principles

CATHODIC PROTECTION DESIGN

Two important questions must be answered in order to properly design a cathodic protection system for a large marine structure. They are: "How much current is necessary?", and "How do we get the current where it is needed?" The quantity of current required to achieve cathodic protection is a complex field in itself. It depends on a number of parameters such as: physical conditions, severity of the environment, and surface conditions of the structure. The quantity of current flowing onto a well designed system will also decrease with time due to a build up of calcareous salts caused by the flow of cathodic current. Much work has been done in this area by Lockheed and others, and a considerable amount of experience has been gained. However, since the determination of specific current requirements is complex, it is customary to design the system using safe, average values based on initial current requirement. This practice is presently used and is generally quite successful.

Once an acceptable criterion for determining total current is agreed upon, the next task is to select the number and location of anodes required to uniformly deliver this current. To do this properly is often very difficult and involves a considerable amount of guesswork. It is for this purpose that Lockheed's Computerized Current Density technique was developed.

CATHODIC PROTECTION CURRENT DISTRIBUTION

Typically, many anodes are installed on a deep-water offshore structure. As many as 700 to 1500 sacrificial anodes or from 15 to 50 impressed current anodes are used. The protective current flowing from each one of these individual sources flows through the highly conductive seawater to the steel cathode along a multitude of paths. Determining the distribution of this current becomes very complicated. We can be sure that the current will find the path of least resistance, but path resistance is dependent upon many variables. These variables include: water conductivity, anode/cathode size and distance relationships, mutual interference between anodes, surface film properties, and lack of homogeneous water and surface properties. To confuse the issue even more, path resistance under the influence of cathodic current is also time-dependent due to the build up of calcareous salts mentioned above.

Even for simple, single-anode systems, current distribution calculations are complex. For complicated structures, such as an offshore oil platform, the calculations are practically impossible without the aid of the computer. Accordingly, the actual distribution of current on such structures has never really been understood until now.

To overcome this rather critical shortcoming, corrosion engineers frequently rely on conservatism in the design. This conservatism manifests itself in high current density requirements for safety factors. Since the weight of sacrificial anodes is directly proportional to the design current density, this practice results in an excessive number of anodes being installed. It is assumed that the large number of anodes will compensate for nonuniform current distribution. In many cases it does, but not without substantial weight and cost penalties.

LIMITATION OF CONVENTIONAL DESIGN METHODS

For many years the conservative CP design philosophy, described above, has been successful. For shallow-water structures (less than 300 feet) adding excessive CP capacity has been proven to be a practical and reasonably economical means of assuring corrosion protection, particularly when the cost of failure to achieve protection is considered. Problems with this approach, however, occur on larger, more complicated structures. Limiting factors, such as high costs, excessive weight, and high wave loading due to the increased projected area, become very significant on deep-water structures.

For example, some offshore operators typically use safety factors of from 50 to 100 percent. For a structure in 500 feet of water, this conservative design would add from 0.6 to 1.3 million pounds of extra weight at an installed price of between 1.2 and 2.6 million dollars. Additional costs would also be incurred due to the larger structural members needed to support the additional weight and wave loading on the structure.

Offshore operators have reason to be concerned about excessive safety factors when the total CP costs are in the range of 5 to 10 million dollars. Costs of this magnitude can be incurred on structures in the 500 to 1200-foot-depth range. Operators also become concerned when the combined weight of the CP system and the accompanying higher strength members increase costly handling and ballasting requirements during installation. Under these circumstances any cost or weight reduction becomes very attractive.

PRINCIPLE OF COMPUTER DESIGN

The program used for CP design is a version of NASTRAN (NAsa STRuctural ANalysis). NASTRAN is a general purpose finite element computer program which is familiar to many aerospace industry engineering divisions. Although this program is primarily a structural and heat transfer analysis tool, it also has many other capabilities.

The mathematical relationships used by NASTRAN, which describe the distribution of stress and temperature fields, also apply to other physical phenomena. For example, the relationships also apply to magnetic field and current flow problems. NASTRAN has been modified for these magnetic field and current flow applications by A.O. Smith Corporation of Milwaukee. In conjunction with A.O. Smith, Lockheed has further modified the current flow application to incorporate the phenomenon of current dependent cathode polarization. Polarization, as used here, is defined as a counter electromagnetic force (EMF) or voltage resulting from the passage of current or charge through the metal/electrolyte (seawater) interface. The result of this development is a new application of modern computer technology. NASTRAN can now be used to quantitatively describe the distribution of cathodic protection current around a complicated steel structure.

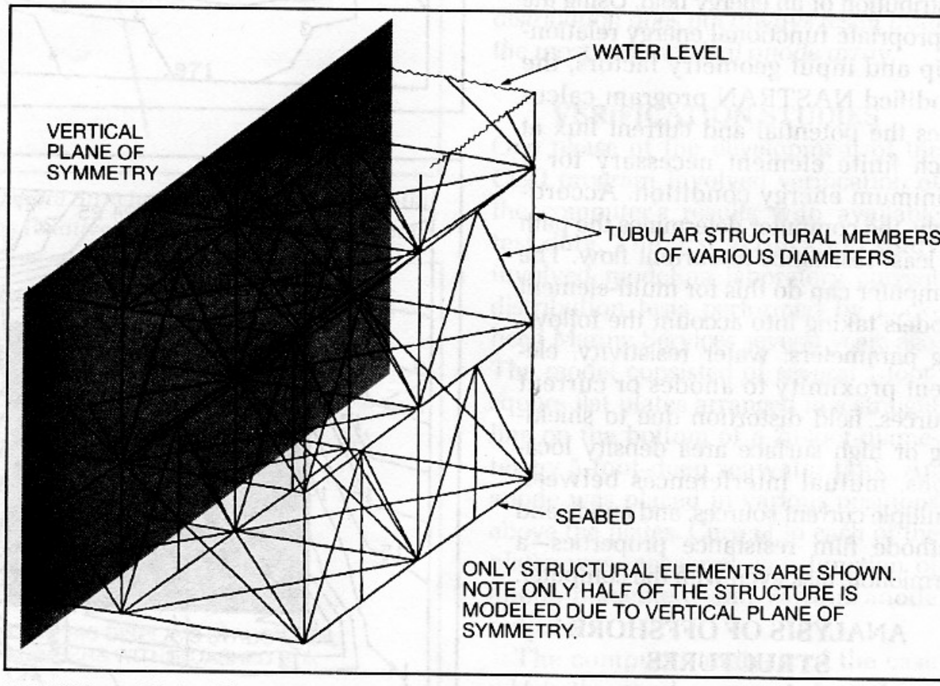


FIGURE 2 Finite Element Model of Shallow-Water Offshore Structure

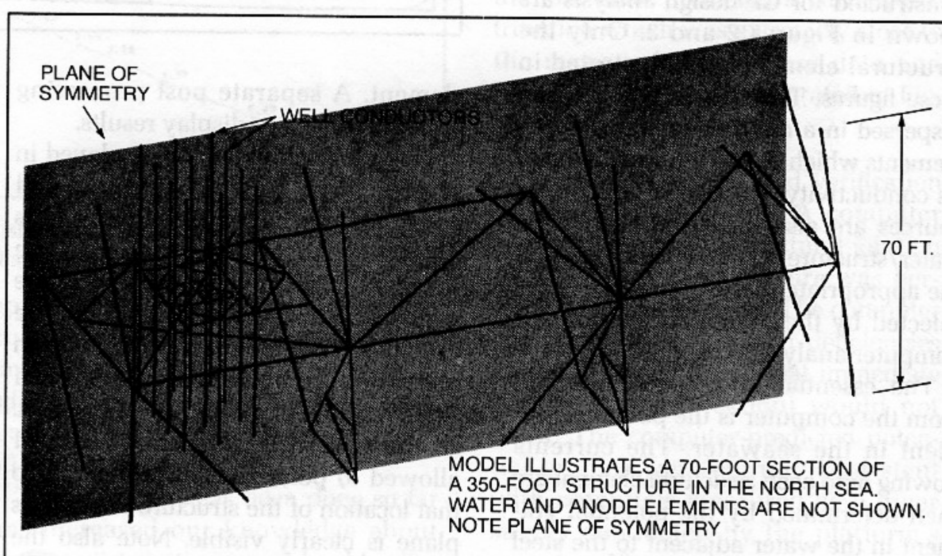


FIGURE 3 Finite Element Model of Horizontal Section of Deep-Water Offshore Structure

The program can also predict the potential or voltage shift anywhere along the surface of the structure. This information is very useful since the commonly used criterion for protection is defined as a potential shift as measured with a constant potential reference half cell.

ENERGY CONSERVATION

A full description of NASTRAN is beyond the scope of this article. Simply described, however, NASTRAN uses the principle of conservation of energy to determine the strength and distribution of an energy field. Using the appropriate functional energy relationship and input geometry factors, the modified NASTRAN program calculates the potential and current flux at each finite element necessary for a minimum energy condition. Accordingly, the computer determines the path of least resistance to current flow. The computer can do this for multi-element models taking into account the following parameters: water resistivity, element proximity to anodes or current sources, field distortion due to shielding or high surface area density locations, mutual interferences between multiple current sources, and anode and cathode film resistance properties—a formidable task even with the computer.

ANALYSIS OF OFFSHORE STRUCTURES

Typical finite element computer models constructed for CP design analysis are shown in Figures 2 and 3. Only the structural elements are illustrated in these figures. The structure is actually dispersed in a matrix of many volume elements which define the seawater and its conductivity. Anodes or CP current sources are also dispersed within the water/structure matrix. Anode sites and the appropriate material properties are selected by the design engineer and a computer analysis is run.

The essential information returned from the computer is the potential gradient in the seawater. The currents flowing onto each structural element are then determined by the potential gradient in the water adjacent to the steel and the surface resistance or polarization characteristics of each structural element. A separate post processing program is used to display results.

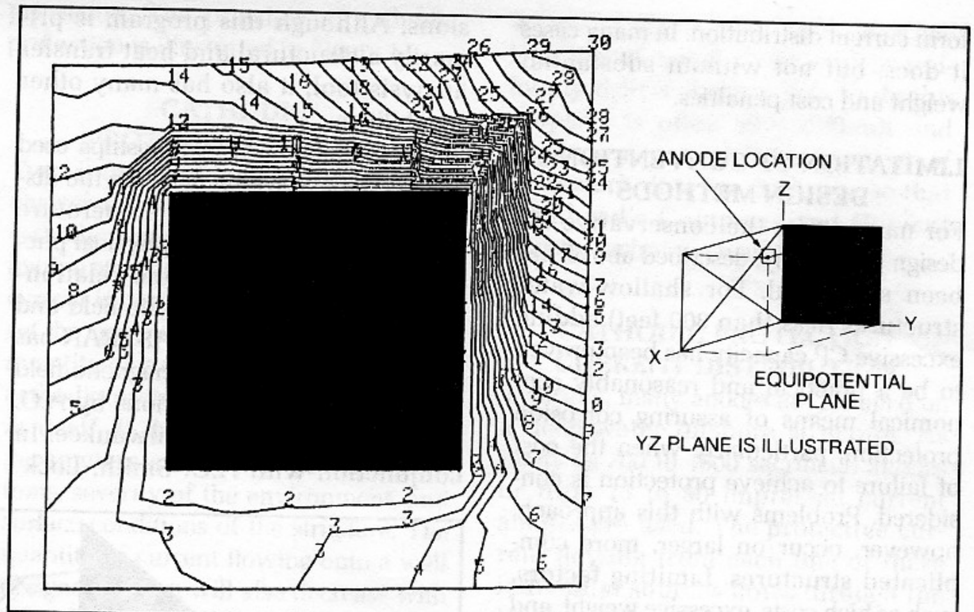


FIGURE 4
Lines of Equipotential Through One Plane Unpolarized or Initial Potential Distribution

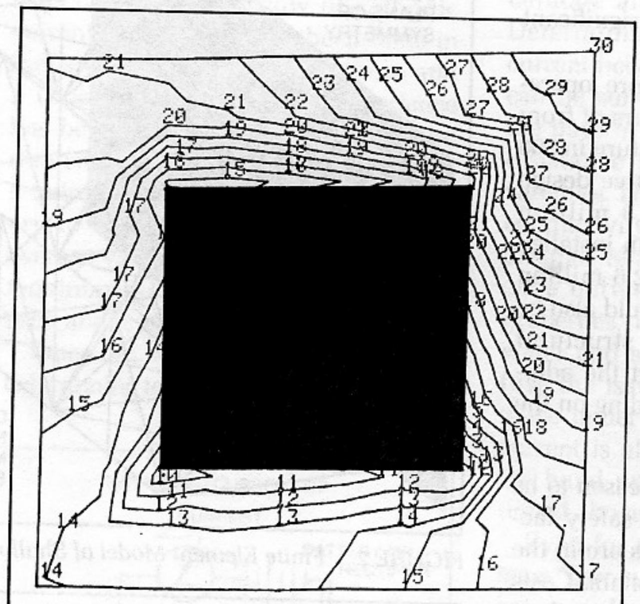


FIGURE 5
Lines of Equipotential Through One Plane Polarized or Equilibrium Potential Distribution

The information can be displayed in several ways. Current densities and potentials can be tabulated as well as displayed on graphic views of the structure. Lines of equipotential in the water within the model can also be displayed. Equipotential lines within one structure-containing plane for a small test model are shown in Figure 4. In this case the structure was not allowed to polarize (shift potential) so that location of the structure within this plane is clearly visible. Note also the concentration of lines in the upper righthand corner. (The numbers adjacent to the equipotential lines represent incremental potential steps.) More current will flow to the steel in this area. This is typical of the initial current distribution before the steel polarizes, i.e., just after current begins to flow.

Figure 5 illustrates the same plane after the steel has partially polarized. Again, it can be seen that a greater potential shift occurs in the corner which is closest to the anode. However, a more uniform potential and current distribution are displayed.

Equipotential displays are quite helpful in analyzing the results within a specific plane. Other output methods which can display 2 or 3-dimensional

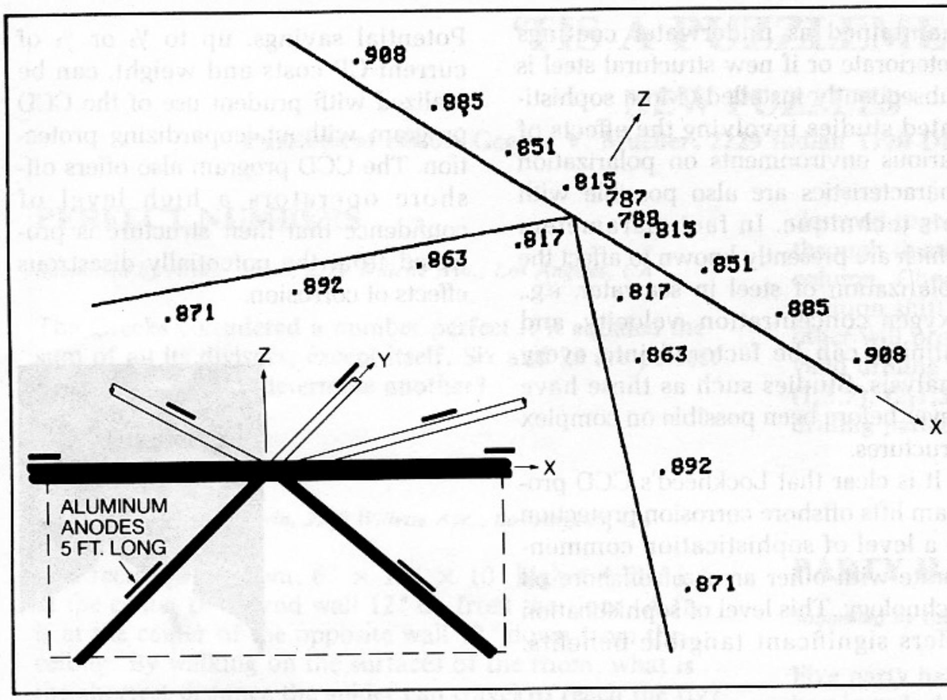


FIGURE 6 Finite Element Model of Typical Offshore Structural Joint Showing Potential Profile—Potential Values are in Volts Relative to a Silver Chloride Reference

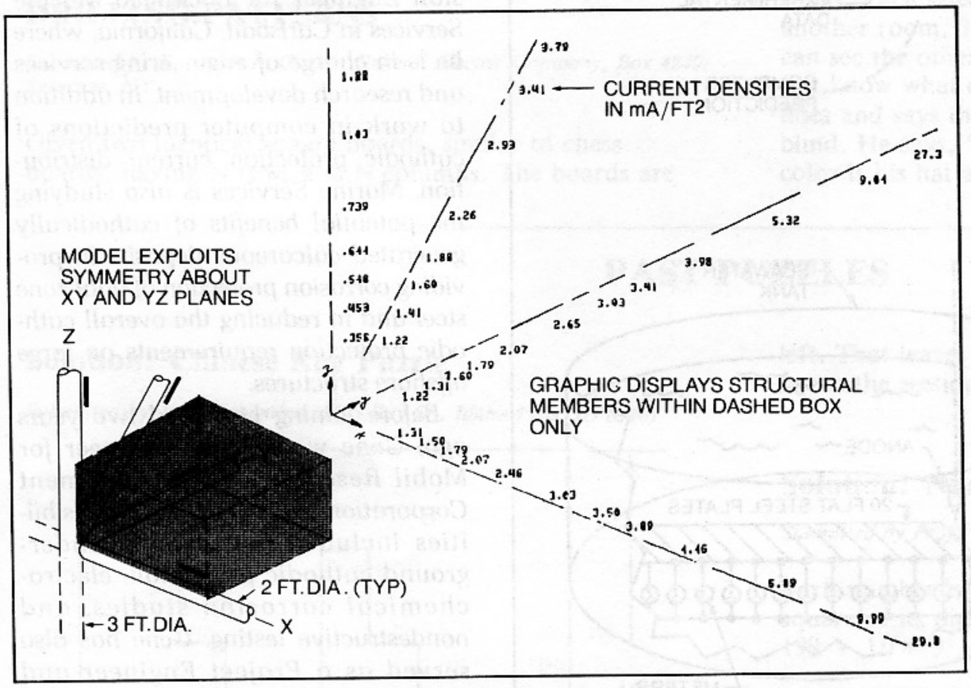


FIGURE 7 Finite Element Model of Typical Offshore Structural Joint with Sacrificial Anodes Showing Current Density Distribution

structural segments are shown in Figures 6 and 7 wherein values of potential (Figure 6) and current density (Figure 7) are displayed adjacent to each structural element.

OPTIMIZING A CP DESIGN

With current distribution and potential data available, it can be determined if the anode sites selected are indeed the optimum ones. Anode positions and current output (in the case of an impressed current system) can be adjusted until a specified current density and/or potential criterion is met in all critical areas.

The work that has been done so far has increased our knowledge about current distribution considerably. For example, computer output indicates that current shielding is likely to occur at structural joints and that larger diameter members receive less current per area than smaller members.

Poor current distribution at the joints is a major concern since corrosion and pitting in welds are known to cause stress in critical load carrying areas. An example of current reduction in a typical joint configuration can be seen in Figure 7.

Computer potential profiles also show that the electrostatic field is distorted in areas where there is a large steel surface to water volume ratio. *Accordingly, it follows that the best current distribution does not always result from the most symmetrical anode array.*

VERIFICATION STUDIES

One phase of the development of the CCD program involved verification of the computer's results with available test data. The first verification study involved modeling laboratory current distribution tests performed by Lockheed Marine Services several years ago. The model consisted of several 1-foot-square flat plates arranged in a straight line on the bottom of a 20-foot-diameter by 5-foot-deep seawater tank. An anode was placed in various positions above the plates. Current to each of the plates was measured as a function of anode placement and various anode outputs.

The computer analysis of the case where the anode was one foot above the first plate predicted a current distribution which was extremely close to the measured data. These data and computer results are illustrated in Figure 8.

The next step was field verification of the CCD technique. A computer analysis of a typical structural joint on a large North Sea structure was performed for this purpose. The computer analysis indicated certain deficiencies in anode placement so that immediate polarization (protection) would not occur. The computer-predicted potential profiles were entirely consistent with potentials measured by a diver survey conducted by the platform's operator. The structure actually took greater than two years to polarize.

FUTURE EXPECTATIONS

The use of the computer opens up a whole new era in the field of marine cathodic protection. The technique described here allows the designer to make intelligent decisions regarding the level of conservatism to be used in each design. The decision can be made from analytical studies based on known input parameters, rather than based on crude assumptions or nonspecific "rules-of-thumb."

In addition to being an extremely effective design tool, the CCD technique can also be used to predict the level of corrosion protection for "worse case" or extreme conditions. For example, how will the CP system perform if several anodes are lost during installation or storms? Will protection be maintained as underwater coatings deteriorate or if new structural steel is subsequently installed? More sophisticated studies involving the effects of various environments on polarization characteristics are also possible with this technique. In fact, parameters which are presently known to affect the polarization of steel in seawater, e.g., oxygen concentration, velocity, and salinity, can be factored into every analysis. Studies such as these have never before been possible on complex structures.

It is clear that Lockheed's CCD program lifts offshore corrosion protection to a level of sophistication commensurate with other areas of offshore oil technology. This level of sophistication offers significant tangible benefits. Potential savings, up to ⅓ or ½ of current CP costs and weight, can be realized with prudent use of the CCD program without jeopardizing protection. The CCD program also offers offshore operators a high level of confidence that their structure is protected from the potentially disastrous effects of corrosion.

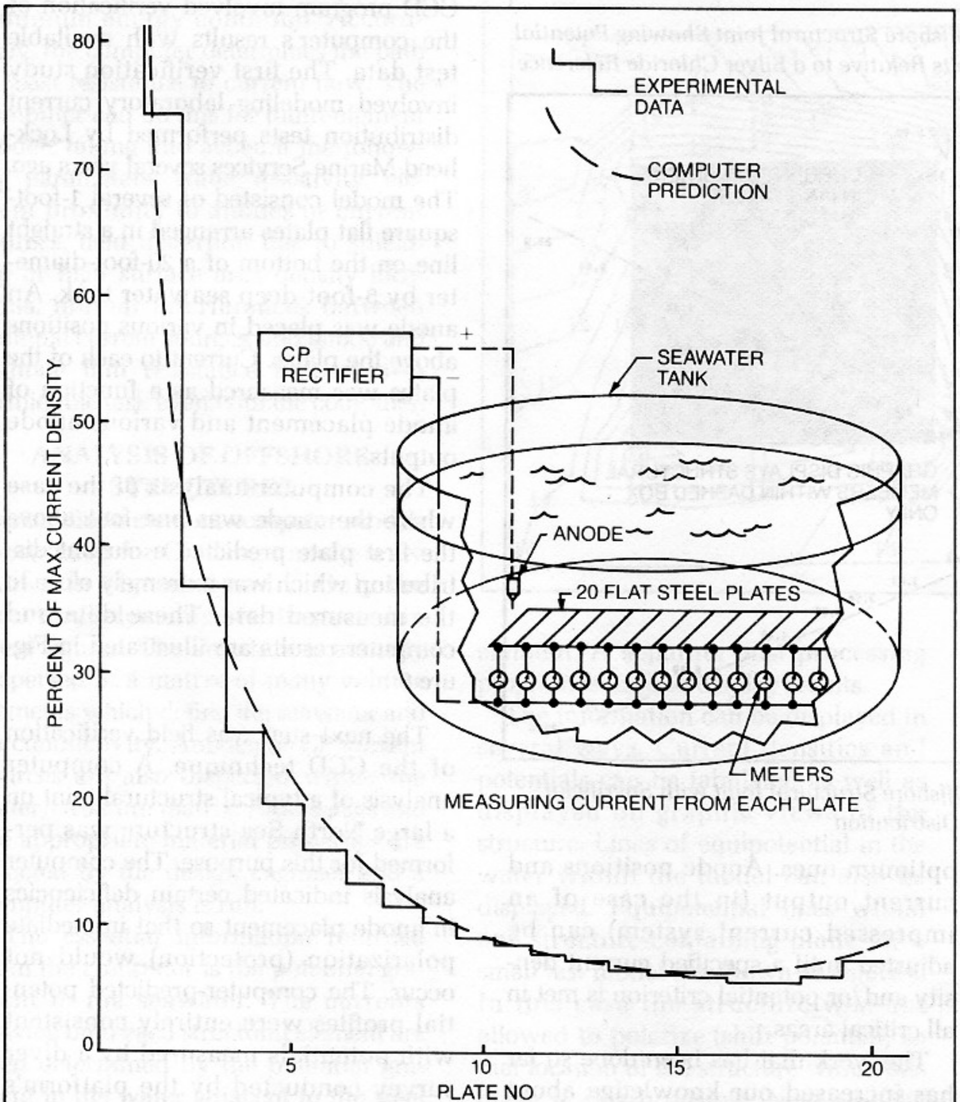


FIGURE 8 Computer Predicted Current Density Versus Measured Current Density for Flat Plate Test Model

GENE DECARLO is a Senior Corrosion Engineer for Lockheed Marine Services in Carlsbad, California, where he is in charge of engineering services and research development. In addition to work in computer predictions of cathodic protection current distribution, Marine Services is also studying the potential benefits of cathodically generated calcareous deposits in providing corrosion protection of tidal zone steel and in reducing the overall cathodic protection requirements on large offshore structures.

Before joining Lockheed two years ago, Gene was Senior Engineer for Mobil Research and Development Corporation. At Mobil, his responsibilities included marine and underground cathodic protection, electrochemical corrosion studies, and nondestructive testing. Gene has also served as a Project Engineer and Maintenance Supervisor for a major Mobil refinery.

DeCarlo graduated with honors from California State Polytechnic University at Pomona with a BS degree in mechanical engineering. His graduate work at UCLA and Drexel University is in materials engineering. Gene is a member of the National Association of Corrosion Engineers (NACE) and is Vice Chairman of the NACE technical committee dealing with cathodic protection in natural waters.

'TIS A PUZZLEMENT

NEW PUZZLES

Puzzlement editor: George V. Mueller, 2229 Indian Trail Dr., West Lafayette, IN 47906

PERFECT NUMBERS

Submitted by Arthur Levin, 2229 Willette Ave., Los Angeles, CA

The Greeks considered a number perfect if it equaled the sum of all its divisors, except itself. Six and 28 are perfect numbers. Can you determine another?

SPIDER AND FLY

Submitted by Arthur Levin, 2229 Willette Ave., Los Angeles, CA

In a rectangular room, 6′ × 14′ × 10′ high a spider is at the center of an end wall 12″ up from the floor. A fly is at the center of the opposite wall 12″ down from the ceiling. By walking on the surfaces of the room, what is the shortest distance the spider can travel to reach the fly?

DRILLING PATTERNS

Submitted by Dr. John P. Costas, General Electric Company, Box 4840, Syracuse, NY

Given two identical square boards, similar to chess boards, having N rows and N columns. The boards are clamped together and N square-centered holes are drilled through them such only one hole appears in any row or column. Choose a drilling pattern such that any x and y position shift combination of one board relative to the other will produce at most one hole alignment. For N = 3 valid drilling patterns are (row position in column order) (1,3,2), (2,1,3), (2,3,1) and (3,1,2). Determine all valid drilling patterns for N = 5.

PARTY HAT COLORS

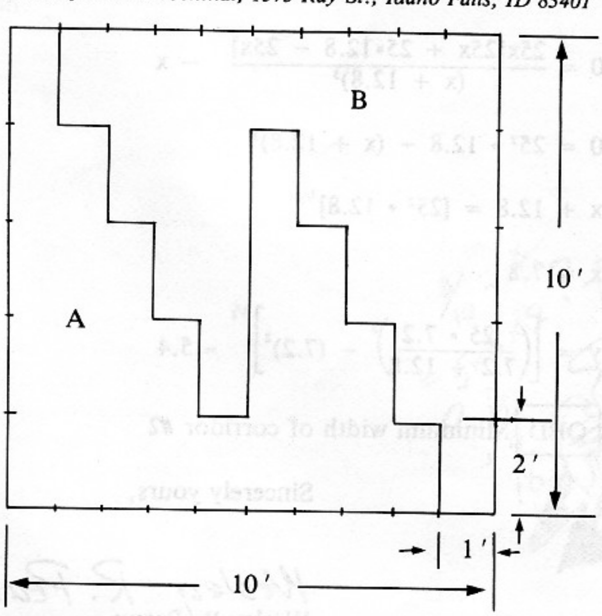
Submitted by Charles A. Lawton, Springfield, OH

Five party hats, three blue and two red, are placed in a box in a dark room. Three men, each knowing the detaios about the hats, are blindfolded and in turn led into the room. Each selects a hat from the box and is led into another room. The first man removes his blindfold. He can see the other's hats but not his own. He says, "I do not know what color my hat is." The second man then does and says the same as number one. The third man is blind. He says, "I know what color my hat is." What color is his hat and how does he know its color?"

PAST PUZZLES

Solution: Chinese Rug Puzzle

Submitted by Jack Liebenthal, 1573 Ray St., Idaho Falls, ID 83401



Cut the larger run into two sections, A and B, along the line indicated. Shift B two feet up and one foot to the left. That leaves an opening 1 ft wide and 8 ft long between the sections. Insert the smaller rug into the opening.

Solution: Number Sequence

Submitted by Prof. W. K. Sonnemann, Univ. of Texas, Austin, TX

Each number is the sum of the preceding one and the square of its digits. The next number in the sequence is $199 + 1^2 + 9^2 + 9^2 = 362$.

Solution: Auld Lang Sine

Submitted by Robert Dome, Syracuse, NY

The length of a curve is given by the equation

$$S = \int_{x_1}^{x_2} \sqrt{1 + (dy/dx)^2}\, dx$$

Here $y = \sin x$ and $dy/dx = \cos x$.

Then

$$S = \int_{x_1}^{x_2} \sqrt{1 + \cos^2 x}\, dx$$

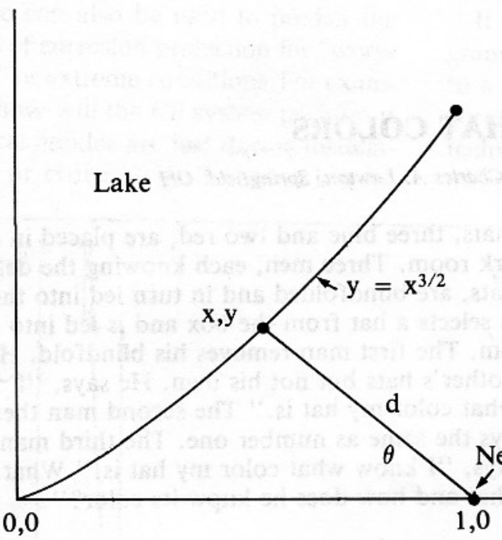
To convert this into the form of a typical elliptic integral substitute $1 - \sin^2 x$ for $\cos^2 x$ and obtain

$$S = \int_0^{\pi/2} \sqrt{2 - \sin^2 x}\, dx = \sqrt{2} \int_0^{\pi/2} \sqrt{1 - 1/2 \sin^2 x}\, dx$$

By reference to a table of elliptic integrals of the second kind it is found that the value of the above integral, to five digits, is 1.3506. Then $S = \sqrt{2} \cdot 1.3506 = 1.910$ units.

Solution: Lame Duck

Submitted by Robert Dome, Ibid.



The distance the duck travels is

$$d = \sqrt{(1 - x)^2 + y^2} = \sqrt{(1 - x)^2 + x^3}$$

Then $d^2 = 1 - 2x + x^2 + x^3$ and d^2 is a minimum when $dd^2/dx = 0$. Then $-2 + 2x + 3x^2 = 0$. From this $x = 0.5486$ and $d = 0.6073$. Then $y = 0.4063$ and $\theta = \arctan (0.4063)/(1, - 0.5486) = 41.99°$.

Mr. Harold A. Sabbagh
Analytics Inc.
2634 Round Hill Lane
Bloomington, IN 47401

Dear Harold:

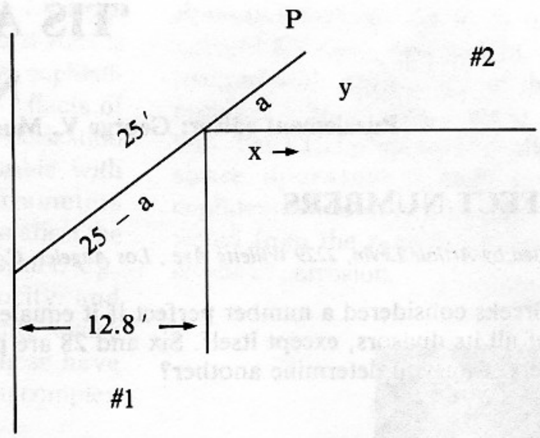
I had difficulty in understanding the solution to the GIRDER MOVING puzzlement. Also the solution to the minimum width corridor is not given.

Enclosed, I feel, is a more straightforward solution.

PUZZLEMENT (Sept. 1981) Moving Girder

Given: 25 ft girder
12.8 ft corridor

Find: Minimum width of corridor (see diagram) EQUATION OF MOTION



1. Equation of point "P"
Use Similar Triangles

$$\frac{x}{12.8} = \frac{a}{25 - a}, \quad a = \frac{25x}{x + 12.8}$$

$$y = \sqrt{a^2 - x^2} = \left[\left(\frac{25x}{x + 12.8}\right)^2 - x^2\right]^{1/2}$$

QED $(0 \le x \le 12.2)$ Equation of motion

2. Find minimum width of corridor #2 (max 'y')

$$\frac{dy}{dx} = 0 = \frac{1}{2}\left[\left(\frac{25x}{x + 12.8}\right)^2 - x^2\right]^{-1/2} \cdot$$

$$\left[2\left(\frac{25x}{x + 12.8}\right) \cdot \frac{(x + 12.8)25 - 25x}{(x + 12.8)^2} - 2x\right]$$

Reduce

$$0 = \frac{25x[25x + 25 \cdot 12.8 - 25x]}{(x + 12.8)^3} - x$$

$$0 = 25^2 \cdot 12.8 - (x + 12.8)^3$$

$$x + 12.8 = [25^2 \cdot 12.8]^{1/3}$$

$$x = 7.2$$

$$y = \left[\left(\frac{25 \cdot 7.2}{7.2 + 12.8}\right)^2 - (7.2)^2\right]^{1/2} = 5.4$$

QED Minimum width of corridor #2

Sincerely yours,

Wesley R. Peavy

Wesley R. Peavy
2905 S.E. Royalwood Place
Port Orchard, WA 98366

Mr. Harold Sabbagh
Analytics, Inc.
2634 Round Hill Lane
Bloomington, IN 47401

Dear Harold:

The answer to Auld Lang Sine, page 9 of the December Newsletter, is 1.9101.

This problem is a wonderful illustration of change in technology. The classical solution by calculus resulted (for me) in the expression:

$$S = \int_0^{\pi/2} \sqrt{\cos^2 x + 1}\, dx$$

but I could not for the life of me integrate it. After a few hours of trying, I decided that a BASIC program simulating the calculus was the way to go. Forty years ago I would not have had that option, nor would Professor Passano have accepted such an approximation.

Are you somehow related to the King of Siam? If so, should not the title of the column be "'Tis a Puzzlement?"

Sincerely yours,

Laurence B. Stein, Jr.

P.S. Have you the nerve to print this one:

What relationship determines the order of the following digits: 8, 5, 4, 9, 1, 7, 6, 3, 2, 0?

Answer: (to help you decide whether you do have the nerve): They are in alphabetical order, in English.

PUZZLEMENT (Dec. 1981, page 9) Auld Lane Sine

y = sin x, find length of curve, S, from 0-90 degrees

BASIC program

```
100 PRINT "CALCULATES LENGTH OF Y = SIN X
FOR 0 to 90 DEGREES

105 REM X INCREMENTS OF 1.8 DEGREES =
0.31416 RADIANS

110 LET S = 0

120 LET X = 1.5708

130 LET A = .031416↑2

140 LET S = S+SQR ((SIN(X) - SIN(X -
.031416))↑2+A)

150 LET X = X - .031416

160 IF X = 0 THEN 180*

170 GO TO 140

180 PRINT

190 PRINT "ANSWER IS"; S; "UNITS"

200 END
```

*Line 160 should really be IF X = 0 THEN 180 but due to small errors in subtraction, it did not work on a TRS-80 so we used IF X < .001 THEN 180.

Answer: 1.9101.

ANNOUNCEMENTS

SOCIAL IMPLICATIONS OF TECHNOLOGY—a new Society in IEEE

The Executive Committee of the IEEE has approved the formation of a Society on Social Implications of Technology (SSIT). The Society will supersede the Committee on Social Implications of Technology and is now enrolling members for 1982. It will work with the other Societies of the IEEE with the objective of providing:

- An open forum for the interchange of ideas related to the technology/society interface.
- A mechanism for focusing relevant ideas developed by members of IEEE.
- Means to encourage and support social responsibility and a professional approach to the practice of engineering.

The Society will:

- Develop programs to explain technology to society through its publication, and through its Chapter and national level meetings.
- Foster communication among engineers and between engineers and society on needs and concerns of society and responsibility of technology.
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SSIT intends to publish scholarly articles on the subject of engineering ethics. It is not, however, the sole IEEE body given responsibility for the development of ethical standards for electrical and electronics engineers or for IEEE members. Positions taken by SSIT will be submitted to the IEEE Technical Activities Board (TAB) and other major Boards under existing policies and procedures for approval as IEEE position papers.

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The journal is a joint publication of four IEEE societies: IEEE Engineering in Medicine and Biology Society, IEEE Nuclear and Plasma Sciences Society, IEEE Group on Sonics and Ultrasonics, and IEEE Acoustics, Speech and Signal Processing Society. The journal is published in cooperation with the IEEE Computer Society.

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The journal will focus on a unified common ground where instrumentation, systems, transducers, computing hardware and software, mathematics and physics are handled together. Authoritative studies will be published on generation, processing and/or display of medical images.

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The journal will publish original contributions on medical imaging relating to ultrasonics, x-ray imaging and tomography, nuclear isotope imaging systems, image processing by computers, microwave and nuclear magnetic resonance imaging, radiation sensors and detectors, mathematical tools and analysis of medical image formation, perception, display, and pattern recognition. Studies involving highly technical perspectives will be most welcome. All submitted papers will be peer-referred.

PUBLISHING

The journal will begin publishing in 1982 as a quarterly journal with 400 pages per year. High quality reproduction techniques will be used. Details related to submission of manuscripts may be obtained by contacting Michael M. Ter-Pogossian, Ph.D., Washington University, School of Medicine, 510 South Kingshighway, St. Louis, MO 63110.

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A member of any IEEE society may subscribe at a cost of $8.00 per year. Non IEEE society member costs are $50.00 per year. To order, write to IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. Telephone (201) 981-0060.

FREE SAMPLE

When available, a sample copy of the *IEEE Transactions on Medical Imaging* can be obtained by writing Martin Plotkin, Brookhaven National Lab, Bldg. 902A, Upton, NY 11973.

EUROCON '82

Fifth European Conference on Electrotechnics Copenhagen 14-18 June 1982

Reliability in Electrical and Electronic Components and Systems is the theme of the Fifth European Conference on Electrotechnics—EUROCON '82—to be held at Lyngby near Copenhagen, Denmark, on 14-18 June 1982. This important international meeting will be opened by His Royal Highness Prince Henrik of Denmark.

Almost 300 papers were offered from 35 countries in Western and Eastern Europe and in the Middle East, and also from Australia, India, Japan, New Zealand, South Africa, and the U.S.A. From this total, 160 high quality papers have been selected for presentation in six sessions, which have the following themes: reliability theory; reliability of components for electrical and electronic systems; reliability of electrical and electronic systems; reliability of electric power systems; reliability testing and data analysis; human aspects, management and economy in reliability engineering.

At the opening session invited experts will speak about the impact of reliability on society: Air Marshal Sir Herbert Durkin (U.K.), Immediate Past President of the Institution of Electrical Engineers, will speak on "Technical and Economic Concerns of Reliability in Industry." Erik B. Rasmussen (Denmark), Chairman of the Federation of Danish Industries, on "The Japanese Callenge and its Impact." Kam L. Wong (U.S.A.), Manager of Design Effectiveness at the Hughes Aircraft Co. on "A new direction for Electronic Reliability Engineering in the 80's.

EUROCON '82 will include keynote plenary sessions at which F. Ohman (Federal Republic of Germany) will speak on "Reliability in Telecommunication." F. H. Reynolds (U.K.) on "Reliability Progress in Integrated Circuits." J. A. Bubenko (Sweden) on "Reliability Aspects in Powers System." J. B. Owens (U.S.A.) on "Reliability of Nuclear Power Stations." F. Ask (Denmark) on "Reliability as a Marketing Factor," and R. Larson (U.S.A.) on "Reliability Aspects in Data Processing Systems."

EUROCON '82 is arranged jointly by the Institute of Electrical and Electronics Engineers (IEEE) and the Convention of National Societies of Electrical Engineers of Western Europe (EUREL). Further information, including registration forms, may be obtained from Mrs. Aase Sonne, EUROCON '82 Conference Office, Danish Engineers' Post Graduate Institute, The Technical University of Denmark, Building 208, DK-2800 Lyngby, Denmark (telephone 45-(0)2 88 23 00, extension 37; telex 37529 DTHDIA DK).

In association with EUROCON '82 there will be a technical exhibition in the Technical University of Denmark in the building where EUROCON '82 will be held. There is also a social programme for persons accompanying participants, which will include local visits and an evening in the world-famous Tivoli Gardens in Copenhagen.

XVII UPADI CONVENTION

The College of Engineers and Surveyors of Puerto Rico will host the *XVII UPADI Convention* from August 1-7, 1982 in San Juan, Puerto Rico.

The central theme to be followed in preparation of papers for the Convention, both in subtopics of the Convention and in the joint meetings, is: ENGINEERING: KEYSTONE IN THE DEVELOPMENT OF NATIONS.

The following joint meetings will be held at that time:

- 1st Pan American Congress on Civil Engineering
- 2nd Pan American Congress on Oceanic Engineering
- 10th Pan American Congress on Engineering Education
- 1st Pan American Congress on Energy/ 2nd National Congress on Renewable Technologies
- 5th Pan American Congress on Costs and Engineering Economics
- 2nd Pan American Congress on Environmental Engineering

This week long meeting which will bring together the engineering leadership from the American hemisphere, as well as other parts of the world, will have an expected attendance of 3,000.

Topics to be covered during the XVII UPADI Convention, some or all of which are applicable to the other Congresses, are:

1) Environment
2) Urban Planning
3) Food
4) Communications and Transportation
5) Energy
6) Specific Industries (e.g., Mining, Chemicals, etc.)
7) Professional Practice

Engineers interested in attending the XVII UPADI Convention should contact Ms. Julie Gibouleau for further information at the address below:

Ms. Julie E. Gibouleau, Convention Secretary for USA
c/o American Association of Engineering Societies
345 East 47th Street
3rd Floor
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INDUSTRY

GOVERNMENT EDUCATION

The 'Oceans '82' conference and exposition, co-sponsored by the Marine Technology Society and the Institute of Electrical and Electronics Engineers/Council on Oceanic Engineering, will convene in the Nation's Capitol on September 20-22, 1982 at the Shoreham Americana Hotel, located on 2500 Calvert Street Northwest. This will be a convenient and dignified locale for the presentation of a diverse array of marine technology products and comprehensive discussions on the means by which technology can be applied to promote economic, defense, environmental and other goals and objectives.

This forum is utilizing the theme 'Partners in Progress' to portray the association of the varied elements of private industry engaged in the research, exploration, development, manufacturing and marketing of goods and services related to marine resource development, together with the governmental and educational institutions who must facilitate the efforts of the private sector in satisfying national economic and other public policy needs. If the 1980's are to be characterized as a 'Decade of Ocean Development,' a productive partnership of industry, government and academia should be forged. This relationship should have as its overall objective the optimum return on investment for offshore hydrocarbon and other coastal mineral exploration and development, marine transportation services, fisheries production, deep seabed mineral extraction, marina and recreational boating enhancement and other industrial endeavors which involve the inland waterways, coastal areas and oceanic spaces.

This partnership must also promote development in an orderly manner so that multiple-use conflicts are minimized and adequate attention is given to foreign policy, national defense, environmental and related societal concerns. Thus the technical and policy sessions of the conference will include representatives from several nations and international institutions to convey their thoughts on various national and regional development needs, Law of the Sea and other official positions. All of these issues can be discussed, both formally and informally, under the interesting setting which 'Oceans '82' will provide.

An extensive exhibit will feature a showcase of the latest, state-of-the-art in marine technology products, services and publications. Over 2000 conferees from industry, governmental agencies and academia, as well as a significant international representation, are expected to attend.

For additional information on conference attendance and/or exhibit bookings please contact: Marine Technology Society, 1730 M Street, N.W., Washington D.C. 20036, Phone (202) 659-3251.

OCEANS '82 1730 M Street, N.W., Suite 412, Washington, D.C. 20036 / Tel. 202/659-3251

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