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PORTABLE COMPUTER KEEPS TRAVELING WRITER IN BUSINESS

Computing and Data Processing Newsletter

DATA PROCESSING SYSTEM REPRODUCES SATELLITE IMAGES IN 10 MINUTES RATHER THAN 10 HOURS

Ruder Finn & Rotman, Inc.
110 E. 59th St.
New York, NY 10022

Any earth-bound amateur photographer can appreciate the beauty of a photograph taken by a satellite high in the atmosphere. But beyond a pretty picture, satellite photography provides vital information on weather and climate conditions, atmospheric disturbances, and air navigation. And now this information can be provided in 1/60th the time it once was.

The new processing method, a result of Fujitsu Ltd.'s latest software, can accurately convert up to 99.9% of satellite data into a light and dark image of a ground area covering 9000 square kilometers. It converts the data in as little as 10 minutes. The data processing system required for this function consists of two parts: a supercomputer to make calculations, and a very large-scale mainframe computer to store and retrieve information. The system makes its calculations in 5.7 minutes and only 9 minutes are required to complete the entire process.

The process begins with a satellite orbiting the earth for signs of natural resource deposits. The satellite then transmits data to a ground station, where the data

Satellite photograph produced by new processing system which converts data into photographs in 1/60th the time usually needed for this procedure.

is processed for development into aerial photographs. Because this method of photo development requires a great amount of computer processing, conventional methods can take up to 10 hours. Previous experiments with high-speed computers in Japan had only reduced the processing time to 3.5 hours. Fujitsu officials attribute the success of the new system as much to the new software as to the capability of the Fujitsu computers.

This new technology has the potential for applications in such fields as ground resource exploration, oceanographic surveys, and space technology.

NEVADA COMPUTERIZES ENTIRE JUDICIAL SYSTEM, SAVING TIME AND MONEY

Bob Coupland
Alpha Micro
17332 Von Karman Ave.
Irvine, CA 92714

Nevada is the nation's first state to computerize its entire judicial system, from local municipalities all the way up to the state Supreme Court, by linking microcomputers together into a statewide network.

The Nevada system, which will eventually include more than 120 courts in 17 counties, is a case management program designed to connect most traffic, criminal and civil courts across the state and throughout all court levels. The system records each case and tracks documents, court hearings, calendars, and individuals involved in cases all the way through the judicial system.

According to Mike Brown, court administrator for Nevada, the system greatly reduces record keeping and retrieval costs by eliminating manual filing. It speeds up the court system at the trial level as well. "The new system will answer 90 percent of all questions about any individual case by enabling any court to call up statistics and trial information instantaneously rather than waiting for documents to be located and transcribed," Brown says.

The computerization program began in July, 1983, with the passage of Nevada state legislation. The state law empowers the judicial system to include a $10 "administrative assessment" with all guilty pleas or convictions for misdemeanors or violations of municipal ordinances. The resulting fund will contribute $240,000 per year to the Uniform Record of Accounting project, the court computer system's official name.

The program uses a microcomputer system, with multi-user, multi-tasking capabilities, manufactured by Alpha Micro.

MATHEMATICAL MODEL RESEARCH AIDS STUDY OF UNDERWATER SOUND WAVES, HUMAN IMMUNE SYSTEM

Dept. of Information
Oregon State University
Corvallis, OR 97331

What does the human immune system have in common with the sonar tracking of a submarine? Not much, it appears. But, in fact, from a mathematical perspective such phenomena are very similar. The same type of equations can explain sound moving through water and the body fighting off infection.

At Oregon State University, the study of these mathematical systems is offering new insights into immunology, general defense processes and other apparently unrelated physical patterns in engineering, biology and socioeconomics. "The object of the immune research is for improved health care in the long range and, more immediately, a better understanding of body defense," says Ronald Mohler, a professor of electrical and computer engineering at Oregon State Univ. "Some aspects of immunology can be understood more easily with mathematics than with biochemistry, and this is an area of research that deserves more attention." Once scientists can explain how the immune response operates, they will be better able to influence it or control it, according to Mohler. He believes this type of analysis may eventually be used in immunotherapy for allergies, or cancers such as leukemia.

Mohler has a two year, $100,000 grant from the National Science Foundation to work in this area. He is just completing a three year, $500,000 study sponsored by the Office of Naval Research, which deals with the same "bilinear" mathematical systems in research on signal processing, primarily related to sonar.

"Even with this work, the U.S. is playing catch-up in this field," says Mohler. "Other countries, particularly the Soviet Union, devote far more attention and research to these systems. The Soviet effort is at least 10 times that of the U.S." One major science center and university in a single Siberian city has about 15,000 electrical engineering students, and the University of Rome has about 35,000 engineering students, according to Mohler.

In their work with sonar, Mohler and his colleagues try to improve the equations that describe how sound and its source move through sea water. The challenge is to consider as many disturbances as possible, such as sea life, earthquakes, shipping and cracking icebergs. "If, as in sonar, you want to locate the source of an underwater sound wave, you have to develop mathematical models that describe its action," states Mohler. "Your accuracy improves as the equations get more complex."

JAPANESE COMPUTER SYSTEM LEARNS TO RECOGNIZE ITEMS VISUALLY

Based on a report in the Japanese Economic Journal, July 24, 1984

Professors K. Nakano and T. Omori of Tokyo University have developed a "human-like" computer that gathers information from its surroundings and is capable of learning to recognize items visually. The computer learns through simple questions and answers, often merely "yes" or "no," from the human operator, much as a child learns from its mother.

When a human recognizes an image, information is first sent from the eyes to the visual area of the cerebrum, where the features of the image are analyzed. The information is then sent to the centric part of the cerebrum, where processing and recognition take place.

The television camera in the computer system moves freely like the human eye. The visual area of the cerebrum is represented by 64 microprocessors, and a large computer performs image processing and recognition.

Programs are not required to educate the computer. In a simple example, the computer "looks" at an object like a triangle with its TV eye as the instructor inputs the word "triangle" by speech or keyboard, repeating the process with other geometric figures. The computer is then tested to see if it gives the correct response to various visual stimuli; if the response is incorrect the in-

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computers and people
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including *Computer Graphics and Art*

The magazine of the design, applications, and implications of information processing systems — and the pursuit of truth in input, output, and processing, for the benefit of people.

Announcement

The Computer Directory and Buyers' Guide

We have finished entering and updating the names, addresses and descriptions of over 3600 organizations into our computer data base for the 1984 Directory issue. We are now working to produce photo-offset master for printing. We expect this, our 27th edition, to be mailed to Directory subscribers by early December of this year.

Meanwhile, any current subscriber to *Computers and People with Directory* who does not already have a copy of the 1983 *Computer Directory and Buyers' Guide* may on request to us receive a copy of that issue.

Front Cover Picture

The front cover picture shows free-lance writer Steve Roberts using his portable computer to compose stories on his bicycle trip across America. Here the Rocky Mountains provide his inspiration, but he has also travelled around the Midwest, cycled down the East Coast and across the Gulf Coast, and plans to tour Southwest California and Canada. Roberts recharges his nine-pound, full-functional Hewlett-Packard computer with power provided by a solar panel attached to his unusual eight-foot long bike. With the aid of the computer and an assistant back in Ohio, Roberts is able to operate his office by remote control. When he needs to transmit messages and stories, he goes to a phone booth and uses a modem to send files directly over the phone lines.

Corrections

Please see page 26 for corrections of the September-October, 1984 issue.

Key

[A]	–	**Article**
[C]	–	**Monthly Column**
[E]	–	**Editorial**
[EN]	–	**Editorial Note**
[F]	–	**Forum**
[FC]	–	**Front Cover**
[N]	–	**Newsletter**
[R]	–	**Reference**

Notice

*D ON YOUR ADDRESS IMPRINT MEANS THAT YOUR SUBSCRIPTION INCLUDES THE COMPUTER DIRECTORY. *N MEANS THAT YOUR PRESENT SUBSCRIPTION DOES NOT INCLUDE THE COMPUTER DIRECTORY.

Editorial

Rational Hope

Edmund C. Berkeley, Editor

Often science becomes an end unto itself. That is, the pursuit of scientific knowledge, the work itself, is most important. There is little or no evaluation, by those doing the work, of the consequences of that work. Not enough thought is given to how what we are doing affects how we will live.

But science, and here particularly computer science, does not exist in a vacuum. It does directly affect the quality of human life. Indeed, it affects our very survival. How, then, do we evaluate our work in human terms? There are probably four basic principles that computer scientists and computer people should recognize and put into their work and operations with science and computers.

First, computer scientists and computer people should not hurt human beings. They should not devote their talents to war or torture or brainwashing or harming people in any way.

Second, computer scientists, computer people, computer professionals, should not hurt the environment. Of course, if a mosquito bites me and transfers a parasite to me causing malaria, I need to join in working to eliminate that kind of parasite and mosquito. But, otherwise, the environment should be protected, safeguarded.

Third, computer scientists need to realize that probably at least a billion people in the world do not have enough to eat, enough shelter, enough clothing. A portion of the time, energy, and resources of every scientist and professional should be devoted sensibly to this problem. Given the will, ways can be found. All pushes in this direction are helpful.

Fourth, there is the problem of the navigation of our fragile spaceship Earth, the understanding and protecting of the globe. All of us (mankind, or humankind), and the biosphere without which we cannot survive, are passengers together on the planet Earth going around the sun, one orbital revolution each year, for (we hope) many thousands of years to come. We must find a way of living together, a <u>modus vivendi</u>. We have no choice: we live together cooperatively or we die together, in unison. The nuclear holocaust and the nuclear winter await.

Fortunately, we do observe that history shows improvement in human conduct. Practices of cannibalism, human sacrifices, slavery, genocide, and similar human behavior are less and less sanctioned. There is rational hope for those who dream of and work for a better world.

Ω

The Information Industry and Possible Shackles

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"Our objective should be that 10 years from now people will be able to look back and say that this industry has been not only dynamic and innovative, but responsible as well."

Based on the keynote address to the National Computer Conference, Las Vegas, Nevada, July 9, 1984.

The Limit to Our Industry's Growth Is Us

I'm going to do something we seldom do in IBM: I'm going to make a prediction. It is this: the future of this information processing industry of ours is unlimited, as far ahead as we can see, except to the extent that, by default, we encourage society and its institutions to impose shackles upon us.

That's quite a mouthful and I'll try to explain what I mean.

I have no doubt that technology will continue to move ahead, creating new applications and exciting opportunities. And I'll make some predictions on this. I believe the industry can continue to grow at a dynamic pace as far into the future as any of us can see. I'll make some observations on this, too. But over the long haul, the problems that could limit our growth are not so much technological as human. If those problems are not adequately addressed they could inhibit our industry in significant ways. I will focus especially on this.

Progress Is a Series of Technological Breakthroughs

Let's begin with technology. Our progress is a never-ending series of breakthroughs. Whether you call it continuous breakthrough or incredibly rapid evolution, the fact is that progress will continue and at a very rapid rate. I believe we'll see workstations at the desk of almost every professional and administrative employee of industry, government and academia and in their briefcases and their homes, too, quite probably. In college dormitories, computers will be part of the furniture.

Price/performance will continue to make the difference. For about the price of today's Personal Computer it will be possible to buy 32-bit workstations operating at 10 MIPS, with up to 16 megabytes of main storage and 400 megabytes of disk storage.

The centralized system, or "glasshouse," will continue to grow, with multiple systems per center and multiple centers per enterprise. Networks will tie the various levels of computing together. Larger systems will have 100-MIPS uni-processors, a hierarchy of storage speeds and sizes and transaction rates of 10,000 per second. Then there's the integration of data, text, image and voice. We'll see PBXs with data processing functions built in, and the converse, data systems with voice capability.

We'll see electronic mail among enterprises, file sharing among non-similar workstations, software that integrates systems across the network and data portability. Artificial intelligence tools and techniques will be widely available to help generate new applications, improving the productivity of programmers and users. And all these systems will be interconnected by networks -- centralized systems, distributed systems, department systems and workstations. The key to all this growth will clearly be led by software, with significant improvement in systems that are much more comfortable to use. So in summary, technology will continue to create tremendous opportunities for us and for our customers.

Continued Growth Comes Through Solving Problems

Now let's look at growth. In the past 30 years, our industry has grown to about $250 billion; by the early 1990s, it is predicted to have sales of more than $1 trillion.

Let me suggest some reasons: first, mankind has a knack for creating an ever-growing list of problems. They're in health care and education, in brokerage houses and food distribution, in institutions public and private. They are everywhere. Second, the happy fact is that our industry can help provide answers to many of these problems. The ability to deliver these answers is growing at 15 to 20 percent per year, in terms of revenue, and more than twice as fast in terms of computing capacity. Finally, this industry spans the world and reaches even into outer space. This conference is billed as the "National" Computer Conference, but it attracts a growing number of visitors and exhibitors from outside the United States.

This industry has a truly global dimension. There never was another industry like this, so universal in its scope and application. Automotive and oil may be larger today, but ultimately they can be limited by the nature of their products. Our industry will keep on growing because we'll never run out of problems to solve, never have too much information.

To summarize my first two points, the technology and growth potential of our industry is exciting and unlimited.

Our Goal Is to Be Innovative and Responsible

I come now to the limitations that could inhibit this growth. These limitations are not so much technological as societal; and they could be serious inhibitors to us if we fail to live up to our responsibilities to society. Our objective should be that 10 years from now people will be able to look back and say that this industry has been not only dynamic and innovative, but responsible as well. If we don't step up to these responsibilities, others could force us to do so in ways we may not like, and with results that could severely hinder our industry.

There is an analogy with the biomedical industry. Advances in science and technology have brought it face to face with many new dilemmas. The ability to splice genes, to control conception, to prolong life, have led to new questions: What is life? When does it begin? When does it end? And what are the responsibilities of the medical profession in helping to answer these questions?

In our industry the issues are not usually life and death and I don't want to overdramatize the analogy. But the implications are far-reaching. They compel us to take a new look at the old problems of quality, privacy, data security, fraud and fair-play, to name just a few.

Let me preface my remarks on this subject by saying that I believe our industry has a great deal of which to be proud. To a degree almost unmatched in the history of industry in general, our products are safe, reliable and highly productive. On issues like privacy, we all have done a service to society by enhancing public understanding and promulgating safeguards. And, as people in this industry are fond of pointing out, if transportation technology had progressed as rapidly as we have in price performance, we would now be able to go around the world in a matter of minutes for a fraction of today's airfare. The only problem would be that the planes would have been miniaturized to the point where there would be no room to sit.

But there are exceptions to this record of achievement, as we all well know. And we have a responsibility to address them. Our responsibilities fall into three categories: we have a responsibility to our customers and the users of our products; we have a resonsibility to ourselves, as an industry; we have a responsibility to society at large which goes beyond our own interests and those of our users.

Consumers Expect Safe and Reliable Products

Let's look at each of them in turn. First, reliability. The first thing our customers have a right to expect from us is products and systems that are reliable. The quality story this industry has written in the past few years demonstrates what can be done.

The concept of "zero-defects," once believed to be an impossible dream, is on the road to reality.

But, as our own IBM ads say, "If your failure rate is one in a million, what do you tell that one customer?" It's not just a matter of staying ahead of the posse, that is, of avoiding the regulations and recalls that have burdened other industries. Rather, quality is important because it is sound and responsible business.

Prevention -- doing it right the first time -- is the real payoff, in both hardware and software. In IBM, we believe we can reduce by 50 percent the costs associated with rework and repair over the next few years. For the industry as a whole, such improvements could translate into savings of billions of dollars, and more importantly, continued public trust, which is beyond price. As our products multiply, we must intensify our efforts to ensure that every product is defect-free and truly reliable. And as service depends more and more on remote diagnosis, we must ensure that we, the people responsible, are not also perceived as being remote when the human touch is needed.

Finally, we have a responsibility to provide users with systems that are safe, comfortable and easy to use. We have already seen what happens when we fail to convince people that all necessary safety precautions have been taken. An example is the controversy over use of video display terminals and the fear of radiation. Around the world, such fears have led to strikes, prolonged labor negotiations and loss of public confidence, despite the fact that medical and scientific studies to date have demonstrated that the concerns are not justified. Clearly, we have a responsibility not just to provide systems that are safe and pleasant to use, but to communicate and educate on those issues, as well.

Public's Respect Gained by Honest Conduct

The second responsibility -- to ourselves, as an industry -- deals with the way we conduct ourselves. An industry that wants to deserve the public's respect will not tolerate dishonesty -- for instance, the appropriation of the fruits of other companies' work. It's by no means only my company that has suffered such misappropriation.

Company after company has been affected. Software copyrights have been widely violated, by other companies and by individuals. Chips that cost millions of dollars to develop have been copied for a fraction of their original cost. Systems have been pirated and sold to the public.

One result has been legislation, actual and proposed, to inhibit such conduct. And while we can support much of this legislation as eminently necessary, we should be aware that we are weaving a complex web of rules and regulations.

Public Views the Industry as One of Cut-Throat Competitors

To avoid this becoming unduly burdensome, we must explain ourselves to government, press and public. We have not always done that very well. The image we project to the media too often seems to be that of a battlefield, a place of cut-throat competition. Country A is pitted against Country B and Company X is perceived as seeking to destroy Company Y. To a limited extent, we may have brought this imagery on ourselves, by our own conduct.

On the other hand, such reporting results also from a lack of understanding of the competitive process in this industry. The fact is, there is hardly an enterprise in our industry that is not dependent in one way or another on the products of what we have historically called competitors. We need press and public to understand that in this industry, this morning's competitor may be this afternoon's customer and this evening's partner in some joint venture, not gladiators in some mortal combat.

It's true this is a highly competitive industry, but the premise that for every winner there must be a loser is sheer nonsense. As long as this industry is growing at 15 to 20 percent a year, there will always be many, many more winners than losers. We have a responsibility to communicate that understanding to the press. And the press, in turn, is challenged to communicate in a balanced way to the public.

A Key Obligation to Society is Through Education

Finally, I want to say a few words about our third responsibility, to society at large. One of our key obligations is to education. There is a natural and growing interdependence between our industry and colleges and universities. On the one hand, scientific discoveries in universities can lead to major new developments in the industry. On the other, universities need our help if their scientific curricula are to keep pace with the rapid developments being made by the industry itself.

For example, back in the 1960s thousands of computer scientists were working in the industry but they were all trained as mathematicians, physicists and engineers and they learned computer science on the job, in effect by apprenticeship. It was not until 1964 that the first advanced degree in computer science was awarded.

Then in the late 1960s and early 1970s, the industry became highly dependent on microelectronics but no degrees were granted in large-scale-integrated electronics until the late 1970s. You could make the same point today about our dependence on magnetic technology, CAD/CAM and other advanced areas. So the interdependence is very real and very important.

Here's another example: as we push the limits of technology further and further ahead, we find ourselves using materials in ways never before attempted. Our materials engineers require knowledge at the molecular level. Thus, the dependence of industrial technology on leading-edge science grows increasingly acute.

Self-Interest Served by Sharing Experience with Colleges and Universities

At the same time, modern science owes an increasing debt to the latest technology. Therefore it is enlightened self-interest for our industry to collaborate with universities, to share and compare our experience with faculty and students, and to support their efforts in computing, from small workstations to large scientific computing. It is the responsible thing to do.

Then there's privacy. As an industry, we have done a notable job of exploring and explaining privacy in the computer age. We have studied and publicized the rights of the individual and helped put in place principles and policies to safeguard those rights. But more needs to be done.

Misuse of Information Threatens Privacy

Congress is concerned that the use of computers to gather personal information about people may be outpacing legal and ethical safeguards. The critics claim that dossiers assembled by political groups, private companies and law enforcement agencies could be used for purposes far different from those for which the information was originally volunteered. Unless our industry is a constructive part of this debate, we will have only ourselves to blame if the laws that eventually emerge are unduly burdensome, as they very well could be.

Billions of Dollars Per Year Lost Through Computer Crime

Another aspect of responsibility to society relates to computer crime, meaning both crimes directed against computers and those in which the computer is used as a tool for committing the crime. The American Bar Association says estimates of losses range up to $45 billion a year. They include theft of tangible or intangible assets including software, destruction of data, embezzlement of funds and fraud.

So there are proposals in Congress for bills that would make computer fraud and the counterfeiting of credit cards a federal offense. A Bar Association survey shows many people support such legislation. But, interestingly, when the pollsters asked people how to prevent computer crime, most said the better way was not legislation but self-protection by business itself and, secondly, more education of users and the public about the vulnerabilities of their computer systems.

I take both these points as a direct challenge to our industry. The electronic locks and keys to help safeguard data security already exist, but we have much to do to educate people in their full use and implementation.

Benefits of the Computer Must Be Available to All

Finally, we must realize that in the international arena the computer, which is fundamentally useful and wealth-creating, is viewed with fear by some societies. They worry they may be left behind, they fear they may be at a disadvantage in the general progress of mankind. These fears are a jumble of the real and the unreal. We must do what we can to assist legitimate national goals and to see that the benefits of the computer are made available to all peoples of the world. This can be achieved only in a spirit of cooperation and partnership.

If We Don't Behave Responsibly, Society Will Need to Shackle the Information Industry

The bottom line in all this is economic. For the reasons I've mentioned, people won't use our products as fully as they might unless we merit their trust. And if we don't conduct ourselves responsibly, governments and other institutions will be encouraged to put up barriers and fences that could restrain growth and limit the usefulness of our industry.

Society must know that ours is not the sort of industry that turns a blind eye to computer crime, fraud or unethical behavior of any kind and it's incumbent upon all of us to see to it that the evidence bears that out. In our industry, therefore, we must concern ourselves not just with leading-edge technology, but with leading-edge ethics as well.

(please turn to page 26)

Now Is the Time:
To Design a Safer World Structure

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"There seems no way now to avoid nuclear catastrophe unless we can develop very quickly a larger framework, some kind of worldwide system for nuclear management and peace-keeping."

Reprinted with permission from "Creating a Global Agenda: Assessments, Solutions, and Action Plans", edited by Howard F. Didsbury, copyright © 1984 by and published by World Future Society, 4916 St. Elmo Ave., Bethesda, MD 20814, 346 pp.

The development of a global peace-keeping system is now urgent and may be easier than we think.

The Certainty of Change

In the next few years, we will probably make an evolutionary jump to a new global management system. Our great technological developments of the last 40 years, especially in biology, weapons, and communications, are transforming the world and are leaving us with no alternative. They are squeezing us into the future like a melon-seed squeezed between the fingers. We are like people on a raft being swept onward through a turbulent rapids, with problems coming at us from every direction. We cannot fight the river but we must paddle furiously and together as new dangers or new opportunities appear.

Many of the new problems are very serious indeed, but the greatest danger of all, the hard rock just ahead, is the danger of the escalating nuclear arms race between the United States and the Soviet Union. Neither fear nor elaborate arms-control efforts nor improved weapons nor peace movements have slowed it down. There seems no way now to avoid nuclear catastrophe unless we can develop very quickly a larger framework, some kind of worldwide system for nuclear management and peace-keeping. We need some new arrangement that all the major powers would be willing to adopt simply because it would be so much safer for them than the present arrangements.

The time we may have for doing this is not very long. At the rate things are going, we may pass a point of no return within something like five years, by 1989 or so, with breakdown becoming inevitable if we do not make a major reconstruction by that time. Today we may be in a pre-Revolution or pre-Constitution era, somewhat like 1784 or 1914. If we do slide into a nuclear holocaust, it would still mean a global restructuring; any peoples who are left afterwards will still know how to make nuclear weapons and will still have to create a peace-keeping system in their devastated world. It would be infinitely simpler to do it ahead of time.

After examining the long record of power struggles, the historian William H. McNeill puts it this way:

> To halt the arms race, political change appears to be necessary. A global sovereign power willing and able to enforce a monopoly of atomic weaponry could afford to disband research teams and dismantle all but a token number of warheads. Nothing less radical than this seems in the least likely to suffice.
>
> ["The Pursuit of Power," 1982]

It is curious how many of our best social thinkers and futurists avoid dealing with this catastrophe-or-change turnaround that is so close at hand. They pass on to other problems, or to "surprise-free" projections of 20-year development, or ultimate global reforms, or hoped-for changes in morality or the psyche. But most of these analyses and predictions would be totally upset either by catastrophes or by a revolutionary step-up in global organization. It is the conventional wisdom of 1784 or 1914.

The Nation-State Barrier

There are others who do deal with the catastrophe problem but who speak and act as though our framework of nation-states will remain uncoordinated indefinitely. This includes not only hawks but doves. Any yielding of sovereignty to a larger management structure is said to be "out of reach" at present. Whether they urge increased strength, or arms-control treaties, or disarmament, there is no explicit vision of a new global system. No one would deny that the building of any new system will be immensely difficult, but so are the present fragmentary arms-control efforts.

What frustrates these efforts, the hard core of the catastrophe problem, is the nation-state framework itself. To go back to the raft analogy, we are behaving like paddlers on opposite sides paddling harder and harder against each other instead of having a plan to steer together. The truth is that no arrangement with independent national control of nuclear weapons can be stable or can be steered. As "The Federalist Papers" said 200 years ago:

> A man must be far gone in Utopian speculations who can seriously doubt, that if these States should either be wholly disunited, or only united in partial confederacies, the subdivisions into which they might be thrown would have frequent and violent contests with each other.... To look for a continuation of harmony between a number of independent unconnected sovereignties, situated in the same neighborhood, would be to disregard the uniform course of human events, and to set at defiance the accumulated experience of ages. ... The causes of hostility among nations are innumerable.

Recently this kind of instability in competitive interactions has been studied in the laboratory, in the new social-science field of "non-zero-sum games." These simulate situations in real life in which both parties may win or lose together, and the arms race is a particular kind of non-zero-sum dilemma of this sort. The instability in such a game has now been demonstrated by thousands of experimental and theoretical studies of conflict and cooperation between individuals and groups who win or lose different amounts with each other. In this kind of game, no matter what either player does, locked-in confrontations become permanent, and escalations will continue indefinitely to a breakdown. It is like children trying to build a tower of blocks indefinitely high, which will eventually collapse no matter how careful they are. These are social-interaction laws as inevitable as gravity, unless the game is by-passed by fitting it into some larger framework of communications and cooperative advantage. It is wishful thinking by hawks as well as doves -- whether we start with the armed hostility of balanced forces or with mutual good will -- to suppose that any arrangements between independent nations can get past these theorems so as to remain stable for long.

If we are to move forward, would it not be worth starting a discussion of some larger workable alternative so as to see whether any other arrangement is possible and to make vivid how easy or difficult it might be? There are ways out, as we know from these social-science studies, as well as from many cases of successful peace-making in the real world. Locked-in game-theory confrontations can finally be changed if a larger view is imposed, for example by third-party pressure, re-negotiating the payoffs, or moving to a new system. If we had leadership to begin to think about this question and to debate some possible plans and develop a larger view, it might change our whole framework of discussion; and a step-up to some minimum global nuclear-management system in the immediate future might not be nearly as difficult as we suppose.

Sudden and astonishing step-ups to new levels of organization have happened repeatedly at crisis times in history. Sometimes they are created by empire-builders, sometimes by small alliances. But sometimes they are created by agreement in peacetime, under the leadership of a dedicated group, as in the case of the U.S. Constitution or the partial economic integration of the European Common Market.

With strong leaders and a sound design, a movement toward a better world system today could also take off, because it would be supported by many factors. The U.S. and the U.S.S.R. have many mutual interests besides arms-control. And the worldwide problems of food, health, energy, the monetary system, aviation, communications, environmental protection, the oceans, and space are too large for even these nations to deal with by themselves. A global technology, with the global problems it creates, both makes possible and demands a step up to a global level of human organization.

The Need for Design

But the military nation-state will not disappear by wishing it. Arms and sovereignty have a purpose: to protect people from coercion by others and to strengthen them in pursuing their own interests. In a state of anarchy between nations, they perform the function that government would perform better, trying to protect life, liberty, and the pursuit of happiness. No group or nation would even conceivably be willing to give up its arms and troops unless some minimum system was already in place that would keep the peace and guarantee these objectives.

The design of such peace-keeping systems is not impossible. In civil life they are all around us. It took thousands of years, but we have social and political structures today that keep the peace over enormous areas of the world, larger than ever before. Most of them grew very gradually, of course, and it is a very different thing to have to plan a total peace-keeping system that can move into full operation almost immediately. This is why the examples of the U.S. Constitution and the European Common Market are so important, because they show that it can be done.

Nevertheless, any design of a global peace-keeping system that would be adoptable and generally workable from the beginning will require far more than a copy of some older system. It will also need major inputs of what can be called social technical knowledge. There are technical requirements for a self-stabilizing social structural design with democratic or mutual self-management by the parties, just as there are technical requirements for designing the supports of a table or a bridge so that it will be stable under gravity and varying loads.

It is not generally realized how much we have learned in the last few years about social and political feedback and stabilization mechanisms. Great advances have come not only from studies of game-theory, but from experimental and theoretical studies of cybernetics, psychological reinforcements, management theory, theories of democracy, micromotives and macrobehavior ("social traps"), and the art and science of negotiation. Our knowledge of social structure and stability goes far beyond what the Federalists knew. The knowledge will be essential in the design of any acceptable and stable peace-keeping system.

There is a widespread ignorance of these stabilization principles that is a defect in many global proposals. A self-governing structure that takes care of the interests of its participants is not a hierarchical pyramid of command, but a complex of interacting feedback loops, like the interacting blood loops and nerve networks of our bodies. It does not necessarily require either a world parliament to debate, or a nuclear autocrat to decide and act, as many writers suppose. Yet at the same time, goodwill and ingenuity are not enough; and strengthening the United Nations is not enough. [The Charter of the U.N. violates rules of stability that were known to the Federalists.]

What is needed at this point is to bring together multinational social and technical study groups to analyze and make proposals for the stabilization and design problem. The aim would be to apply sound feedback and control principles to outline a minimum global nuclear management system, one that would offer equal security to the participating states, protection against terrorists and mad nuclear dictators, and stabilizing feedbacks -- "checks and balances" -- with fail-safe mechanisms that could make patriots and conservatives on both sides feel more secure with the system than without it. We need, so to speak, a new Hamilton, Jay, and Madison to come together to write the new Federalist Papers on which a new working Constitution can be securely built.

The Four Requirements

A design-study group will have to work on hundreds of questions, but underlying them are four general requirements that any peace-keeping management system will need to satisfy if it is to be persuasive to the world. They are principles of stability and acceptability that in fact were emphasized so long ago by the Federalists, but that have been neglected or violated in many discussions of how to keep the peace. [See "The Federalists and the Design of Stabilization," in John Platt, "The Step to Man."]

The first of these requirements for a peace-keeping system is, of course, that it be workable and effective. Its structure must be designed so that the roles and rewards of administrators and personnel lead to almost automatic feedback responses adequate against a host of dangers: coups d'etat, the rise of Hitlers, or renewed confrontations and escalations, as well as financial crises and bureaucratic rigidity. The system should have a range of time-constants for different needs, from rapid emergency action to long-run deliberation.

An effective feedback system must also be tough-minded, prepared to assume the worst, because as Hamilton said, men are "ambitious, vindictive, and rapacious." "If men were angels, no government would be necessary." The checks and balances should be operating to avert problems long before they become serious. Only if it is "realist" in this sense can such a system convince intelligent conservatives in every country to adopt it. This does not mean that it will operate primarily by last-ditch punishment or retaliation, because this would produce hostilities and dissipate the feelings of security and goodwill that are essential. It must create instead a thousand little continuous pressures and rewards for cooperative behavior, both of men and nations, of the kind that make any good organization satisfying and effective.

The second requirement of a good design is that it be modifiable. The structure should not be trivially changeable, veering with every wind, but it needs to be open to criticism and adjustment with reasonable speed to revealed imperfections or changed circumstances, if it is not to break down under growing stresses. No system is perfect or can stay perfect for long. And when governments or leaders have initial objections to a particular design, as they always will, it is much easier for them to adopt it if it offers a clear mechanism for amendment later.

The third requirement is that any new system for global nuclear management, requiring political acceptance by numerous parties, must be an absolute minimum system. There should be nothing in it that is not essential for its effectiveness. Adoption of any workable system is going to be almost, if not quite, impossible, and every requirement that encroaches unnecessarily on the present interests of the participants should be eliminated.

This also means that individual countries will have to give up, at least within this system, those demands on other countries that have nothing directly to do with the peace-keeping mechanism. This will be one of the hardest concessions for countries to make, and there will have to be other channels through which these important interests can be pursued. But no ideological objections, no refusal to communicate with de facto governments, and no righteous indignation over their past actions or their present corruption or oppression should be allowed to increase by a single degree the enormous difficulty of adopting any real peace-keeping system.

The fourth requirement is that an adoptable design needs to offer its participants not only a minimum of negatives, but a maximum of positive advantages of personal and national self-interest, both for the present and the future. For the nuclear powers, each side will take immediate delight, of course, in a visible nuclear build-down on the other side; and the world will rejoice with both of them. With a peace-keeping system that we can begin to trust, there will also be new opportunities for unhampered development in every country, and a worldwide surge of hope and economic improvement. The conversion of the giant defense industries and their scientists and engineers into a peace-keeping system and then into new enterprises would have to be supported, but it would cost no more than they cost now; and it could be as dramatic as the surge of growth after World War II and the injection of the Marshall plan.

For a peace-keeping system to be adopted and successful, it must be effective, modifiable, minimal, and rewarding. As with building a successful commercial enterprise, we do not need a system that punishes and postures and fantasizes, but a working system that bargains and compromises, that manages and watches and responds.

Within these general guidelines, there are many alternative self-stabilizing arrangements that would be stable -- just as with living systems, where there are many different kinds of self-stabilizing biological creatures that have learned how to survive. This again helps to make the initial negotiations easier, because many of the specific demands and preferences of different countries can be accommodated in a complex system, as long as the crucial stability rules are not broken.

Stages in the Process

The process of analyzing possible designs and then going on to a working peace-keeping system could be done in three stages, although they might overlap.

The first stage will be the assembly of one or more technical-analysis and design groups, who would work full time for many months on general stability principles and applications and alternative proposals.

Such groups might be organized under European or other auspices, or in any of several centers of advanced study. They would need to include practical politicians and diplomats and experts in law and economics and science and arms, as well as experienced negotiators and social analysts. Qualified people from both East and West should be in every such group, to avert the danger the Federalists warned against when they said, "Men often oppose a thing, merely because they have had no agency in planning it, or because it may have been planned by those whom they dislike." The long-run peace-keeping process, like government itself, is a political process involving informed participation by all parties, bargaining, compromise, and wary trust, and it will not work unless it has these characteristics from the beginning.

This stage can make use of the many years of hard work and ideas that have already gone into arms-control negotiations and treaties between East and West. Questions of multinational administrative structure, of financing, of what laboratories and plants and bases are to be monitored and controlled, of access and adequate guards, of fail-safe mechanisms, and so on and on, are discussed in hundreds of documents going back to 1945. The difference here is that the analyses are directed toward creating a business organization, not a double-spy system. Some large multinational corporations might even serve as models. It could be a refreshing change. No arms discussions afterwards would be the same.

The second stage of the process of adoption will be the effort to explain to a worldwide public how such a system would work to increase everyone's security. This means making converts; and energetic political leadership will be important. Yet the worldwide peace movement and nuclear-freeze movement today show that, in these matters, millions of people are already ahead of their governments. There is now both a political and economic constituency for the world as a whole, just waiting to be tapped. Any group of leaders with a well-designed plan that offers some immediate hope to everyone could sweep the planet almost overnight.

The third stage of the process will be the actual convening of a top-level design-negotiation conference between East and West to decide on a system and adopt it and begin the steps of implementation. It would have to work out hundreds of details to meet the needs of all the participant countries as well as possible, and it would need technical advisers who have taken part in the original design-study groups, to make sure that stability requirements are not compromised. The recent Law of the Sea Conference was remarkably successful negotiation of this kind, with agreement worked out by a hundred nations on a hundred points over a 7-year period. At the end it was marred by the withdrawal of the U.S. after a change of administrations -- which shows the danger of excessively long negotiations -- but the general success and the negotiating mechanisms developed there may provide useful lessons for the nuclear peace-keeping design negotiations that lie ahead.

Easier Than We Think

The whole process might go faster than anyone supposes. Things are far more complex now, but it is worth remembering that the U.S. Constitution was hammered out in four months by less than 40 delegates. The stabilization-design problem is no longer a question of confrontation and counting; it focuses on fresh and larger arrangements. Lesser details might not be such sticking-points as they usually are, because there would be good adjustment mechanisms for working them out later in an ongoing system. And public enthusiasm and mass pressure, along with the nuclear urgency, might make the delegates surprisingly eager to finish their task and move into the new world.

If experienced and influential representatives of the great powers agree on and endorse the main features of a peace-keeping system, they might be able to convince every country that it would be a hard-headed improvement in security. All around the world, it could give such an increased sense of plan, of security, and of hope, that people across the political spectrum would rally to it, allies would press and bargain for its adoption, and the move to a new system and the reduction of nuclear armaments might suddenly become psychologically and politically easier than anyone believed. After these turbulent rapids, if we survive, there is a boundless ocean of new potentialities opening out before us.

What is important is to get the first step started now. When people need to build a new building, they call in architects. Calling together a conference of architects who can design a safer structure for the world must be done eventually. Now is the time.

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King Canute and the Information Resource

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"Out there in the marketplace of ideas, this expandable, leaky, shareable resource is creating a lot of confusion as it undermines our inherited wisdom."

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Some people collect coins or stamps or snuffboxes or forgeries of Salvador Dali paintings. I have taken to collecting Canutes -- instances of behavior reminiscent of the legendary Danish monarch who stood on the beach and commanded the tides to stand still as proof of his power.

The information environment created by the explosive convergence of computers and modern telecommunications is full of examples of Canutish behavior. The trouble seems to be that, in our thinking about information, we have carried over concepts that used to work pretty well for the management of material things. But information (enhanced by modern telecommunications and fast computers) is such a different kind of resource that our inherited wisdom is somehow transmuted into folly.

Unlike coal or uranium or steel or automobiles or food or clothing, information is expandable (it grows with use, enhances its value through dissemination), diffusive (it leaks at nearly the speed of light, and is therefore harder to hide), and shareable (if I give you food or sell you an automobile, you have it and I don't; if I give you a fact or sell you an idea, we both have it).

In the United States, still the most "post-industrial" country, about half of all work, as defined by the Census Bureau's employment categories, is now information work -- not only writing and calculating, but what executives, salesmen, advertisers, lawyers, accountants, secretaries, programmers, consultants, and hundreds of other kinds of workers do. And, though the Census Bureau doesn't say so, the ratio of brainwork to drudgery in nearly every job keeps rising. What are the implications for our inherited social wisdom of this sudden dominance of the information resource?

Information now plays so prominent a role in post-industrial society that we are tempted to treat it as a new subject or field -- even a separate discipline. It's something like the early reaction to space exploration. When the Mercury and Apollo programs were projected, it seemed at first that outer space might become a new principle of organization. But it soon dawned on us that space was not a new subject but a new place where all the old subjects -- physics, biochemistry, medicine, military science, law, economics, politics, even art and philosophy -- took on interesting new dimensions.

In a similar way, the convergence of computers and telecommunications doesn't resolve the ancient puzzles about human rights and responsibilities, Man and Nature, liberty and authority, productivity and fairness, pursuit of the common good in a world full of individuals, and protection of the global commons in a world full of nation-states.

But the new information environment, what the French call "the informatization of society," does change the context in which these durable dilemmas present themselves in the 1980s and 1990s. Out there in the marketplace of ideas, this expandable, leaky, shareable resource is creating a lot of confusion as it undermines our inherited wisdom. Out of a hundred possible examples, consider what's happening to our ideas about "control" and about "ownership."

The Nobody-in-Control Society

Knowledge is power, as Francis Bacon wrote in 1597. So the wider the spread of knowledge, the more work has to get done by horizontal process -- what the Japanese call consensus, the Indonesians call mushyawara, communists call collective leadership, and Americans call teamwork. If the Census Bureau counted each year the number of committees per thousand population, we would have a rough measure of the bundle of changes we call "the information society."

The King Canute prize for 1981 was easily won by Secretary of State Alexander Haig. Shortly after the attempted assassination of President Reagan, Haig announced on television from the White House that "I am in control here." That produced neither reassurance nor anger from the American people but nervous laughter, as in watching a theater of the absurd. We, the people, know by instinct that in our pluralistic democracy no one is, can be, or even should be "in control," that by Constitutional design reinforced by information technology we live in a nobody-in-charge society.

We all know other Canutes whose absurdities don't get on national television: executives who give orders when they should be asking questions, managers who think of their co-workers as superiors or subordinates, impatient doers who don't have time for lateral consultation -- in sum, the builders of bureaucratic pyramids who haven't adjusted to the new information environment.

In an information-rich polity, the very definition of "control" changes. Very large numbers of people empowered by knowledge -- coming together in parties, unions, factions, lobbies, interest-groups, neighborhoods, families, and hundreds of other structures -- assert the right or feel the obligation to "make policy." Decision-making proceeds not by "recommendations up, orders down" but by plural improvisation on a shared sense of direction. Secrecy goes out of fashion, because secrets are so hard to keep. Participation and public feedback become conditions precedent to decisions that stick. And "policy" widens out to become what Paul Appleby called it a generation ago: "the decisions that are made at your level and higher."

Information As Property

The openness that the informatization of society brings in its train is bound to raise fundamental questions about the idea that information "belongs" to a person or an organization. The propensity of information to leak is, like waves eating away the foundations of a seashore condominium, eroding the doctrine that information can be owned, exchanged, and monopolized the way "real" resources can. Those who persist in treating information as property are likely to get wet.

Two kinds of waves are rolling in. Dynamic high-technology keeps developing better and faster techniques of piracy -- xerography, videotape, the backyard dish for picking up signals from satellites. The knowledge explosion also produces new kinds of works (computer software) and means of delivery (microfiche, videocassettes, computerized data bases). Laws written to protect books and phonograph records and broadcasts, the products of the past, are getting harder and harder to apply. Laws that address technologies not yet invented are hard to write.

Yet the Canutes persevere.

The Association of American Publishers sued New York University and nine professors for infringing copyright when they helped students learn by copying useful literature. They had to settle for vague promises to be good, at least for four years; the publishers didn't even get their court costs back.

...

When I first acquired a home computer, I found the ethical dilemma right up front; it came with the instruction manual. On its opening page I was threatened with litigious mayhem if I copied any of the instructions. On the very next page, I was told that before I did anything else I should make at least two copies of the floppy disk provided with the manual. Since then, the technological fix is increasingly in vogue: a couple of more recently purchased software packages contain floppy disks that self-destruct after the first backup copies are made, so they can't be replicated ad infinitum and furnished to my friends.

But the leakiness of the information resource seems destined to overwhelm the Canutish efforts to imprison it. The history of arms control, and the teenage computer pirates, teach us that there is always a technological fix for a technological fix.

Is the doctrine that information is owned by its originator (or compiler) necessary to make sure Americans remain intellectually creative? In most other countries, creative work is overwhelmingly controlled by organizations and carried out by salaried people. In Japan, even the most inventive employee is likely to have a lifetime job and receive salary raises in lockstep with his age cohort, his morale sustained not by personal ownership of his ideas but by togetherness in an organizational family.

Most U.S. patents are held by organizations (corporations, universities, government agencies), not by the inventors. Many copyrights, perhaps most, are held by publishers and promoters, not by the authors and songwriters the Founding Fathers may have had in mind when they sewed information-as-property into the U.S. Constitution.

An author or songwriter who helps a publisher make money should certainly participate in the profits. But direct agreements about profit-sharing or joint venture arrangements (the movie industry is already full of relevant examples) seem a less fragile basis for such cooperation than fraying fictions that the author "owns" the words in a book and that shared information is being "exchanged."

In U.S. universities and research institutes, creative work is already rewarded mostly by promotion, tenure and tolerant traditions about teaching loads and outside consulting. We generate a respectably innovative research-and-development effort in public-sector fields such as military technology, space exploration, weather forecasting, environmental protection, and the control of infectious diseases without the scientists and inventors having to "own" the ideas they contribute to the process.

In the private sector, the leaders of industries on the high-technology frontier are already saying out loud that their protection from overseas copyists doesn't lie in "trade secrets" but in healthy research-and-development budgets. John Rollwagen, chief executive of Cray Research, which produces the world's most powerful computer, puts it this way: "By the time the Japanese have figured out how to build a Cray 1, we have to be well along in designing Cray 2 -- or we're out of business."

The notion of information-as-property is built deep into our laws, our economy, and our political psyche -- and into the expectations and tax returns and balance sheets of writers and artists and the companies, agencies, and academies that pay them to be creative. But we had better continue to develop our own ways, compatible with our own traditions, of rewarding intellectual labor without depending on laws and prohibitions that are disintegrating fast -- as the Volstead Act did in our earlier effort to enforce an unenforceable Prohibition.

Governments and Secrecy

In international politics, the doctrines affecting information are in maximum disarray. Every newly miniaturized recording or micrographic device, and every new satellite launched for communication or photography or remote sensing, makes it more difficult to sustain the doctrine that national governments can own, or even control, their information resources.

In 1979 the U.S. government sent two delegations to two world meetings about the control of information. At a UNESCO conference in Paris, the instructed delegates righteously advocated the "free flow" of information -- information furnished by U.S. news agencies, U.S. television producers, and U.S. movie studios. At the U.N. Conference on Science and Technology for Development in Vienna a few weeks later, an equally righteous group of instructed Americans came out against the free flow of information -- information as technology we were anxious to hoard.

Both principles are authentically American: the right to choose, the right to own. In international discourse, we will hardly be able to have it both ways. Yet there is no evidence that the two groups of delegates, and the government that instructed them both, perceived the irony or the contradiction.

If information is inherently hard to bottle up, policies based on long-term information monopoly are likely to have a short half-life. For the 1980s and beyond, the principle of action is clear: if the validity of your action depends on its continuing secrecy, watch out!

In our generation-long arms race with the Soviet Union, successive U.S. administrations have managed to persuade themselves that each new U.S. weapons system -- its made-in-America technology a continuing mystery to our adversaries -- would enable us to stay "ahead." In the most Canutish of these actions, the United States in the early 1970s decided to stuff multiple independently targetable re-entry vehicles

(MIRVs) into single missiles. Despite elaborate secrecy on our part, the Soviets very soon figured out how to do likewise. But since they (for other reasons) had built much bigger missiles boosted by more powerful rockets, they were able to stuff more MIRVs into their canisters than we could. Thus did we outsmart ourselves by taking an action that depended for its validity on technological secrecy, and created the famous "window of vulnerability" instead. ...

Our own government has for three decades engaged in half-hearted and demonstrably inefficient efforts to bottle up "strategic" U.S. science and keep foreign nationals out of "sensitive" university research. In our mostly open society, it never has worked well. Americans have no corner on the market for brains; scientists talk across frontiers to each other; our European and Japanese allies never had much enthusiasm for controlling transborder information flows (because sales of equipment mean jobs for Europeans); and Soviet technological espionage has long been a thriving industry.

Keeping R & D to ourselves is a policy that depends for its validity on secrecy; as the informatization of society intensifies in the post-industrial world, it can be expected to work less and less well.

Similar government behavior used to work better for dictators and totalitarian bureaucracies in societies where keeping information from spreading is honored by doctrine and practiced ad absurdum. Xerox machines are still licensed by the government in the Soviet Union; in Bulgaria, even typewriters are closely controlled. Ideas are harder to license: Russian youngsters readily learn about blue jeans and hard rock, and scientists on both sides of the porous Curtain seem to know how far along their peers are in unraveling (for example) the puzzlements of rocketry and space travel.

The good news is that information is leaky, that sharing is the natural mode of scientific discovery and technological innovation. The new information environment seems bound to undermine the knowledge monopolies that totalitarian governments convert into monopolies of power. In the horoscope of the USSR and the "Soviet bloc," a future looms where nobody is in charge.

Information and Wealth

The informatization of society may destabilize more than the Soviet bloc. It may help undermine the systems that keep two billion people in relative poverty, and more than a third of them in absolute poverty.

In the industrial era, poverty was marked by an absence of things -- minerals, foods and fibers, manufactures. In the post-industrial era, these physical resources are joined at center stage by information, the resource that is harder for the rich and powerful to hoard. But whether the informatization of the globe will make for a fairer distribution of its resources depends on the extent to which people in the traditionally poor nations are motivated (and allowed by their own suzerains) to educate themselves for full participation in the information-rich environment.

The key that unlocks "growth with fairness" in this changing context is thus the widespread delivery of relevant education.

More than any other one factor, it was that prescient nineteenth-century decision to offer free public education to every citizen that enabled the United States to pull itself out of under-development. It was another wise educational policy, the Morrill Act of 1862 -- using federal land grants to set up university-based agricultural research stations and build a county-by-county extension service to deliver the resulting science directly to the farm -- that created the productivity miracle that is American agriculture.

Today, around the horizon of the developing world, in Asia, Africa, and Latin America, the close connection between education and "growth with fairness" is now crystal clear.

The growing importance of information in creating wealth has to be good news for countries less favored by geology and arable land than the early arrivers in the industrial age. The poor can get rich by brainwork -- the Japanese have amply illustrated the new wealth-creating theorem, and the hustling, educated peoples of South Korea, Taiwan, Singapore, and Israel have more recently provided a similar demonstration. Not only have they grown faster than other developing countries, they have spread the benefits of that growth more fairly among their people than most countries that are favored (as they are not) by oil or hard minerals or soil or climate.

Around the developing world, indeed, the striking paradox is that the most successful countries are precisely those blessed with rich natural resources.

A country such as Japan, with virtually no fuels or minerals, with a short growing season and much farmland we would call marginal, is forced by physical poverty to bet on the only sure resource it has, the brains of its own people -- by getting them all, not just an elite few, educated. That turns out to be the most profitable investment of all. The educated brains seem able to pull in from the global information flow the data, knowledge, and insights needed to create a development strategy of their own.

Even if the richer countries are not very good at helping the poorer ones -- even if we ourselves act in Canutish ways (limiting access to our markets, trying to hoard our technologies, starving our educational exchange programs) -- the developing countries that bet on universal education for their own people, and thus learn how to seek facts and ideas about technology, management, markets, and governance, can readily secure these hardest-to-hoard resources.

By contrast, in the countries whose people have been kept in ignorance (by colonial policies, or their own leaders' mismanagement, or first one then the other), it doesn't seem to matter what riches lie in the ground they occupy. Most of their citizens become the peasants of the global information society -- along with the dropouts of the post-industrial world. The physical riches get siphoned off to the educated folk huddling in the affluent sections of their central cities -- and to the information-wise foreigners who come in to do good and do well.

The excuse for poverty in the industrial era was that there weren't enough resources to go around. If the rich and powerful believe that it's only at their expense that resources can be shared with the less fortunate, they will cast themselves as the Canutes of world politics: that is, they will dig in and resist spreading information around through education. But if information, the increasingly dominant resource, is really expandable, diffusive, and shareable, there will be less excuse in the future than in the past for depriving whole populations of the benefits of positive-sum development.

The modern Canutes will be wise to assume that the information tide is coming in -- and adapt their behavior accordingly. Knowledge is power, and let's not forget it. Ω

Problems, Solutions, and Methods of Solving —Part 2

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"Problems play an essential role in the progress and teaching of science."
- George Polya

The first part of this series of articles stated three main propositions:

- The problems that computers can solve are far fewer than all the problems that human beings are faced with;
- These other problems are important and worth attention; and
- It is desirable to notice and consider all the problem solving methods that human beings use.

In that first article we talked about:

1. The Principle of No Action
2. The Principle of Feedback Control

Here we shall consider:

3. The Principle of Action
4. The Principles of Authority

Names of Methods of Problem Solving

The names of the general methods of problem solving that human beings use, so far as the literature is concerned, have not been systematically classified and scientifically organized. Instead they remain in an early stage of common sense recognition. This is like the early common sense principle of geographically recognizing new roads and streets, and naming them on the basis of associations. This is shown for example in old Boston and other old towns with street names like Milk St., Water St., Park St., Beacon St., Hill St., Maple St. There are more than 60 streets, avenues, roads, drives, etc., called "Park" in the Boston metropolitan area, partially subdivided by some 30 zip codes.

Of course, the names of particular methods of problem solving, such as mathematics, logic, geometry, mechanics, ... have been used for centuries. However, the territories which they cover are a strange mixture of culture, history, observations, generalizations, experiments, theories, evidence, and more besides.

For example, in the last 100 years the territory of chemistry has expanded greatly to cover newly discovered compounds of new categories; the territory of physics has expanded to cover new fundamental particles; the branches of chemistry once called organic and inorganic have more or less merged; biochemistry has budded off to form a new large specialization; and some entirely new principles of knowledge have become well confirmed, such as the expanding universe of the galaxies, and the energy and power in the nucleus of atoms.

3. The Principle of Action

A method of problem solving is the Principle of Action. It can be expressed in many ways:

- Get ready, get set, go.
- Don't just stand there -- do something, anything.
- Decide and start.
- A journey of ten thousand miles begins with the first step.
- Don't be the donkey that starved between two haystacks.

In the world of nature, there is no doubt that the doing of something has more survival value than the doing of nothing. A beetle eating a rose in a rose bush, if disturbed, will fly away if it is a hot sunny noon, or drop to the ground if it is a cool dewy morning. A fly that is blocked by a pane of glass buzzes here and there over a partially open window, and sometimes finds the airway to the outdoors.

The same is true in the human world. A person out of a job scans the help wanted ads in the newspaper to see if there is some organization that might hire him. A newspaper reporter has to produce a story by the press deadline, a story that covers what, where, when, who, how and why. If he fails too often, he becomes an ex-reporter.

Action and Life

Action is the first aspect of nearly all living things which is noticed by observation. If it moves, whatever it may be, it is probably alive. As people attain civilization, they classify more and more things as inanimate, but the early explanations of the world offered by the early wise men (wizards or witches) treat the sun as a sun god, the moon as a moon god or goddess, the rain as a rain god, and so on. Even the ancient Greeks treated the sun as the god Apollo driving his chariot across the heavens each day, and passing under the world each night so as to do his duty again the next day -- even though some of their philosophers advocated more natural explanations.

The personification of inanimate moving things has happened in more than a hundred religions, and probably in more than a thousand. Personification is a very ancient (and probably universal) first hypothesis of primitive humankind, and perhaps of other social animals that can convey messages among individuals, such as dolphins, bees, wolves, and baboons.

The arguments for the Principle of Action are simple and obvious:

- Almost nothing can be accomplished without action.
- Action, even if we have no knowledge of what is sensible to do in the situation, produces experimentation, and experimentation produces experience, and this leads to information and wiser choices.

For example, will a handheld calculator be useful to me? This kind of device now costs so little that the easiest thing to do is to buy one and try it, as we would a flashlight for a dark corner. The decision does not need a computer to produce it.

- Action, if we do have knowledge of what is sensible to do in a situation, produces results, and regularly advantages.

The arguments against the Principle of Action are these:

- It is wise to consider the timing. One must wait a while for green apples to become rosy and sweet.
- Most actions require money and other resources. If they are not available, the action may have to be canceled.

For most individuals and most occasions, the decision yes or no is simple. Only occasionally is a computer needed to produce it.

Change in Behavior

The Principle of Action is particularly important when people come to a point where they have to change their behavior. Many people can come to believe the need to change something they are doing on the basis of hindsight, although some persons, like some kings of France, learn nothing and forget nothing.

Examples may range from rather trivial to extremely costly:

- Running out of gas while driving on the highway;
- Driving a motor car hour after hour while sleepy;
- Allowing a word processor to develop a dozen malfunctions so that it becomes very difficult to repair it;
- Loyally continuing consulting a doctor whose medical advice is making you more and more ill.

One must act when a change is necessary:

- Paying attention to an approaching hazard;
- Make a judgement about the remedy;
- Use initiative so as to make an appropriate change in one's behavior.

Buffalo Creek, 1972

For example, in the Buffalo Creek area, near Man, West Virginia, about 8:00 am on Feb. 26, 1972, after three days of heavy rain, an earthen dam collapsed. It had consisted of a coal mine waste pile that had accumulated over 15 years, and was holding back some 17 acres full of water. A wall of water, mud, and debris 20 to 50 feet high, rushed down the narrow valley causing at least 100 deaths.

Early that morning, Otto Mutters, a deputy sheriff of Logan County, received a phone call saying that the pile was about to give way. About 6:10 am, he reached the base of the slag heap. The mine superintendent told him they had ditched around the heap, and "now everything will be all right".

"But it just seemed to me like it might possibly break." So he notified residents on his way down the 14 miles of hill road.

"Some people laughed at me," he said. "They stood looking at the creek water as if that was all they had to worry about. Some of those people are dead right now."

4. The Principles of Authority

We turn now to the Principles of Authority, which can be divided into a large number of principles according to the name of the authority. In the following table is a list of 20 Principles of Authority.

20 Principles of Authority

Aristotle / Read Aristotle's writings and be guided by what they say.

Bible / Study the Bible and do what it directs.

Clergyman / Consult your clergyman, and be guided by what he says.

Conscience / Listen to the voice of your conscience, and do what it says.

Dictator / Do what the dictator of your country requires.

Doctor / Consult your physician, trust him, and do what he recommends.

Expert / Select a capable expert, consult him, and do what he recommends.

Family / Consult your family, and do what they advise.

Friends / Talk to your friends, see what they think, and be guided.

Guru / Find a wise guru, and do what he says.

Koran / Study the Koran and do what it directs.

Law / Obey the law; ignorance of the law is no excuse.

Oracle / Find a divine oracle, and do what it says.

Parents / Ask your parents and do what they say.

Pope / Study what the Pope has said, and do what he directs.

Prayer / Pray to the divine being for guidance, and hope for an answer to your prayer.

Precedent / Find a precedent, and apply it.

Priest / Consult your priest, and be guided by what he says.

Regulations / Check the regulations and abide by them.

Supervisor / Ask the supervisor of your work, and do what he says.

Second Hand Information

A great many more authorities could be listed, especially if we consider authorities in various fields such as science, economics, politics, and others. However, by far the largest amount of information that we who live in the 1980's must rely on is information that we cannot ourselves verify firsthand. Instead, we must accept it fully or partially on the authority of what other people have said or written or told us.

It is extraordinary how differently the same happening or event in the human world, such as "news", may be reported in different newspapers, magazines, and textbooks. Fortunately, when reports from different sources (authorities) are compared, one is often able to fit together, like the pieces of a picture puzzle, that which probably is fact. For example, two different source books that I consulted one day while I was writing this, said that the area of Sweden is a little over 173,700 square miles. I accept that; I could never measure that myself; it looks like solid fact about solid land. But a land area can vary. On the south coast of France, at Aigues Mortes, a port from which a king of France set sail to the Crusades 700 years ago, the Mediterranean Sea is now two miles away to the south.

Conflicts Among Authorities

Clearly, if an authority A says one thing, and an authority B says something very different, A disagrees with B. Then, of course, one has to decide which one to believe, how far to believe A or B, and for what reasons.

Of course, a bold authority will say:

- I am an expert, and you ought to believe me, and if you don't, you will be laughed at and ridiculed.

A modest authority will say:

- Such and such is my evidence, and the conclusions I draw are this and this, and here is my reasoning, which many colleagues and I find convincing, and many experiences confirm it.

A religious authority will say:

- God has ordained me, and it is only right for you to believe me, and millions of people belong to our faith.

And a government authority will sometimes say:

- The government directs such and such, and if you disagree, you will be punished, officially and also unofficially.

The Argument of the Club

This last principle, the Principle of the Authority of the Government, is (in the study of logic) a fallacy, older than 2000 years, named Argumentum at Baculum, the argument of the club, the argument of force or compulsion. This argument is often necessary in simple cases such as obedience to traffic instructions, like keeping to the right on the highway and obeying detour signs. The penalty is either arrest by a policeman or a serious and often fatal accident.

The argument of the club is also expressed in the Old Testament statement "He that spareth the rod hateth his child" and in the proverb "Spare the rod and spoil the child." When I was a child, my mother's usual punishment was being sent to my room to stay and bread and water till the next morning; my father's usual punishment was a spanking. The spanking hurt, but I knew perfectly well that I should not have thrown a broken milk bottle into the street to cut tires when he ordered me not to; and the spanking was over very fast and finished with. But bread and water till the next morning for hitting my little sister seemed to me more cruel and much more unendurable, and I hated that punishment as rather extreme. There is no doubt that the principle of slapping or spanking a child, producing only a small amount of temporary discomfort for bad behavior, combined with the principle of small rewards for good behavior, makes considerable sense, for it works, and works well, in the training of puppies, kittens, and young human beings.

But it is a dangerous principle in many cases, for the immature parent or unprofessional animal trainer may not have good judgement, rational emotions, or conspicuous caring. It leads to many tragedies in the relations of members of a family: grudges, hatreds, and rebellions. It indulges sadism, the enjoyment of torture, the intoxication of power, and other perversions.

Beating and similar tortures happen in the actual current practices of more than 120 nations, according to a recent report of Amnesty International. In Argentina between 1976 and 1982 more than 25,000 children and adults "disappeared", and the recently elected government of Raoul Alfonsin has begun to reveal the extent of the torture chambers and illegal killings.

As usual in difficult cases, the principle of authority of the government, the community, the parent requires judgement, wisdom, and common sense for it to produce advantages and not disadvantages for society. Perhaps in days to come the exercise of authority can be computerized with artificial intelligence techniques, but it is likely to be biased in its design by programmers, and unable to adjust well to unforeseen cases and situations. Any teaching of wise parental behavior should be welcomed.

The Choice of an Authority

The Principle of Authority, the principle of deciding a question by finding out what an authority (or expert) says about it, does not tell us how to choose an authority to rely on. For this choice we have to make use of other principles of reasoning, and whatever evidence we can find in the record of the authority that we consider selecting:

- What it has recommended as actions or stated as predictions;

- What has happened as a result of those actions or predictions.

Evidence is essentially experience of our own, or the experience of other people, written or told or circumstantial, and confirmed in many ways.

Experts have to be judged by nonexperts. The judgement has to be based on the evidence. For example, weather prediction could be of great benefit for many people, but in spite of large computerized efforts, including satellite mapping of the atmosphere, to predict weather, the forecasts of the weather bureau are notorious for their mistakes.

Some recent computer programs in certain fields like reference to laws and diagnostic medicine have become expert in these fields. But the programs have been derived from the knowledge of human beings who are expert in these areas. As the experts learn more, and the knowledge in the field increases, the computer expert programs have to be revised and updated.

So what we should do next is to consider tests or criteria by which experts can be judged by nonexperts.

Criteria for the Choice of Experts

Here are some of the tests or criteria which can be applied:

Historical Date / The longer in the past the statement was made, the more likely the statement must be modified or changed. For example, "stones never fall from the sky", accepted in 1700, changed to "stones sometimes fall from the sky", accepted in 1800.

Potential for Change / Any expert or authority for any area of knowledge (especially ethics or morals) must have a potential for change, and if possible a potential for both evolutionary and revolutionary changes, slow changes and quick ones. For example, in some navies, as late as 1800, human slaves for rowing galleys were chained to their seats for months at a time irrespective of bodily needs, and this practice was considered in certain navies normal and beyond reproach for more than 3000 years of human history. But by 1900 this practice had almost disappeared.

Contradictions / The more contradictions one finds in the writings of an authority, the less the authority is to be believed or trusted. Example: In old epochs of many religions, there may be much emphasis on bloody sacrifices of persons and animals actually performed to please a god; but in current times, sacrifices may be only verbal, metaphorical, token, without the shedding of blood.

Question-Answering / For a source of information to be qualified as an expert it should be able to answer questions, and the answers should satisfy many tests of reasonableness and common sense. For example, two clinical thermometers should be able to give the same reading of the temperature of a sick and feverish person. And an expert computer programmer should be able to answer the question "Why doesn't such and such a computer program run?" by finding the error or errors and making it run.

Miraculous Events / The more miraculous the event, the less likely that it actually did happen, and the more likely that the report of it resulted from defective observation, interpretation, or human invention. Example: A mirage of an oasis far off in a desert used to be interpreted as a miracle, but now is interpreted as the result of repeated reflections from heated layers of air.

Faith / Any expert or authority who makes use of faith is likely to become entangled with what we may call the Medicine Man Fallacy. "If you take my medicine with proper faith, it will make you well; but if you do not have proper faith, it won't." The trouble here is that the prediction is unable to fail (self-fulfilling). If you return to the medicine man some time later, and say "It did not work", he questions you about your faith, and says "Aha! You did not have proper faith." Another example is the contractor who sells an anti-ballistic missile system that cannot be physically tested in reality without utmost disaster. A third example is the team of doctors and hospital who say "The operation was successful but the patient died."

Messianic Complex / An authority who says or claims that he has had dreams, visions, divine messages, and the like, directing him to do such and such is likely to be suffering from the "messianic complex", a recognized, abnormal, and scientifically understood psychological illness. Such an authority often utters truths, metaphors, and falsehoods, and is unreliable. With enough power in the grasp of such an authority, enormous tragedies may occur. Examples include Joan of Arc, Hitler, Mahomet, Gandhi, many martyrs and criminals.

To sum up, for a person to be qualified as an expert guide, he or she should be living (or only recently deceased), trained, educated, responsible, experienced, literate, compassionate, lucid, and have an excellent record of worthwhile accomplishments.

For any writing to be qualified as an expert guide, it should be authored by an expert and fairly recent, the meanings of the terms used should be clear and suited to the audience of readers, it should include knowledge of recently determined facts and conditions and it should not contain contradictions. For example, an astronomy textbook should include information about and photographs of the satellites of the planet Jupiter, obtained from the space probes of recent years.

Oneself as One's Authority

When all is said and done, each person has to be his or her own authority in countless actions as the days go by. Choice as to what one will or will not do is possible and frequent; people behave as if they had free will, whether or not they actually have free will. They can make appointments and keep them, if they so choose. They can get up when the alarm clock goes off in the morning, if they so choose. If a friend of mine says he will meet me at such a time and such a place, and if on six consecutive occasions he is late by 10 or 15 minutes, I naturally decide on my own authority that I expect him to be late, and adjust by bringing a book to read while waiting. If a doctor gives me advice to have my tonsils removed, and in that particular town the newspaper reports that tonsillectomies are three times the average, I as my own authority become very skeptical and seek additional advice.

These are some but certainly not all of the criteria for judging authorities and experts. We will turn next to what we may call the Principles of Analysis and Synthesis.

(To be continued)

Akers – *Continued from page 10*

" . . . Business is built on trust, which depends in turn on honesty and sincerity"

Recently, two business school professors surveyed business executives about what they thought should be emphasized in the education of the entrepreneurs of the future. Somewhat to their surprise, 72 percent said ethics. Ethics could and should be taught as part of the curriculum, they said. One of the respondents summed it up with this comment: "If the free enterprise system is to survive, the business schools had better start paying attention to teaching ethics. The entrepreneurs of the future should know that business is built on trust, which depends in turn on honesty and sincerity." Well said.

So these are my three predictions: that the technology of our industry will continue to make dynamic strides; that there will be great elasticity of demand; and that the information processing industry can and must continue to merit the public's trust in order to continue to grow to its full potential.

This responsibility is not "someone else's job."

It is a direct challenge to each one of us, to you and me, to our companies and to the professional organizations that represent us. Let us give this task the high priority it deserves. Ω

Corrections

In the Sept.-Oct. 1984 issue:

1. On page 14, right hand cloumn, bottom third. The eighth argument against the Principle of No Action is garbled. It should read:

   - It cannot be applied to the problem of improvement of one's self, or one's family, or one's world: improvements require action.

2. On page 2, right hand column, last excuse in List 840903, should read, "Continued excuses form ...", not "Continued excuses from ..."

3. On page 15, right hand column, "The Long Neck of Giraffes" should have been underlined but was not.

We regret these stupid mistakes.

Newsletter — *Continued from page 3*

structor inputs "wrong," repeating this until the response is correct.

Unlike most computers cu rently in use, the memory capacity of the present system can be expanded step by step. As in the human brain, information that is used repeatedly can be retrieved very rapidly, while incorrect information that has been stored is not used and, in effect, "forgotten."

CENTRIFUGE AND COMPUTER MODELING AID IN UNDERSTANDING OF MINING PROBLEMS

Based on a report in Sandia Science News
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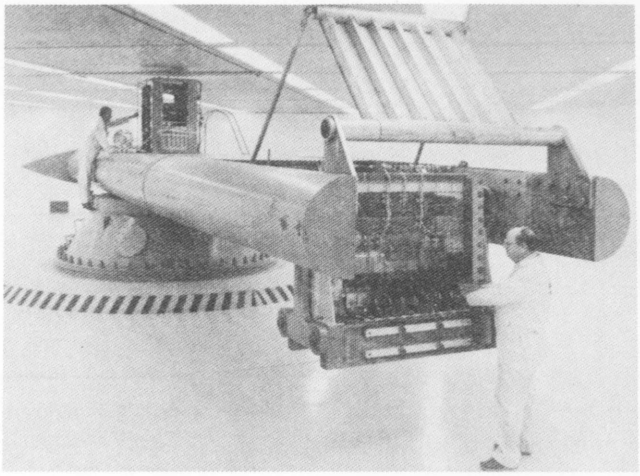
Tests conducted on a 25-foot-radius centrifuge are contributing to a better understanding of land subsidence, dam failures, and other related mining and civil engineering problems. The tests, sponsored by the U.S. Departments of Energy and Interior, involve loading scale models of coal mines, dams, or other earth structures in a compartment at the end of the centrifuge's arm and rotating the arm at speeds up to 155 revolutions per minute.

The tests, sponsored by the U.S. Departments of Energy and Interior, involve loading scale models of coal mines, dams, or other earth srtuctures in a compartment at the end of the centrifuge's arm and rotating the arm at speed up to 155 revolutions per minute. These tests simulate the high pressures caused by gravity and earth overlying the structure.

The centrifuge studies illustrate one way of modeling how a geotechnical system such as a coal mine, a section of gas-bearing rock, or an earth embankment dam can be expected to behave under different situations. Physical modeling such as this was established as a research/design tool in the U.S. during the 1930s. However, with the advent of computer modeling (the use of detailed mathematical description of a geotechnical system), it was virtually eliminated in this country as a research tool. That has not been the case, however, in Europe or the Soviet Union.

Centrifuge modeling has several major advantages. For instance, materials from the actual site or structure being analyzed can be used in the scale model. With these, the



A scale model coal mine is loaded in a compartment at the end of Sandia's 25-foot centrifuge. Tests on the model simulate high pressures caused by gravity and earth overlying the structure.

stresses and strains present at the site can be duplicated in the model and three-dimensional effects can also be readily observed. Also, because centrifuge modeling allows researchers to develop laboratory models of phenomena that normally only occur in the field, analysis is less complex than with computer modeling.

The strengths of centrifuge modeling coincide with the weaknesses of computer modeling. Consequently, centrifuge modeling helps to develop more precise computer models of complex geotechnical systems. Improved computer models, in turn, contribute to improved project planning.

A major contribution of Sandia National Laboratories' centrifuge modeling work occurred late last year when a computer model that was developed from results of earlier centrifuge modeling correctly predicted that subsidence would not be a problem following a major underground coal gasification operation near Centralia, Washington. Sandia engineers also believe that centrifuge modeling can play an important role in studies about more efficient oil recovery. Centrifuge modeling and companion computer models can also be applied to studies of radioactive waste disposal.

The centrifuge is located in an enclosed pit 80 feet in diameter and 12 feet high. Its maximum speed is 155 revolutions per minute. Up to 150 channels of test data can be acquired and reduced by a computer-based data acquisition system.

(please turn to page 28)

TREEPEOPLE USES COMPUTERS TO REACH OLYMPIC GOAL OF ONE MILLION PLANTINGS

Lori Sutherland
New Venture Communications
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One ambitious Los Angeles group reached its 1984 Olympic goal through the use of volunteers and computers. TreePeople, a non-profit organization, spent over three years coordinating involvement by Southern Californians in the planting of smog-tolerant trees in the Los Angeles basin. On July 26, two days before the opening ceremonies of the 1984 Olympic Games, the millionth tree was planted.

Andy Lipkis, founder of TreePeople, originally enlisted the aid of Californian politicians and Los Angeles newspapers to get surplus seedlings from the California Division of Forestry. Lipkis then persuaded directors of 20 summer camps in the San Bernadino Mountains to oversee mass tree plantings by their campers.

When Los Angeles was selected to host the 1984 Olympic Games, TreePeople (officially the California Conservation Project, Inc.) set its goal. In the Olympic spirit of peaceful ambition and competition, TreePeople decided to plant one million trees by opening day. To coordinate thousands of people planting thousands of trees, the organization needed, and received, a donated database management system and microcomputer time.

TreePeople's database used zip codes to keep track of the type and location of the trees planted. Every planting was reported by mail or telephone hotline and entered into the database. TreePeople knows when each tree was planted, its growth since planting, and its species. Predictions for future growth or problems can be made based on this data.

The database also generates a mailing list and prints mailing labels. It will soon be used to systematize the names of all 200,000 volunteer planters for inclusion on a monument commemorating the Olympics project. The monument will be a low, 100-foot wall adjoining the Olympic forest, which will have trees planted by a child from each country participating in the 1984 Olympic Games.

The database management software for this project was donated by Microrim, Inc., and microcomputer time was given by Inacomp Computer City.

COMPUTER "EXPERT SYSTEM" SUPPORTS TEXAS POWER PLANTS

Susan L. Howell
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Seven large turbine-generators at three major power plant sites in Texas will be the first in the world to be connected to a remote, central computer programmed with artificial intelligence. The system will enhance the operating performance of the plants by giving early warning of potential trouble.

The project marks the first application of artificial intelligence to power plant operations. It is also the first time that turbine-generators will be equipped with a diagnostic system which provides around-the-clock support. The system also provides maintenance planning assistance.

Based on original work in "expert systems" done at Westinghouse Research & Development Center, in cooperation with Carnegie-Mellon University, the system is highly advanced in its ability to analyze complex instrument readings quickly and accurately. It can then immediately prescribe action to be taken by plant operators.

Three power plants operated by Texas Utility Generating Company (TUGCO) will be tied into the Westinghouse Steam Turbine-Generator Diagnostic Center in Orlando, Florida, in two phases over the next three years. Initially, the Orlando computers will be linked to sensors and monitoring equipment already installed at the three sites and perform diagnostic work during normal working hours. When all Westinghouse instrumentation is installed by early 1985, the project will go into its final phase, full 24-hour operation.

The artificial intelligence system used to program the control computers organizes the knowledge of the best turbine and generator technical experts. The computer can draw on this knowledge to analyze the information coming from the power plant equipment -- data such as temperatures, pressures, speeds, vibration and radio frequency emissions. The goal of the system is eventually to tie the entire power plant -- turbune, generator, boiler -- into an on-line, continuously running expert diagnostic system.

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