

Engineers' Forum

VIRGINIA TECH

MAY 1994



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Engineers' Forum
VIRGINIA TECH
MAY 1994

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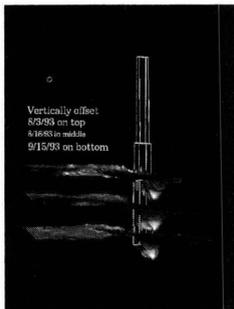
Job outlook bleak for graduating class of 1994

The roots of this recession we are in lie much deeper than the economic misfortunes of the past few years.

When you take a look at all of the graduating seniors of the class of 1994, what will you see? Most likely, it will be future graduate students and a lot of students with sketchy job opportunities. It is a rare occasion that you will meet someone graduating with a solid job lined up, and if you do it will most likely be a student at the very top of their class. The graduating seniors of the class of 1994 are ample proof that the recession this country is in isn't over, and it won't be over for a while.

The roots of this recession we are in lie much deeper than the economic misfortunes of the past few years. When this country began, it thrived on industry. Between the military, railways, airlines, infrastructure, steel industry, and automotive industry there were more than enough jobs to go around. America had a huge industry. America was also at the top of the field in each of those areas, and was at the forefront in the development of such everyday items as the automobile, airplane, television, telephone, refrigerator, and stereo. People were coming over by the boatload who wanted to get into the country. America was the land of opportunity. America was on the winning side in the first two World Wars. Everything in this country was running along great.

So now let's fast forward, say to the 1970's or 1980's. Our automotive industry has taken a turn for the worse. American cars cannot compete with Japanese or German cars in our own country. Our cars suffer in quality and the automakers suffer in sales. In the early 1980's, we almost lost one of our big three (Chrysler) to bankruptcy.



Vertically offset
8/3/93 on top
4/16/93 in middle
9/13/93 on bottom

ON THE COVER

The three meshes show channel scour on different occasions at the center pier of the bridge at the Chester, IL, crossing of the Mississippi River. The center mesh is at the correct elevation. (Created by Lisa Traub for the U.S. Geological Survey.)

EDITORIAL

Our railroad industry has dropped off; the country utilizes other means of transportation and all of the railroads across the country have already been built. Our steel empires that the Carnegies and Rockefellers built have virtually disintegrated. Our airline business is huge, but virtually no new planes are being built. Aerospace engineering is considered by many a dead end field. We have taken a big fall in the electronics industry. After virtually starting the electronics field, we have turned it over. The Japanese have taken over the field with such products as the Walkman, VCR, and CD player. We do have some electronics companies, but imports command a large share of the market. At least there was a booming defense industry to keep this country thriving, thanks to Reagan.

Of course, when the bottom fell out of the defense industry in the late 1980's, our economy dropped too. We have been in that state of recession since then.

Presently, there is not much in the way of industry in this country. There are lots of engineering consulting firms. There are lots of jobs that involve money and making money with money. There are many civil service jobs and blue collar jobs. The main exports this country is known for are our McRestaurants, rock groups, and fashions. This country just isn't thriving as a worldwide producer the way it used to.

This country needs to change its focus if it ever wants to support a thriving economy. A good start for all the private industries would be to follow the lead of the American automakers. The cars they are produc-

ing now are excellent and they are re-establishing their position as the top automakers in this country. After a long lapse, they are once again putting out cars that are at the top in performance and quality.

In the beginning of this country, there was a great expansion outward. Now there is a great expansion inward. Electronics, already a big part of society, will become an even bigger part as they become smaller and more powerful. The fields of communications and computers are areas where great advances will be made in the coming years.

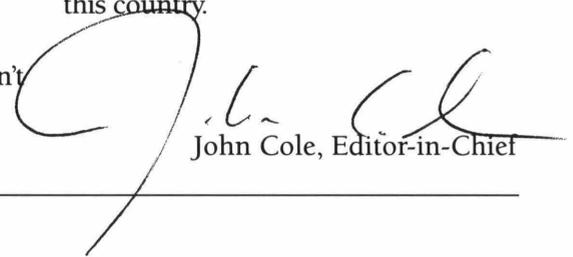
The government could do something to facilitate the development of industry in this country. Instead of increasing taxes, incentives to investing might work better. The government could also try to stimulate industry directly. The main thing the government seems to be doing now to fix the economic situation of this country is to instigate huge budget cuts to reduce expenditures. Budget cuts are certainly a start, but they don't generate income for a country.

In addition to cutting expendi-

tures, this country is also real concerned with social issues such as health care and the environment. What seems to be missing in the overall attitude of this country is the entrepreneurial and opportunistic spirit that turned this country into a producer of world wide proportions.

The fact that we're in a recession makes revitalizing industry that much more difficult. However, it seems if we could start making money as a country we could pay our way out of debt faster than by cutting everything until we save enough money. Making money would be an active way of tackling the recession instead of the present passive way.

The graduating seniors in engineering this year are the future of this country, especially when it comes to manufacturing and industry. The fact that a large portion of them cannot find employment after graduation should serve as a big warning signal to this country.



John Cole, Editor-in-Chief

The main exports this country is known for are our McRestaurants, rock groups, and fashions. This country just isn't thriving as a worldwide producer the way it used to.

DISASTERS: EARTHQUAKES

Earthquake research:

by Nathan Phillips and Jessica Smothers

Dr. James Martin in the civil engineering department helps with the worldwide earthquake problem by researching and analyzing the quakes.

I felt the floor shaking beneath me. When I opened my eyes, I saw the hanging lamp swaying in time to the vibrations. I knew it was an earthquake.”

How many people have experienced scenarios similar to this? Millions of people have been affected by earthquakes, especially in areas near active faults. On average, it is likely that there will be over a million shocks a year. Most of these aren't felt, but these odds also call for one great quake, 10 major ones, 100 destructive shocks, and 1,000 damaging shocks.

“On June 28, 1991 a quake hit the San Gabriel Valley at 7:43 a.m. At the epicenter it measured 5.8 on the Richter scale. It was felt from Santa Barbara to the Mexican border and as far east as Palm Springs. It was a rude awakening during a vacation to California,” said Jessica Smothers, *Engineers' Forum* writer, who experienced her first earthquake almost three years ago.

A more recent example of an earthquake's power was the one in January 1994 in Northridge, California. This one killed over thirty people and did between \$13 and \$20 billion worth of damage. With this level of destruction, researchers are especially

anxious to be able to predict where the earthquakes will occur and how strong they will be. But scientists are hampered in their predictions because of a lack of knowledge, they just aren't sure how and why earthquakes happen.

The ancients believed the earth rested on the back of an animal, the animal varying from culture to culture. In Japan it was a giant spider, and later a giant catfish. In South America it was a whale, and in North America it was a giant tortoise. Earthquakes were caused when the animal moved and shifted the earth. In modern times, the causes of earthquakes, while still unknown, are believed to be vastly different from ancient explanations.

According to *Encyclopaedia Britannica*, an earthquake is “a shaking of the ground caused by the breaking and shifting of subterranean rock under immense pressure.”

This idea supports the theory of plate tectonics: The earth is believed to consist of several layers. A molten core, a solid-liquid mantle, and a rigid crust are the three basic layers. The crust is not a solid shell, but is made up of a number of pieces, called plates, that “float” on the mantle. It is the shifting of these plates that causes earthquakes. How and why the

shifting occurs is the mystery.

The study of plate tectonics is still relatively new, the actual theory was not proposed until 1968. After only about 25 short years, this theory has been commonly accepted as fact (replacing the earlier Continental Drift theory). The young sciences of geophysics and seismology have also progressed dramatically, especially with the advent of computer technology.

Computers can quickly solve the large systems of equations necessary to trace the paths of seismic waves from an earthquake. Here at Virginia Tech, the civil engineering department uses a program called Shake to estimate how a given “stack” of soil will react to any given earthquake, depending on the make-up of each layer. Seismic waves will often partially reflect or refract on a layer, so these simulations can get complicated. Since hitting a soil surface can be similar to hitting a drum, the resulting vibrations can start new seismic waves, thus complicating the system further.

Finally, a layer of soil may completely lose its shear strength by liquefying. If it is near a body of water or close to the water table, the soil and water may mix into a soup consistency, further changing how seismic waves will react passing through it.

Dr. James Martin, a professor in the Civil Engineering department, does a lot of work with soil amplification and liquefaction. He states that, “...as a geotechnical engineer what I'm generally concerned about is the

DISASTERS: EARTHQUAKES

Trying to stop the disasters

influence of ground conditions on earthquake motions.” In a given area, different types of soil can have markedly different damage patterns — the stability of the soil can determine whether a building collapses or stands after an earthquake. Soil amplification can have major effects on the path and intensity of seismic waves, since a layer of soil could amplify or dampen a wave. As Dr. Martin states, “...amplification and liquefaction...are the two main issues associated with geotechnical engineering.”

Martin has done a lot of work with the Shake program, as well as other computer modelling systems. Although Shake only determines horizontal motion, it has been calibrated by enough field studies to be very accurate. However, in special instances, such as a basin or other non-uniform region, there are three dimensional programs available. The cost of these programs is very high, however, and they take considerably longer to run. Shake may take between 15 and 20 minutes to run; a three dimensional dynamic analysis of a large area (a few square miles) can take up to about 12 hours on a Cray supercomputer. If the soil behavior is considered non-linear, thus obtaining even more accuracy, the program will take considerably longer. After these analyses, geographical information systems are often used to see how the shaking affects roads, lifelines, buildings, and other structures. Similar programs have been used for years in environmental engineering, agricul-

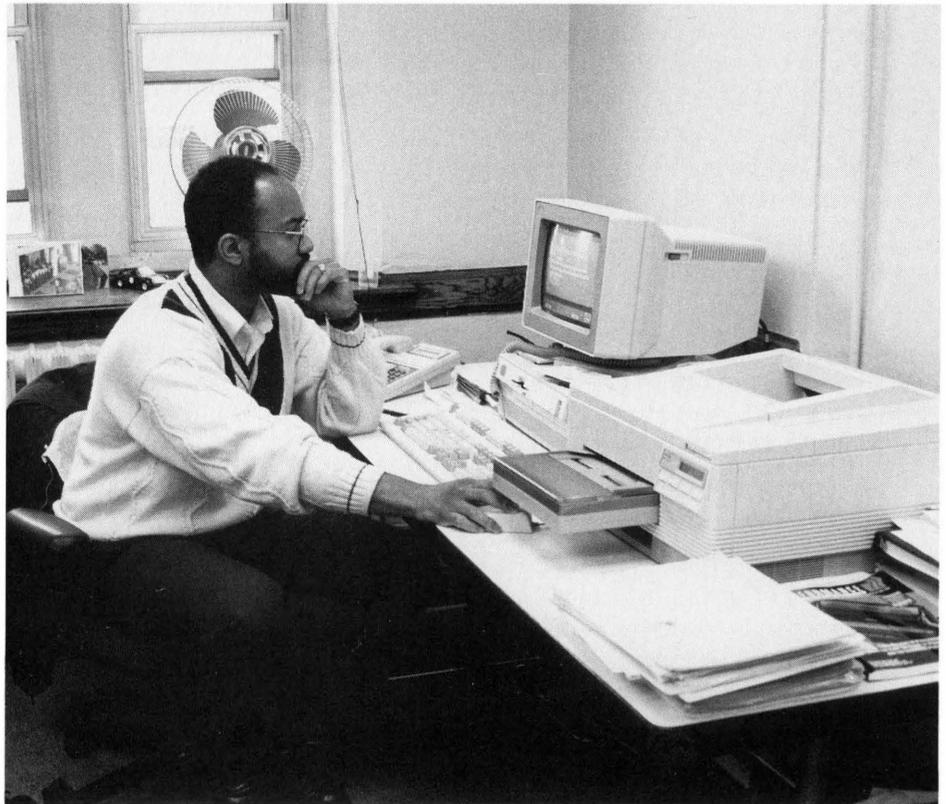


photo by Lisa Traub

Dr. James Martin at work in his office: “...as a geotechnical engineer what I’m generally concerned about is the influence of ground conditions on earthquake motions.”

ture, entomology, and in determining risk hazards by life and health insurance companies. By taking large amounts of data, probability tables can be generated. However, concerning earthquake analysis, Martin says that, “It’s new and it’s very difficult now to get systems that work, but we’re making progress.”

The future of earthquake analysis and predicting damage patterns will likely grow more accurate with every new earthquake that hits. Regional seismic networks have been proposed to

the US government, which would obtain much larger amounts of data and get considerably more information about the inside of the earth. Of course, such networks would be exceedingly expensive, but could eventually pay for themselves in minimizing damage from earthquakes. Such networks could also advance studies in predicting earthquakes, as well as help people follow safer emergency procedures. With more information and research, earthquakes may eventually become less of a hazard than they are today. **EF**

FEATURE

Program scheduled to begin in 1996

VCU builds an engineering future

by Jessica Wilt

With more than 850,000 residents, the Richmond/Petersburg metropolitan area is the largest urban area in the United States without an undergraduate engineering education program."

"Virginia Commonwealth University plays a significant role in providing a college-trained workforce, high-quality health care, and cultural enrichment for the Richmond area and the Commonwealth."

"The demand... for an increasingly skilled, technically-oriented workforce and the need of states and localities to pursue new economic development initiatives during the 1990s will increasingly depend on access to science, technology, and engineering in both academic programs and research."

"An undergraduate engineering program should be established in Richmond."

These compelling statements come from Dr. Frank A. Franz, president of the University of Alabama Huntsville, Dr. Robert R. Furgason, president of Corpus Christi State University

and president-elect of the Accreditation Board for Engineering and Technology (ABET), and Dr. James H. Woodward, chancellor of the University of North Carolina at Charlotte and the chair of the Visiting Committee. These prominent men were commissioned as consultants to study the feasibility of developing an engineering program at Virginia Commonwealth University (VCU). As it may appear, their decision was very favorable to the establishment of an engineering program.

Once an engineering program was deemed feasible and reasonable, plans begun. Dr. Eugene Trani, president of VCU, looked to existing Virginia state colleges for advice and involvement in the program's foun-

ation. He also looked at model programs experienced in this situation. Based on its world-class teaching and research efforts, Virginia Tech was asked to collaborate in the creation of the VCU engineering school. Tech's role is to assist VCU in establishing a high-quality program in a short amount of time.

The format of the new program is based on recommendations from the consultants, model programs, and colleges. Electrical, mechanical, and chemical engineering programs and an existing graduate biomedical engineering program will be offered. In 1996, when the program will begin, approximately 500 undergraduates will be enrolled in the program under the supervision of about 40

faculty. Virginia Commonwealth University will seek independent accreditation from the Engineering Accreditation Commission and the Accreditation Board of Engineering and Technology. The first class, graduating in the year 2000, will be awarded degrees equivalent to those awarded at Virginia Tech.

Even though Virginia Tech will play an important role in development, the new VCU program will stand-alone within five to six years. The faculty will report solely to the Associate Provost of Engineering at VCU.

It is an essential part of the agreement between the two schools that Virginia Tech is simply assisting VCU in getting the new program off to a great start. VCU doesn't want to copy the strong program at Tech, but instead to provide an engineering education that complements the strengths of VCU, such as the Virginia Medical College.

On January 20, 1994, Dr. Henry A. McGee was named Associate Provost of Engineering at Virginia Commonwealth University.

*With help from
Virginia Tech,
Virginia Commonwealth
University is creating a
new engineering school
in Virginia.*

McGee served for 23 years as a professor in the Chemical Engineering Department here at Virginia Tech, and as the department chair for 10 of those years. He has held a visiting position with the National Science Foundation (NSF) in Washington, D.C., and has done research for NASA, NSF, and the U.S. Air Force.

As associate provost, McGee will be in charge of curriculum development, administrator selection, and faculty recruitment. He is currently heading a major fundraising project, creating a local industrial council on science and industry, and setting up an academic planning committee consisting of faculty from all departments at VCU.

McGee is also overseeing the design of the new engineering building setting up a faculty planning committee with top faculty from the electrical, mechanical, and chemical engineering departments at Virginia Tech.

Virginia Commonwealth University is one of Virginia's three largest research institutions with approximately 22,000 undergraduate, graduate, and professional students enrolled. The combination of VCU's Academic and Medical College of Virginia offers 143 degree programs. However, the lack of an engineering program is seen as a flaw for

VCU and the Richmond area.

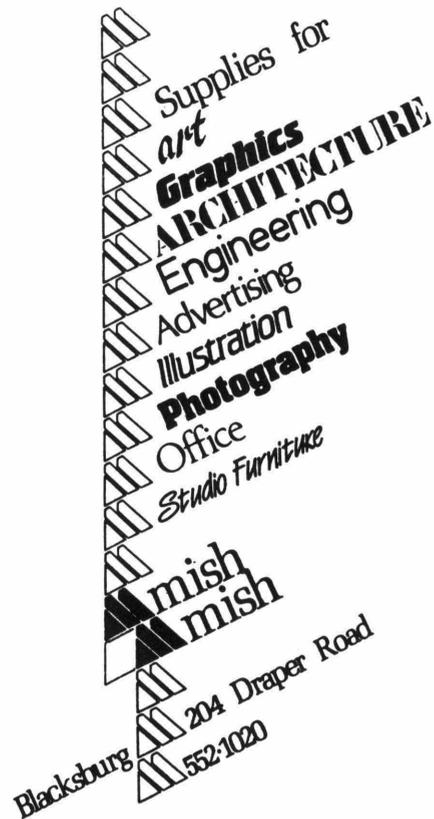
As James W. Dunn, the president of the Greater Richmond Metropolitan Chamber of Commerce put it, "High tech companies looking for a place to expand require a strong local engineering education program." The creation of an engineering program would greatly benefit the economy of VCU, Richmond, and the Commonwealth.

Virginia Commonwealth University already supports the Virginia Biotechnology Research Park, a joint effort involving VCU, the city of Richmond, the state of Virginia, and the business community designed to increase economic development through the growing biotechnology industry.

One of the program's greatest attributes will be building relationships with industry in the Richmond area, a high priority of the new program. For prospective students, this will mean valuable real-world interaction with the private sector.

On the industry side, high-tech businesses value an educated work force and an education infrastructure.

The VCU engineering program has the potential to make the Richmond area a technologically advanced, economically strong and prosperous hub of engineering. **EF**



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DISASTERS: FLOODING

Modern technology allows scientists

by Lisa Traub

The use of scientific visualization is on the rise as the scientific community begins to see it as a tool to analyze and present data in a more efficient manner.

According to Ronald Kriz, the Director of the Laboratory for Scientific Visual Analysis at Virginia Tech, in visualizing their data, scientists do not expect to find anything new, but this can be far from the truth.

While designing a submarine in a group project for graduate school, Commander Debra L. Deacon, USN, accidentally designed in a large bulb on the side of the vessel. Through the use of visualization they would have been able to see the mistake early on, not at the time the model was being built. This would have saved her group time, frustration and, in the professional world, several million dollars.

According to Tom West in the magazine *Computer Graphics World*, November, 1992, In the 1870s at Yale University, J. Willard Gibbs developed a complex mental model visualizing the interaction of thermodynamic property variables. Today this can be done through the use of computers.

As a co-operative education student at the United States Geological Survey, I worked with raw channel bathymetry and water velocity data to enable its visualization. The data was collected on a five-mile reach of the Mississippi River at Chester, Illinois during the flood of 1992.

There were many different software packages available for this, all with different features that make them better for different types of visualization. These packages include AVS, PV-Wave,

PLOT3D, SGIs Explorer and Spyglass Transform.

AVS, by Advanced Visual Systems, is one of the most versatile of the commercial packages. It allows the user to incorporate other software packages and user written routines into the program. At the North Carolina Supercomputing Center (NCSC) there is a depository of hundreds of user written modules that

One interesting discovery that would have been difficult to see without visualization showed that the water was moving almost perpendicular to the river channel at the peak of the flooding.

be obtained to accompany the original AVS package. These modules range from general all-purpose types to those that are specific to a project. Because of this flexibility, AVS was chosen as the program to use.

AVS has a large learning curve, but once educated in it, AVS can be a very powerful tool. The most difficult part to understand is data input. To truly know what is going on with data input, knowledge of computers and computer science helps.

There are a series of commands in AVS that tell the computer what to do with the data. The two most confusing of these is *n*space and *ndim*, which describe the dimensionality of the data. At first it looks as if both describe the same traits, but they are truly different. The variable

*n*space tells the number of dimensions in space the object resides in. Thus, if looking at the combustion inside an engine, its *n*space would be three because it occupies three dimensions. The variable *ndim* describes the number of dimensions of the array structure the data is stored in in the computer. If heat data from the above example was collected along one plane, the value of *ndim* would be two, so the data would be stored in a two-dimensional array. If the data was collected along multiple planes, then it can be stored in a three-dimensional array, making the variable *ndim* three. If the data is in three-dimensional space and is randomly placed in that space then it would be in a one-dimensional data array, not three, but its *n*space would be three.

The scientist also has to understand the difference between real and double data types. A real is stored as an exponential number, an eight bit base number connected to an eight base exponent. A double is real with double the number of bits to store the base of the exponential number. This allows for more precision in the base. This is needed when working with very large or small numbers, in which all of the digits are significant.

Some of the modules used in producing the various images were Field to mesh, transform xyz and show flow. Modules in AVS act like procedures or subroutines in computer programming. You connect the modules up in the order that produces the desired result. The Field to mesh module inputs a two-dimensional data field and outputs a mesh triangulated out of the points in the two-dimensional grid. The mesh triangles are set to the color

DISASTERS: FLOODING

to visualize potential flood damage

that corresponds to the average value from the colormap previously generated. This module has a user defined value for the z-scale. When this was first encountered, it was assumed to be the vertical exaggeration scale or the percentage of exaggeration in the z direction. The z-scale turned out to be the number of units high, from the lowest value to the highest, that the mesh would occupy. From this, one could determine the exaggeration used or set that value. The vertical exaggeration of the mesh would cause anything that was to be placed upon it to have the same exaggeration.

For the bridge piers and deck, a

module was written to combine a line drawing routine with a module that shifts the coordinates of the points in the data field. This new module would allow the points to be read in and shifted, then drawn out in an appropriate manner. The module show flow was used to see the water velocity vectors on top of the bathymetry, which was a mesh. The module show flow is one of the modules that is available at the depository at NCSC. It was written to be used with meteorological data, making it more versatile than the similar one that came with the AVS package. The show flow module allows for multiple types of

data fields to be inputted, allowing the arrow, or barb size, to be set. This permitted me to display the scattered velocity data that I had.

One factor I studied with the help of visualization was the channel scour created by the piers. The shape and size of the scour holes were compared on the days that data was collected. One interesting discovery that would have been difficult to see without visualization showed that the water was moving almost perpendicular to the river channel at the peak of the flooding. While the river channel went from the northwest to the southeast, the water

Continued on next page

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Flooding

Continued from previous page

was flowing from the north-northeast to the south-southwest at the bridge.

By visualizing the data, many tasks in the analysis of the data were made easier. One of the many things that needs to be done after a flood is for someone to look at the level of the pier bottoms in relation to the level of the river bed. Using visualization techniques makes it quicker to see which piers may need more study to see if they have been undermined or not. Scientific visualization techniques can be applied to many other data collection projects. Many years ago, scientists and data collectors had to visualize their data mentally, but now computers are invaluable in this task. Scientific visualization will change how scientists and engineers conduct research while also making their results more accurate than ever. **EF**



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BLAST FROM THE PAST

New systems demand new technologies

When a freshman enters the engineering program at Virginia Tech, they must enter with a computer. They can buy it on their own or buy it from the bookstore, but they must also buy the software, including operating systems, word processing, and CAD systems. The requirements for entering freshmen's computers have also gone up over the years. Today's systems are powerful and they are also indispensable. However, that wasn't always the way it was. This article is reprinted from the January 1938 issue of The Virginia Tech Engineer.

White Magic

[This article appears in response to popular demand for information concerning slide rules and their uses]

It is almost imperative that every engineer own and know how to operate a slide rule. Slide rules may be obtained in many different styles and sizes. Since the accuracy of the rule varies directly with the length, only convenience of handling limits the size. The style of rule used is determined by the type of work to be done with it. However, the student engineer at Virginia Tech will be served well by at least one of the three types described in the following paragraphs.

The simplest of these three is the polyphase duplex slide rule. It can be used for multiplication, division, determining second or third roots, and raising numbers to the second and third powers. In addition, it can be used to determine approximately the trigonometric functions of angles and logarithms to the base 10. Practically all problems presented to students in civil, architectural, industrial, and mining engineering may be solved by the use of this slide rule as quickly as with any other. Moreover, this is the least expensive of the group.

The log log duplex slide rule is preferred by chemical and general engineering students and is essential to mechanical and agricultural engineers. It

has all the advantages of a polyphase duplex plus a scale which makes it possible to take any root of a number, or to raise it to any power. It also permits determinations of logarithms to the base e (2.718281830) which are frequently encountered in engineering calculations. Complicated empirical equations involving fractional powers may be solved by a few simple movements of the slide. This rule is slightly more costly than the polyphase duplex but well worth the extra expense to those who need it.

The electrical engineers are solidly in favor of the log log decitrig rule. This rule has all the scales of the log log duplex, but the trigonometric scales have been expanded, rearranged, and divided into degrees and decimals of a degree. This change expedites the solution of a right triangle — an important feature in vector problems, which appear frequently in electrical engineering. This slide rule can be had for about the same price as the log log duplex.

The earlier the student learns to use a slide rule and depend on it, the sooner he will be a good engineer. Problems which would take hours to work by ordinary methods may be solved in minutes by use of this magical little piece of enamelled wood.

DISASTERS: BACK-UP SYSTEMS

Thinking about engineering backups to everyday systems

by Monta Elkins

*The power went out. No lights, no water, no heat
and the temperature went well below zero.*



photo by Lisa Traub

*Trees weren't the only living things that suffered during last
winter's ice storms.*

I'm getting cold, and the freezer is getting warm. Everything glistens with an inch of ice but the stores are sold out of it. My wife, son and I were in the middle of the worst storm in recent memory, along with more than 200,000 people without power. It was time to think about backups for everyday systems; it was PAST time. Systems we all take for granted.

Think about backups to everyday systems. And when/if you design products, let the ghost of "backup" haunt your thoughts.

Why worry about backups? You say you made it through the storm o.k. It's possible you didn't even lose electricity. Besides, these storms are once-in-a-lifetime events... right?

Well, maybe — but there are many more types of disasters than "freak ice storms." Earthquakes like those in California had those folks scrambling for backup systems (including basic shelter). Tornadoes are not that uncommon. North Carolina was recently reminded that tornadoes are not to be forgotten. Then there are the man-made causes. Riots (California again), war (Bosnia),... terrorism. The U.S. has been rather fortunate with regard to terrorism, with only the World Trade Center bombing in recent years, but these activities could increase. Living/working in another country could increase the changes of terrorist activity significantly. Don't forget that some countries have been blasted back into the middle ages for periods of months or years. (Can you say "Iraq?" How about "Bosnia?") Ignoring the riots in L.A., armed insurrection is as close as the uprising in Mexico.

So far I've mentioned malicious causes. What about the benevolent

DISASTERS: BACK-UP SYSTEMS

ones? Virginia Power imposed “rolling blackouts;” intentionally turning off power to different areas for 15 to 30 minutes. Their peak demand for electricity was 15,000 Megawatts (!), which exceeded their previous record peak by 10%! The rolling blackouts were to keep the entire eastern power grid from collapsing.

Levels: Goals and costs

There are many levels of backup preparation. One must consider the goals and the costs. At the lowest level is physical survival. (Pardon me, Abraham Maslow [1908-1970], for adapting your hierarchy of needs.) If physical security is your only concern and the problem is a 10 minute blackout, the solution is “Sit still and breathe.” It costs virtually nothing. Just don’t walk around, so you don’t fall down any steps, and you should survive. Surviving at home is just as simple.

“Security and Safety” is the next level of consideration. Emergency battery-powered lights should provide enough light to move around or leave the building (in case the problem is greater than “10 minute blackout.”) The costs are not that high; the lights only need to remain lit long enough to safely leave the building.

At the next highest level, “Comfort & Competence” (or the ability to continue work), the lighting requirement, for example, becomes much greater. It takes much more light to do “real work” than it does to survive and the costs escalate quickly. A gasoline-powered generator is probably in order.

Of course, at each of these levels, extending the time period from minutes to days will considerably increase the costs. I will not consider

higher levels of backup protection. My justification is that while disasters do happen in today’s society, the likelihood of long term (> three months) consequences is low and the costs of preparation are very high. Your risk-coverage/cost estimation may be different. You must balance the cost of preparing for disaster with the cost of not doing so.

Disaster example (too) close to home

The recent ice storm is a good example for talking about backups for systems. The lifeblood of our society seems to be electricity. Remove it for an extended period (try five days or more) and you’ll understand. Some consequences were not so severe. Walking into the local video store with my VCR tucked under one arm announced my problem. I had movies due and when the day came to return them I was still without power. The tape was in the machine and the only eject mechanism was electrically powered.

If it is ever your job to design a recording device with removable media, consider the problem of disaster situation media-removal. In my case, the costs weren’t very high (I might have to pay to rent a video a few more days) and the solution was relatively simple (carry the VCR to the store where there WAS power.)

In other situations this problem could have higher costs. Let’s imagine a tape backup for a financial institution in California. Millions of dollars depend on having daily access to the information. Now assume that the primary insurance against disk crashes, the tape backup, is built into a large cabinet for security reasons and the threat of earthquakes. Whoops.

Now when the quake/fire/riot comes AND the power goes off, what happens? You don’t want to have to find a forklift to move the cabinet onto a truck and drive it to your branch office in New York. I hope the engineer designed an easy way to remove the tape from the device (without destroying the tape) without power. Air mailing a magnetic tape is much quicker/easier and cheaper.

During this time, being without electricity for five days, heat was a serious concern. The outside temperature was well below zero. We used a kerosene heater to keep warm. I even mastered the art of cooking on top of it. With the heat problem temporarily solved, the more difficult problem was staying cool. For longer term backup plans (oh, say FIVE days) you must also consider food. I pulled the food (which was quickly thawing because of the kerosene heater) out of my freezer and packed it in the bathtub. I surrounded it with ice I shoveled up from outside and mixed with rocksalt to keep it well frozen.

Backups for the backups

I’m quite conservative and had prepared for three days without electricity. For my small residence, 10 gallons of kerosene was enough to heat for three days as a backup to my electric heat. After the primary system went down (the electric power grid,) people scrambled for secondary systems. These, too, were exhausted and became scarce as the stores sold out of batteries, candles, flashlights, etc. During the disaster was the worst time to engineer some tertiary systems.

Many stores sold out of kerosene. Fuel companies delivered only ra-

Continued on next page

DISASTERS: BACK-UP SYSTEMS

tioned, minimal amounts. Hotels and motels throughout the area were filled to capacity, sometimes leaving the managers in a quandary. Some businessmen flying in from other parts of the country had reservations in rooms that were filled by local residents. Ignore reservations placed in advance, or kick out local residents without heat at

home? Not much of a choice for the managers. I wonder if their backup plans will change. The real point is that planning for disasters is best done BEFORE they occur and don't depend on someone else to provide the solutions for you.

Many water supplies (including mine) were dependant upon electricity. My "three-day supply" of bottled water wasn't enough. Although melting the snow and ice seems like a good idea, it just wasn't practical. It takes too much heat/time to get any water. I managed to catch water that melted from the snow on the roof (with the sun's help) for sanitary needs such as washing and flushing. As with many other items, most people considered Kroger as their backup systems but the shelves were quickly cleared. Fortunately, the roads were clear and emergency shipments to local stores were possible. Otherwise, the situation could have been much



photo by Lisa

Before there were computers, people used pencil and paper to record transactions. The earliest radios were battery powered. (The only news I got during the storm was from my nine-volt powered cheap transistor radio.)

Battery powered AM/FM radios are available for under \$10. If you don't have one at home, go buy one. Do you have

worse. Don't depend on Kroger, the government, or the tooth-fairy for your emergency backup plans. Engineer them yourself.

Look to the past for backup solutions

For backups to many of the everyday systems we use, we need only to look into the past. For longer-term food backups, canned items or a firearm would be useful. Before Kroger and large police departments, firearms served to gather food and as protection from four- and two-legged animals. Squirrel and rabbit were common foods. It was said my great-grandfather, Christopher Columbus McCoy, cooked a mean ground hog and it was his kerosene reserves that helped my parents through recent storms.

Kerosene lamps served for light. Spring houses and cellars were used to keep things cool. Meat was smoked or salted to keep it from spoiling. Vegetables were canned in glass jars.

matches? Are they "somewhere in the junk drawer?" Can you find them in the dark? What about your flashlight? Where are the disaster plans for the equipment you design or use?

During the recent ice storm, I was prepared for extended periods of basic lighting with kerosene lamps. They burn for many hours on a few ounces of kerosene or lamp oil. But I was not as well prepared as I thought. I found out that it was hard to get real work (reading/studying) done with kerosene lamps. For short periods, the lamps could be augmented with flashlights, but mother nature conspired against me and we were without power for five days. I was not so well prepared for this duration. I did manage to get by, by using 12-volt yard lights with the (large) rechargeable lead acid cells from my son's favorite riding toy: a battery-powered "Big Foot" truck. To really respond at this level, you're probably talking "gas-powered generator." But it gets expensive quickly. Powering lights isn't so bad @ 100

DISASTERS: BACK-UP SYSTEMS

watts each, but other equipment can quickly tax a 4000-watt, \$700 generator. Then you must also consider gasoline supplies. The point here is that backup systems should be tested before they are required. Do you really want to be the first to test an automatic landing system in an airplane during a zero-visibility storm? Better to test it when you can "fall back" on the primary system, or wait until the bugs are worked out.

I thought that the chances of our great society doing a poor imitation of Iraq after Desert Storm were virtually nil. I was wrong. Dwellings were damaged as ice-laden branches fell through the roofs of mobile homes. The secondary roads became impassable — not from ice, but from fallen trees and branches. I would

suggest that not only systems designed for pay should have adequate backups, but also homes as well. The preparation of creative and diligent individuals is much more effective than any government plan can be. During the ice storm, the National Guard troops could do little to keep everybody warm and comfortable. (Even the mighty 4-wheel-drive Hummer doesn't get much traction on ice.)

Updating backup systems

Every disaster recovery plan should be reviewed at least annually. Even if the rate of consumption of resources has not changed, the expectations for quality or length of service during a disaster may have. Also, some backup devices and supplies may need to be maintained or

replaced. Batteries lose charge and capacity. Machines rust. Perishables, do. Animals or insects may decide that the carburetor of your expensive, impeccable emergency diesel generator makes a lovely home. Annual reviews should check for these problems. Backups are equally important at work and at home. Your company may not survive being unable to conduct business for a month. You may not survive not eating for a month. Some preparation by everyone makes removes an incredible burden from official or government emergency systems.

Multiple points of failure

Good friends of ours used natural gas to heat their home and their water.

Continued on next page

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Neither their gas service nor their water service was interrupted during the storm. They were all set, right? Wrong. While their heating relied on gas as the primary fuel source, it also required electricity to start and circulate the air. When the electricity was lost, so was the heat. The heating system had two major points of failure: loss of gas and loss of electricity.

When designing critical systems, watch out for these interdependencies. It would have been better if the heating system could have performed (at reduced capacity and efficiency) by allowing a pilot light to be lit by hand and the air to circulate by convection. Of course, such a system could still be derailed by "a really efficient super nifty-neato" computerized thermostat designed to turn the heat up in the mornings, down during the day and fail totally during a power outage.

Sharing the costs

In any case, they could take hot showers (by candle light) but then they froze. After three days, we decided to get together and share resources. They had water and HOT SHOWERS! (By the third day, I was really missing running water.) We had a kerosene heater and lamps and my "supplemental" battery lamps. By this time, I was tired of cooking on cookie sheets on top of the kerosene heater and had dug out our propane cooking stove. We brought that as well. Sharing resources allowed us to all to get along better.

Although you must plan backups for everyday systems, you need not provide all of the resources by yourself. For instance, your company in New York might arrange with a company in Orlando to share some computing resources in the event of an emergency. Reciprocally, you may agree to provide 10% of your computing resources to the other in the event of an emergency. Or you may decide to split the cost of maintain a small office in Richmond where either could move to in case of disaster. (Of course, you must consider what happens if you both happen to experience a disaster at the same time, but given appropriate geographical locations you can minimize the risk of this happening.)

Think disaster

Always consider what may happen when the systems you depend on fail. The question is not "IF" they will fail — only "WHEN" they will fail and what the cost of that failure will be. Preparations are MUCH more easily made BEFORE the disaster happens. And don't forget that in most instances, history can provide the solutions of how to survive without high-technology. **EF**



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1. Thou shalt not forget thy Social Security/Student Identification Number.
2. Love thy periodic table and derivative/integral tables.
3. Let not the residence hall food distress ye, for in time thou will grow used to it.
4. Thou shalt not procrastinate with your studying, lest ye be left cramming.
5. Thou shalt not envy a Liberal Arts student's workload.
6. Thou shalt seek the advice of upperclassmen in the engineering curriculum.
7. Conserve thy strength for the unavoidable all-nighters.
8. Honor thy professor who giveth thou thine grade.
9. Thou shalt become a weekend studier, for then ye will inherit the A's.
10. Forget ye not to recharge thine calculator, lest it faileth thee on Physics exams and giveth thee strange and ungodly answers.

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INVASION: The Bradley Experiments (Part I)

by Rich Parish

All I could remember was the sound of the old man's voice. "Don't go near the Two Place!" I recalled the near-dead raspy voice ordering me. "It is full of danger. That river is no place for a child like you. It's no place for anybody who wants to live." I could not understand what he meant. I went down to the Two Place everyday. There was no danger in standing on the shore, fishing. "Many unexplained things have happened down at that river. It's ruined people's lives; made them crazy. Don't you ever go near that place!"

"I've never read anything in the news about Two Place." Unwilling to heed the old man's words, I took my daily venture out to my favorite spot on Two Place. My special place was a small sandbar completely isolated by the forest. The nearest road was at least a mile away, and after five years of coming here, I still had not seen another person near this part of the river.

I tried to keep my mind on fishing, but it kept wandering over to a new pile of sand. How neat it would be if I could dig a really deep hole in the sand, and store my fish there. I could even put in doors on the way

down, to discourage any intruders! Over the next few weeks, that was exactly what I did; the old man's words had been completely discarded from my mind. The day after I finished it, I began to fish again. Any fish that I caught I would throw into my cave.

A month later, though, I was fishing when my eye caught something new glinting in the sand. I tried to take my mind off the glint and concentrate on fishing, but my curiosity was too strong. I walked over to that shining object and dug it up out of the sand. It was a dull and smooth metallic sphere; I could not see my reflection in it, but it did seem to gently mirror the general color of the area. It looked quite interesting, but I quickly lost interest in it, and I tossed it across the river, putting the situation out of my mind. I climbed into my hole, closing door after door behind me. I had installed a few battery-run spotlights, and I saved up my allowance to buy many extra batteries. I must admit, I was pretty smart for a kid of thirteen.

I had just sat down to read Piers Anthony's latest paperback when I felt an odd chill settle over me. My little cave was not soundproof, but I realized I could not hear any noise

coming from outside anymore. Then suddenly I knew what had happened. I did not figure it out; the fact just came to me, as if it was planted in my brain. I know that I cannot go up anymore. I will have to stay here until I die, unless I go crazy and actually leave this space.

mmmmmmmmmmmmmmmmmmmm

One Year later...

"The humans have been taken care of, sir."

"All of them?"

"There is a 99.5% probability that all the human beings have been wiped from the Earth."

"You mean there may still be some left?"

"Well, that's highly unlikely."

"But there still may be some. We can't occupy a tainted planet. All the humans must be destroyed before we can live there. How are we expected to colonize a planet that already has a strong ruling force?"

"Sir, I'm sure they're all dead. We should start colonizing immediately."

"I am not taking any chances. Send teams to sweep the Earth for humans. And get me Dr. Bradley; we may need another one of his life

cleansers. By the time we are done, the human race will be extinct.”

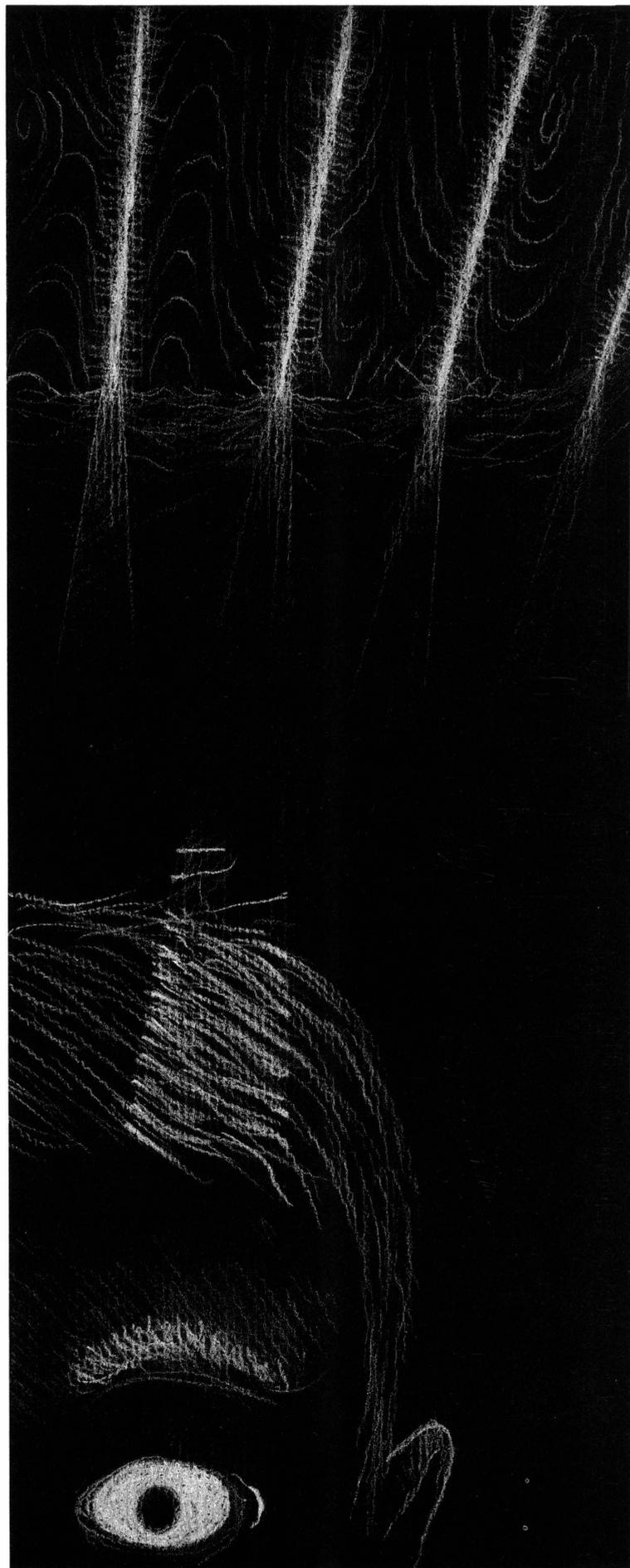
He walked down the narrow corridors of our ship, en route to Dr. Bradley's quarters. After all, an order is an order, and he was expected to obey it. But Celone knew there would be a problem. Dr. Bradley had only built one life cleanser, and it had already been used to exterminate the humans. It could take years for another one to be built, nevermind all the time necessary to find out what the flaw was in the first cleanser; and the blueprints for this device were not even kept on the ship with them. The plans would have to be sent from the home planet, and that would take another year, at the very least. Celone knew that he had no say in the matter though. He may be related to the Overlord, and he may be poised to take over that position in the future, but none of that matters when you're light years away from your home. Here he did not matter any more or less than the pilot or the cook. And when he was given an order, he was expected to carry it out.

After a few more minutes of thought, he reached Dr. Bradley's room. He rang on the signaler to let the Doctor know he had arrived. No response came from within the room. Celone pulled out a device shaped similar to a fork and started to speak into it. “Captain, there's no answer from Dr. Bradley when I call for him at his door. What should I do, sir?”

“I'll give you permission to override the security for his room. I want you to do a complete search of his room. He was just there a few minutes ago, so there's no reason he shouldn't be answering, and he knows that all personnel are confined to their quarters during the pre-meal hours. If he's not there, then we'll start a full search of the ship for him.”

“Thank you sir.” Celone looked into the digital micro-camera, giving it a chance to read his eyes, then he touched the pad next to the door for print authorization. As the captain had promised, he was allowed into the room, even though his statistics did not match Dr. Bradley. The small door opened into a large chamber, larger in appearance than the rest of the ship. Celone knew that parts of the ship were under the control of a newly developed spacewarp drive, but he never realized just how useful this could be. By using that device, Dr. Bradley could live in a mansion just like the one he had on his

Continued on next page



SCIENCE FICTION

home planet. Meaning that the search of his quarters was going to take Celone a long time. From the main chamber branched three passages: one to the right, one to the left, and one right in the center, heading upwards. Celone decided to start with the right passageway, which, by decoration, looked like it led to the sleeping quarters.

There were several subpassages off this corridor, and quite a few closed doors before Celone reached the ornately decorated entrance to Dr. Bradley's sleeping room. He slid open the stone slab that blocked the way, and walked into the bedroom of the legendary Dr. Bradley. In the middle of the room was a large raised platform with green woven sheets laying on it. And there was a lump under the sheets.

"Dr. Bradley, sorry to disturb your sleep, but you were not answering the door, and your services are needed by the Captain immediately. If you would care to get dressed and come with me to the command center, sir. I'll wait outside your room until you are ready, then I will

accompany you to the presence of the Captain." Celone was about to turn away and leave the doctor alone, when something odd struck him. For some reason, Dr. Bradley did not seem to be moving. Usually, when one was asleep, you just had to look at the posterior region to see if they were alive or not. Dr. Bradley's posterior was not moving an inch. Celone walked up to the platform and removed the sheet that was covering the doctor.

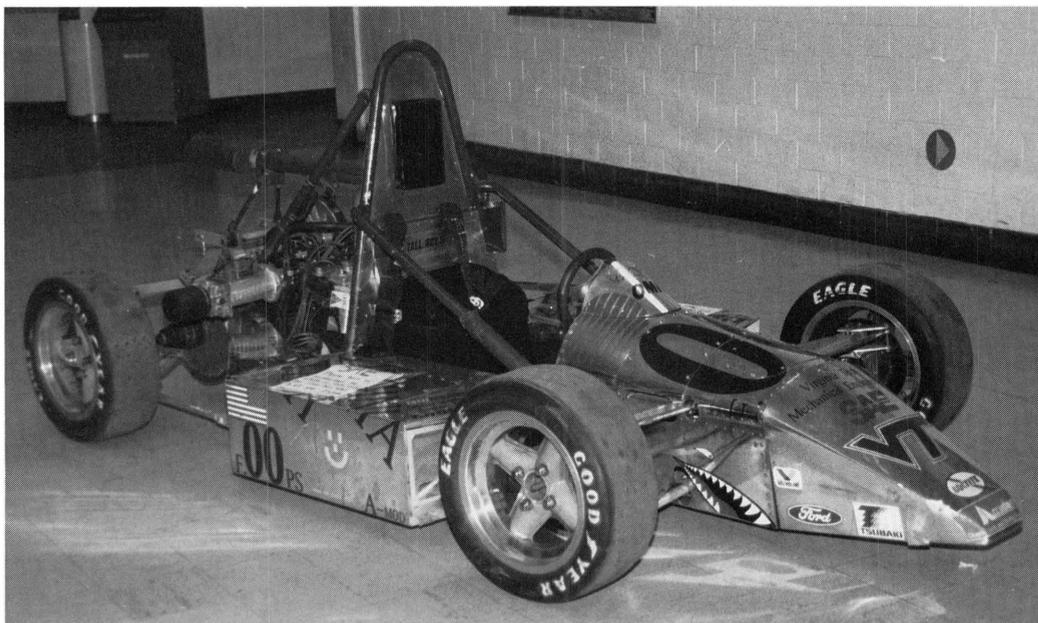
"Sir, it would appear that Dr. Bradley is dead."

MMMMMMMMMMMMMMMM

After two years, I have to admit, I must be going crazy. I've been eating fish for two years straight. I managed to dig a small hole in the sand that went below the water table, giving me fresh water to drink. I keep seeing things out of the corners of my eyes that are not really there. And what's worse, just a minute ago, I could have sworn I heard someone knocking on the outermost door. That

was just a minute ago. I want to go check it out so badly, but what if it's some hideously deformed beast that will kill and devour me the minute I step foot outside of my room here. But if I don't go outside soon, then I'll definitely go completely mad. Maybe it's better to die in the jaws of another animal than it is to go crazy down here. I think I have decided; I have no real choice but to go and see who it is. I mean, it could be another human. That is pretty unlikely, but the human race getting destroyed as quickly as the dinosaurs was pretty unlikely, too. I started going through the doors slowly. No need to rush anything. If they have important business then they will wait till I get there. And if not, oh well. My life wouldn't be for the worse. Except that I would still be alone, and I would probably still spend all my time in my little hole in the ground. Well, it looks like I have reached the last door. Time to see what awaits me on the outside.

To be continued.....



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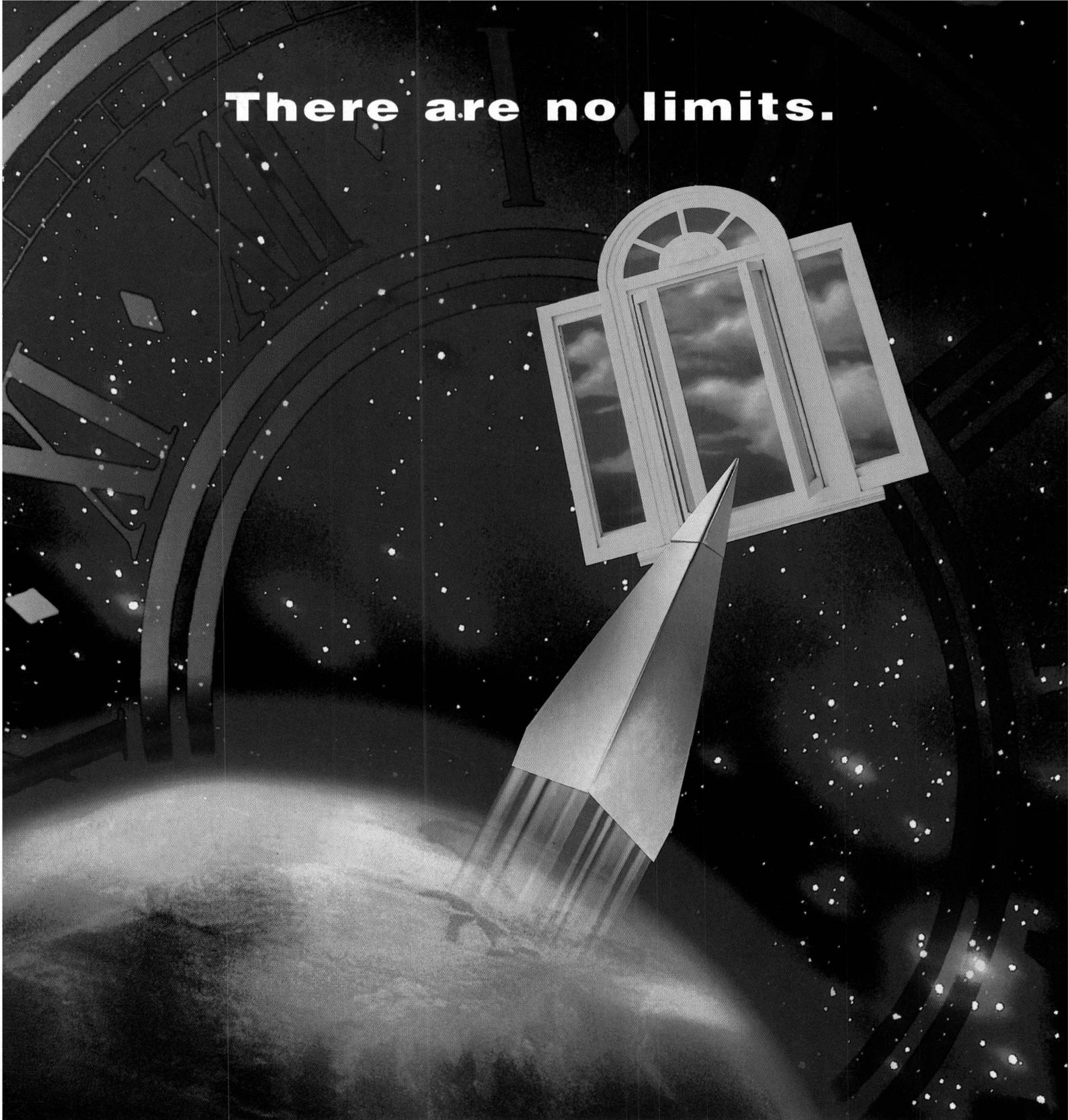
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