Engineers' Forum

VIRGINIA TECH SPRING 1984

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Engineers' Forum

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On the Cover
United States Gypsum Plant in Ripplemead, Va.

Photo by Michael Dietrich

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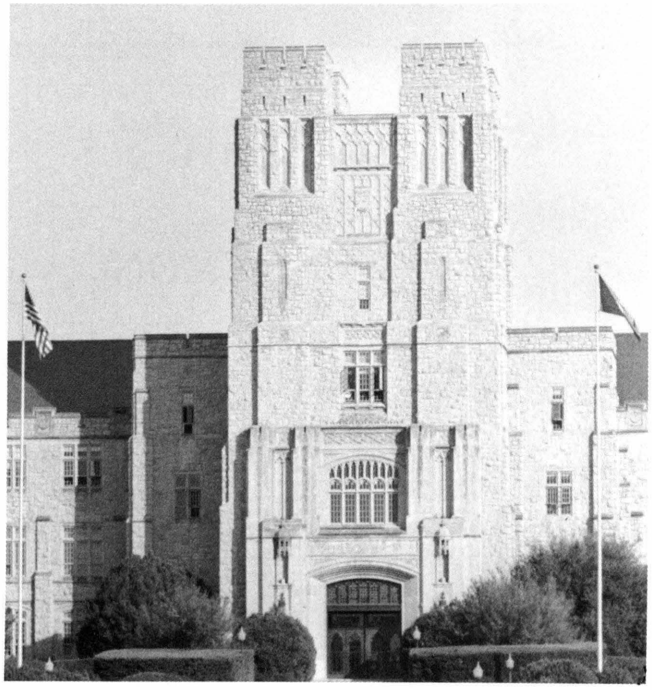
EDITOR'S PAGE



M. Hill

This issue brings to a close the second year of publication for the *ENGINEERS' FORUM*. The magazine was first introduced to the College of Engineering in 1982-83 academic year by Niall Duffy. Since then it has become the major student publication in the College of Engineering. Highlights of the 1982-83 year included publication of three issues and introduction to the Engineering College Magazine Association as associate members. This academic year full membership in the Engineering College Magazine Association was a significant event. Full membership in the coming years will allow Va Tech's engineering magazine to compete for awards.

This year's *ENGINEERS' FORUM*, in addition to attaining national collegiate recognition, increased its distribution to Va Tech students and published the largest issue to date.

Thank you and Congratulations to this year's *ENGINEERS' FORUM* staff for a successful year. I wish the best of luck to next year's staff. I would like to thank Amy Dare and the Student Engineers' Council for their support throughout the year, Dean Torgersen and the College of Engineering for making it possible to send representatives to this year's Engineering College Magazine Association Convention, Greg Feron and Bassett Printing for their patience and advice, Lynn Nystrom for her confidence in me and the entire staff,and all the individuals who contributed their time and talent.

I would ecspecially like to thank Michael Dietrich for the many long and sometimes difficult hours he gave to this year's magazine. I am confident next year's *ENGINEERS' FORUM* will be even more successful under his leadership. I would also like to congratulate him for being selected this year's Most Outstanding Staff Member. Good luck to all next year!

How Come Nobody Told ME?

by Willie O. Moore

In a few short months, many of you will be graduating with high hopes and expectations. A lot of you have been led to believe that your actions are going to change the world for the better. The truth is, less than one percent of you will ever have an impact on how others live.

Consider the recently announced 50 million dollar fund raising campaign headed by some of VPI&SU's most successful graduates. Their accomplishments are truly impressive and read like a Who's Who in America, but these are only 25 out of over 50,000 graduates listed with the Alumni Association of VPI&SU. Figure out the odds for yourself.

What about the other 99.44% of you? The answer is simple - you do what you are told to do. I think you should know this before you graduate. Then you won't hunt down all those former professors who talked about your ability to change the world.

So the purpose of this little discourse is to shed some light on a subject not often broached and to attempt to answer some questions such as, What can you expect? What is the world really like?

For this discussion, we will divide the world into two types of people--the UP's and the BC's. The UP's are the Ut Prosim people who believe the highest calling is to be of service to others. The BC's are the bean counters, those who believe the greatest measure of a person is the number of beans accumulated. (It was called "beans" before it was called "bread".) Beans can have a broader connotation, referring to whatever can be counted--perks, publications, profits. You name it, somebody will count it.

If you are an UP, you are in a vulnerable position. You have been set up for an ambush. You will be asked to take less money because you are an UP and UP's will put consideration of others ahead of personal gain. Further, you will be told this is the way "professionals" react. Be careful whenever this ploy is mentioned and look around for someone who has his hand in your pocketbook.

This indoctrination of engineering students continues because engineering professors want to believe the platitudes expressed by the great leaders of industry. So they repeat their "betterment of mankind" speeches. They never question the motives of those who meet engineering payrolls. How can the engineering professors question these motives when they have never participated in corporate decision making? This is probably good because someone has to have and encourage these ideals. However, the real world does not necessarily operate in the same manner.

The encouragement of UP ideals did not start with the university professors. It is part of our Judeo-Christian heritage. These principles of thou shalt not lie, cheat or steal have been drilled into us. We have been taught to fight our basest instincts and to put the welfare of others ahead of our own. In no way do I advocate giving up these ideals, but one must be aware that others in the world have either given them up or never had them. And the saddest part is that those who are the most larcenous often rise the fastest and are even called to be members of the cabinet.

Another myth is that if you work hard and do what is right, the reward will follow. Your efforts will be recognized by a benevolent employer who will give you that salary raise that you deserve. Not necessarily so. Other things being equal, no matter how hard you work, unless you promote yourself, you won't get the money. Employers think that if they give you a raise, the money is coming out of their own pockets, and they do not want to do that.

So how do you promote yourself? First, find out what the BC's criteria for evaluation are, and then document your case. Sometimes it almost like playing a game, but you must remember that the boss owns the board, the pieces, the cards, and the rulebook. This doesn't sound fair you say. If you have reached this conclusion, then you've got the message. What is right, and what is fair, is not necessarily what happens in the world.

If after this, you still want to be an UP, then do it. But do it with your eyes open. Don't let comments like, "If you're so smart, why aren't you rich," get you down. People are measured by other standards, not readily visible. So stick to your principles, be the best engineer you can be, and get those BC's to work for you. And the next time someone comments that your ideals are pretty hokie, simply reply, "Yeh, how about those Hokies."

CLIFF GARVIN AND EXXON

Clifton C. Garvin, Jr., board chairman and chief executive for EXXON Corporation, visited with VA TECH students in late March of this year.

Mr. Garvin graduated from VA TECH in Chemical Engineering in 1943. After serving in the U.S. Army Corps of Engineers during World War II, he returned to VA TECH to get his Masters' in Chemical Engineering in 1947.

He started working with EXXON as a process engineer and has since held many positions including executive assistant to the president, president of Exxon U.S. chemical affiliate and the world-wide chemical affiliate, a member of the board of directors, an executive vice-president, member of the executive committee, and president of Exxon.

Garvin's talk to members of the Student Engineers' Council (SEC) focused on high technology, industry and society. He suggested that society feels high technology is the answer to its many problems. He projects that technology will expand greatly in the next two decades.

When asked to comment on EXXON and its position regarding high technology he stated that EXXON is not considered by the public to be high technology, but instead a high user of professional people. He emphasized that EXXON is an enthusiastic supporter of computer technology and has embraced the computer as an effective tool. Presently, EXXON employs some 23,000 terminals world-wide.

In addition, Mr. Garvin talked about the smoke-stack industries, American management, and the American worker.

from ENGINEERING NOW

About Higher Education. . .

In 1981, Exxon's support to higher education totalled over $21 million. Also, in honor of the company's centennial, we initiated a one-time, special program of almost $17 million to support engineering education. We hope that this support will serve as a catalyst for other companies to offer similar funding.

Colleges of engineering need help today. If we are not able to support these colleges and if some students are not persuaded to stay on campus to earn a graduate degree and to teach, Exxon and other companies will not be able to hire the engineering graduates they'll need in the future. Our immediate goal, of course, is to hire the people we need today. At the same time, we have tried, through our support, to encourage some young people to consider earning graduate degrees and teaching.

It also has been suggested that the corporate world could provide some assistance in teaching by loaning personnel. This may or may not be realistic. I think the basic idea is sound, but speaking for myself, I haven't practiced chemical engineering in 25 years. Thus, it might be difficult for me to conduct class that would teach the principles of chemical engineering.

However, I and other executives might, on occasion, be able to visit Virginia Tech and share with students some of the problems that we face and some of the solutions we have found in industry.

by Andra P. Yanchenko

M. Hill

THIRD WORLD ENGINEERING IS IT FOR YOU ?

by Matt Hutchinson

INTRODUCTION

The engineering student today faces a bewildering array of career options following graduation. Will it be digital technology with IBM? Computational fluid dynamics at Lockheed? Tribiology research with General Motors? The market is for engineers ready to leap unflinchingly into a fast paced, high-tech world.

As a sophmore engineering student, I am just beginning to peek past graduation and take my first serious glimpse of the Real World. The inevitable questions present themselves. Do I really want to do this? For how long? Where? Why?

In this article, I hope to provide some answers to these questions. Certainly not all of the answers to all of the questions, but at least another option. An engineering career need not be lost in the bowels of a huge multinational just so, to improve efficiency by one tenth of a percent; or typing diligently away at a computer terminal for six hours at a time.

It might deal with something more vibrant, dynamic and pragmatic--it might actually deal with people. Many people I have spoken to have remarked something to the effect, "Yes, well, this $25,000 a year is all well and good--but isn't there something I can do that is a little more demonstratively a way to help people?" The answer is yes.

Some of the neediest people alive today live in the so-called third world, underdeveloped countries. Engineers working in these countries can help people in many practical ways. This article is written for you, fellow engineering student--the one who might be interested in working overseas in a developing country.

I find myself in the dubious--though not actually embarrassing--position of trying to write about a topic on which I have no direct knowledge. Because of this, some might say that I have no business messing about in the subject. Yet it is for precisely this reason that I am "messing about" in it. Wading importantly, I have made a start. I began here, I hope that you can, too.

WORLD NEEDS

The United States, in contrast to much of the world, is almost inconceivalby wealthy. As a country we find it all too easy to close our eyes to the needs of the developing and underdeveloped countries.

Lack of Food

Roughly 460 million people in the world today are simply starving--they take in fewer calories per day than is required for survival. Another one billion people fall short of the protein consumption necessary to be classed as "nourished" (Sider,p.33).

Most farmers in third-world nations are subsistence farmers only--that is, they produce enough food for their families, but not enough to support any others. Cost, too, becomes a significant problem. For many families, paying for food consumes more than 25% of their annual income.

Energy

Insufficient energy resources also poses a problem for the developing countries. In any of its many forms, energy is often considered the key to greater industrial production. In the United States, industry was founded upon, and continues to rely on, relatively cheap sources of power. As a nation, we use on the average about six times as much energy per person as the rest of the world. In comparison to the less developed countries, India or China for example, the U.S. consumes an even more disproportionate amount--close to 25 times as much (Congdon,p.63).

Even without resorting to "gloom and doom" figures on diminishing energy reserves, it becomes apparent that we are going to have to reduce significantly our energy consumption in the future. A more equitable energy distribution worldwide would require substantial consumption reductions in the industrial nations, coupled with a proporational increase in consumption in the underdeveloped countries.

This is not to say that we ought necessarily to reallocate fossil fuels or, say, encourage the development of nuclear power in the third world. Energy comes in many shapes and sizes. Broadly speaking, energy resources can be classed into six categories: fossil sources, nuclear power, geothermal, solar, wind and muscle. Much research time and effort has been invested in the first five, but the last has been largely ignored. It should not be underestimated. For example, the average person can produce about one tenth of a horsepower (approximately 75 watts) for an extended period of time. One tenth of a horsepower may not sound like much, but when you start multiplying factors of several hundred million, or even a billion, "people power" leaps into view as a viable energy source. Dynapods--one-man pedal-power stations--can be used to pump water, winnow grain, even plow fields. People are very versatile. They adapt more readily, require less maintenance, and travel better than the average gasoline motor. This is not to say that pedals should be categorically substituted for a Briggs and Stratton, but they are an alternative to be considered.

NATURAL RESOURCES

Universally, natural resources include water, wood and topsoil. Depending upon the country, they may also include metal ores and mineral deposits.

Water. Water is used for a variety of things--irrigation, human and animal consumption, waste removal, industrial purposes, etc. Ecologically, the water cycle is a delicate one. Too much stress at one point can lead to disastrous consequences--drought in one area, perhaps, and flood in another. Careful management can prevent both.

Wood. Wood serves as both a fuel and a building material. Properly controlled, it is a completely renewable resource. Unfortunately, wood harvested to heat homes, cook meals, or build buildings usually is not replanted. Effective solutions to this problem lies in reforestation and more efficient use.

Topsoil erosion. Widespread defoliation exposes the fertile top layer of the earth to the damaging effects of wind and rain. With the topsoil gone, a farmer must work harder and longer to produce the same amount of food from the same plot of land.

Exportation. Exportation of raw materials from one country to another solves some problems temporarily, but it has far reaching consequences. It provides national revenue that can relieve a domestic problem--but only temporarily. It is a one way cycle--a poor nation may sell steel and aluminum (or iron ore and bauxite), but cannot afford to purchase the airplanes that are made from them. This cycle is not-therapeutic bloodletting--the country is stripped of its most valuable assets and gains no long term benefits in return. Eventually, it is worse off than before. It seems to be an unsolvable problem. Suppose a nation is faced with a critical problem (e.g. famine, disease, etc.) that simply cannot wait. The solution? Sell what they can and try to fix things--but this leads to the effect I just mentioned.

The whole system needs an entirely fresh look. Exporation is not the only way to generate money--it is simply the fastest. Ultimately, a nation must turn to its own people for the solution. Can't afford and airplane? Make it yourself. Well, maybe not an airplane--perhaps a plow or something like that--but it is a start.

Sounds a little idealisitic, doesn't it? Maybe this is just another example of blissfully ignorant optimism. Granted, the idea is somewhat simplistic--it doesn't really touch the issues of education, insufficient skills, lack of capital, etc.--but it is, I believe, valid.

Certainly, this brief overview of world problems has been far from comprehensive. Fortunately, I had no intention for it to be so. I wanted to show that these needs do exist (not everyone lives like Americans!) and let these needs act as a prelude to the concept or appropriate technology.

APPRORIATE TECHNOLOGY

Many view technology as the tool most effective in narrowing the gap between the developed and the underdeveloped countries. It is not, however, a simple or complete panacea--only when it is applied appropriately is it useful.

Technology

Technology. I have used the word many times over the last several paragraphs. This term permeates most treatises on modern society. What exactly is it? The word conjures up visions of vast arrays of blinking lights, a Space Shuttle poised for launch, or a cutaway view of an intricate steam turbine. Do these examples accurately represent "Technology"?

Actually, technology is not a thing or things, it is an idea. Technology is "the tools and the methods to use them that conserves human and physical resources" (Marilyn Hoskins). Note that this definition says nothing about technology as expensive or even especially complicated--it emphasizes effective, ecological use by people.

Appropriate

What does it mean to apply technology appropriately? Simply, it is the most effective form of technology in a given situation. Obviously, this rests heavily upon the judgement of what, precisely, the problem is and how it can best be solved. Appropriate technology has its foundation if the accurate interpretation of a need and its solution.

Situational factors, particularly economy, are crucial. For example, it would be foolish to purchase a combine to do a job that can be handled by several men working with scythes.

Appropriate technology is geared to the smallholder. How can this woman's efforts over dinner be reduced, what's the best way to get water to this village, etc. A country's standard of living is not raised from the corporate level, it must begin at the bottom of the economic ladder. Development is appropriate technology's most important tenet. It seeks to improve the condition of the poor, develop individual self-sufficiency (rather like pump priming), preserve the enviroment and improve environmental compatability, and to use natural resources carefully. It requires that local skills be used for construction and maintenance. It is seated in the realistic and the pragmatic.

Examples

For the engineer, appropriate technology becomes a challenge to innovate design-- new angles, odd approaches, clever simplicity. The unusual methods used in any number of circumstances are striking. Things previously unused are used, someone finds a simpler way to solve a problem--there is no such thing as a "final answer" to any problem.

Social factors. Very often in technological applications, the cultural aspects of a problem matter more than the technical. For example, in East Africa a pedal powered water pump was designed for use at the village well. Technically, it was quite good--efficent, simple, reliable--but it was not being used. It turned out that the women of the town (who got most of the water) thought it unladylike to straddle the seat necessary to use the pump. In a strictly technical sense, nothing was really wrong with the design, yet in terms of function, it failed completely. The moral: design must take cultural factors into account.

Another example belies the fact that people and their social lives are involved at every point of engineering application. "The Politics of Water, Lesotho" relates some of the problems encountered and created by a water program for several villages in this mountainous, arid country. In one instance, a gravity fed water system ran into several difficulties. Technical problems were relatively minor and presented no great obstruction to the future of the product. A social problem, however, arose that presented a major handicap. A technician working on the project was involved in an illicit affair with one of the village girls from which an illegitimate child was born, "the result of which was a split between the men and women of the village. A stalemate was reached in which the men, who were expected and better equipped to carry out the repairs to the (water) supply, (maintenance) committee" (Mitchell, p.59).

Clearly, technical difficulties are often less significant than social difficulties. The people for whom something is designed almost invariably know more about a problem than an engineer or scientist. For example, a scientist in a European research laboratory designed a stove for rural India that would cook corn pancakes more efficiently than the type used presently. A woman from the area took one look and pronounced that it wouldn't work. "Why not?" "Because you cannot put round pancakes on a cooking surface like that, they'll burn." "Oh. Well, you see, it's more heat efficient this way--you'll just have to make square pancakes" (Marilyn Hoskins).

Simplicity. Simplicity harmonizes with the requirements of appropriate technology. The simpler something is, the easier it is to build and maintain.

For example, an article in *Appropriate Technology,* explains the workings of several liquid-piston engines. Rather than a solid metal piston in a cylinder, a fluid such as water is used. Though they operate slowly, liquid piston engines have many positive attributes--they require almost no precision machining, are very reliable and are simple to construct. Pumping water is their main duty.

In Africa, the natives use a pump to lift water short distances (6 to 8 feet, as in over a river bank) that at first glance seems almost too simple to work. The operator holds a piece of pipe into the water and in short strokes, moves it rapidly up and down. On the upstroke, he holds one hand over the top of the pipe and on the downstroke uncovers it. Suction lifts the water when he covers the pipe and, if he moves it down faster than the water falls, inertia shoots the water out the top. Ingenius, isn't it?

Double solution. Ram Bux Singh, in his short book *Bio-Gas Plants, Generating Methane from Organic Wastes and Designs with Specifications,* describes a method to tap a previously ignored energy source. Anaerobic decay of manure, vegetation and other organic matter has long been known to five off a gas similar to methane. Sanitary disposal of human and animal waste has been a persisten problem in the developing nations. Singh has designed several bio-gas plants that alleviate this problem and produce a significant amount of fuel in the process.

A bio-gas plant consists of two basic parts: a digester and a gas holder. It is in the digester that the anaerobic bacteria decompose the manure and produce the gas. The gas holder is simply a place to contain the gas prior to use. There is, of course, a lot of peripheral equipment that is essential to operation but these are the main components.

Bio-gas plants can be made to produce from 100 to 3,000 cubic feet of gas per day. 225 cubic feet of gas contains the same energy as a gallon of gasoline. The gas can be used the same way methane or propane is used--for cooking, heating, lighting, etc. Diesel engines can be modified to run on bio-gas.

Decomposed, the manure remains high in nitrogen and other nutrient content and still can be used as fertilizer in the fields. Bio-gas plants turn a potential health problem (that is, standing manure) into an energy asset.

GOING OVERSEAS

Why? The answer to this question is entirely personal. Some may be motivated by a desire to help their fellow man, others may just want to see how people around the world live and work to gain a new perspective on their own life.

At this point, I will try and avoid the temptation to moralize. As prospective engineers, we have adopted that part of the Creed that says we are to use our skills for the "betterment of mankind". We are in a unique position to use these skills in a practical and rewarding way.

Enough said. I'm walking on the brink of the chasm of ideological coercion. This is not to degrade ideology--but you do not convince others by thrusting your beliefs on them. I emphasize again that the decision to work overseas is up to the individual. By all accounts, it can be a trying and difficult experience--but these same accounts also speak of great rewards.

For how long? By now, some of you may think that this is some sort of lifetime committment. It isn't. It certainly may be, but it doesn't have to be. There are opportunities for internships, one or two year programs, or even summer jobs in third world development.

Education

Language skills. Most employers in the U.S. refuse to hire "illiterate engineers"--the same goes for jobs overseas. Inability to write or speak effectively can be a crippling deficiency. Proficiency in a foreign language is also highly recommended. You need to be able to communicate technical concepts successfully.

Manual skills. An engineer also needs manual skills to complement "book learning." A summer of work as a carpenter's assistant, in a machine shop, or as a mason supplements your formal education very well.

Perhaps even a couple of vocational education classes as free electives--flip through the catalog and use your imagination.

Those hunting jobs in third world development use two basic methods to prepare themselves. They either find out as many specifics as possible and fill as many as they can, or they obtain a very general, solid background applicable in many circumstances. Obviously, a combination of the two would be best, but most students are forced to opt for the first, as it reflects our relative inexperience. Be persistent. Dig around--opportunities come from suprising places.

Special thanks to Marilyn Hoskins for her assistance in providing information for this article.

For further information

Some organizations that might be helpful if you're interested in finding out more about appropriate technology and what you, as an engineer, can do overseas.

Appropriate Technology International
1724 Massachusetts Ave.
Washington, D.C. 20036

Volunteers in Technical Assistance
1815 N. Lin St., Suite 200
Arlington, Virginia 22009

Aprovecho
442 Monroe St.
Eugene, Oregon 97402

World Bank
1818 H St.,NW
Washington, D.C. 20433

WHAT ARE YOU DOING THIS SUMMER?

by Judy D. Moore

Why is it that the interviewer asks first, and most, about your previous job experience? Are those summer jobs critical to finding permanent employment? Does selling hamburgers count? Most of us have had some sort of work experience, whether in selling hamburgers at the local fast food place, carrying newspapers, or working in a laboratory or industrial plant. The question is, what impact do these experiences have on a person's job outlook?

The answer seems to be that very important personal and technical skills develop from summer job experience. While any job is better than none for these purposes, industrial experience is considered most valuable among students in engineering. Students with experience in their field of study list abundant benefits. Beyond the paychecks, which can be quite substantial ($10-$15 per hour), the opportunity to try out the things they have worked so hard to learn was cited as the most important reward among the many students I talked with. In essence, by working in one's own area, a person can find out whether they are interested in pursuing that career. The differences between textbook theories and applied techniques come as a real surprise to many aspiring engineers. Some students find that the subjects they found boring in textbooks can be quite interesting and exciting when actually applied. Others find that while they enjoyed the textbook ideas, the applications and environment just do not fit their style. Either way, the experience becomes invaluable in choosing the remaining courses for graduation. Other benefits include development of career goals, interpersonal skills, and financial management skills. While McDonalds or Burger King will likely help you decide what your career goals are NOT, such employers do teach a person to deal with cranky, sarcastic people who want to know where the beef is (interpersonal skills) and what to do with your modest paycheck this week (financial management skills). Industrial or laboratory experience, however, can be more useful in finding technical employment after graduation.

Students who interview with several companies will quickly notice that many of the questions are similar and most interviewers test for a few special items. They want an individual whose career goals can be advanced by the job they have to fill. Interviewers expect the interviewee to have their objectives and directions mentally outlined and know how this job fits into these objectives. Not only do they want to know how the job will benefit you as a student, but it is imperative that you have the skills and knowledge to benefit the company as well. Be honest with the interviewer: if you tell him or her that you know something that you do not, he or she will probably catch you, either in the interview or on the job. Regardless, exaggeration reduces dramatically your chances of being hired or kept on the payroll. Interview for summer jobs with the companies you feel that you will be interested in working with after graduation. After all, the company is making an investment in you, if you do not return after graduation their rate of return on investment is neglibile, since summers are often spent learning how the company works. Intelligent questions indicating interest in the company and its processes demonstrate that your are not just looking for a good salary. Experiences from a similar industry and extracurricular activities, particularly those requiring leadership skills, are also valued. These show that you can work with people and get a job done.

The bottom line is this:

if you are rich, head for the beach this June;

if you are rich and smart, head for a European beach;

if this job is paying back your VELA loans, head for the placement office;

and if all else fails, head for those Golden Arches!

J. Hein

The Logical Suspect

Soot particle growth as it takes place in wood-burning fireplaces, diesel engines, and industrial furnaces, has been attributed to a complex set of interdependent chemical reactions. A researcher at the General Motors Research Laboratories has demonstrated that the decomposition of a single species is primarily responsible.

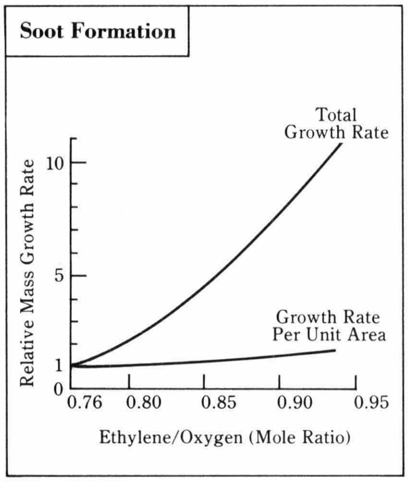
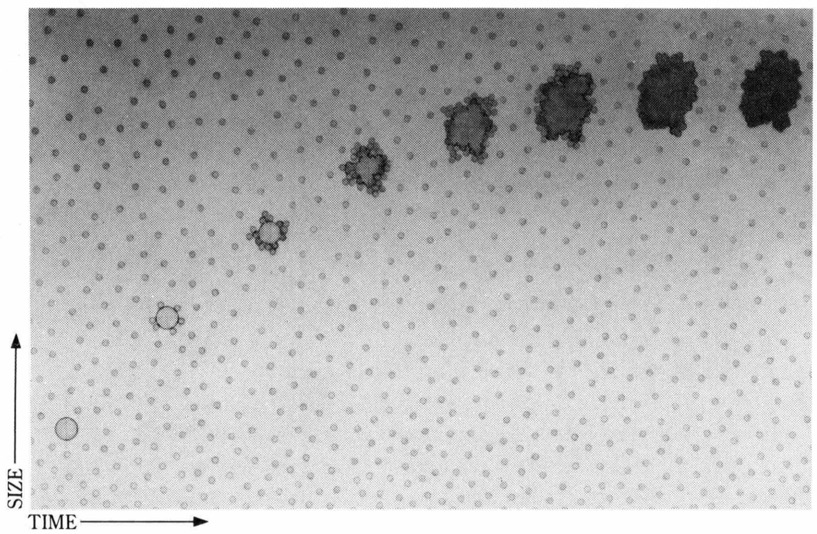


Figure 1: Total growth rate contrasted with growth rate per unit area plotted as a function of ethylene/oxygen mole ratio measured at a given height above the burner face.

Figure 2: Artist's rendition of the surface growth of a single soot particle by the incorporation of acetylene molecules.



SOOT FORMATION may be divided into two stages. Microscopic soot particles are generated in the "inception" stage. They reach full size in the "growth" stage, which accounts for more than 95% of their final mass. Most scientific exploration has concentrated on particle inception which, despite all the effort, remains unexplained. Dr. Stephen J. Harris, a physical chemist at the General Motors Research Laboratories, has reversed traditional priorities. Combining experiment with logic, he has formulated the first quantitative explanation of the growth stage in soot formation.

Dr. Harris arrived at his mechanism through an elaborate process of elimination. To focus on the chemistry of soot growth, he began by eliminating from his investigation the complexities introduced by turbulence and mixing. He limited his research to premixed, ethylene/oxygen, laminar flames with one-dimensional flow.

Previous descriptions in the literature told him that two processes take place simultaneously during growth. Incipient particles collide and coalesce into larger particles, while growing at the same time by incorporating hydrocarbon molecules from the burned gases.

The first process reduces total surface area without changing total mass, while the second, called "surface growth," increases both total surface area and total mass. Hence, the increase in the total mass of soot can be entirely attributed to surface growth.

Dr. Harris set out to identify the hydrocarbon molecules—or "growth species"—responsible for surface growth. Increasing by increments the richness of the flame, he made the key discovery that although the total mass growth rate (gm/sec) increases strongly when the ratio of ethylene to oxygen is increased, the mass growth rate per unit surface area (gm/cm^2/sec) increases only slightly (see Figure 1). Thus, the controlling variable for how much soot is formed is not the concentration of growth species, but the surface area available for growth.

This finding led him to conclude that richer flames produce more total soot because they generate more particles in the inception stage. More incipient particles offer greater initial surface area for the incorporation of hydrocarbons.

Since the growth rate per unit area must depend on growth species concentration, this concentration must be similar from flame to flame. Dr. Harris went on to reason that there must either be enough growth species at the outset to account for the total soot growth in the richest flame, or the species must be rapidly formed within the flame from another hydrocarbon present in high enough concentration.

HE NARROWED his search to the four most abundant classes of hydrocarbons found in flames: acetylene, polyacetylenes, polycyclic aromatic hydrocarbons (PAH), and methane. Methane can be eliminated, because its concentration does not decrease as soot is produced. There is not enough PAH to account for soot formation in any flame. Neither of these two hydrocarbons can be readily formed from the other major species present. That left only acetylene and the polyacetylenes.

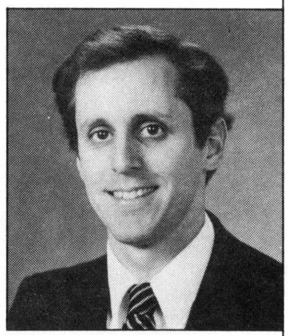
Acetylene contains enough hydrogen to account for the hydrogen content of soot measured in the early stages of growth. But among the polyacetylenes, only diacetylene could possibly supply enough hydrogen. That left acetylene and diacetylene.

There is more than enough acetylene to account for the mass of soot produced. There is not enough diacetylene, and while diacetylene can be formed from the abundant supply of acetylene, the reported rate of conversion is too slow for diacetylene to play a significant role. That left only acetylene.

Dr. Harris verified that acetylene is the growth species by determining that the slight increase in growth rate per unit area is proportional to the increase in acetylene concentration (see Figure 1). He also found that the rate constant he measured was in agreement with the reported rate constant for the decomposition of acetylene on carbon. These findings confirmed his hypothesis that soot particles grow in flames by the incorporation and subsequent decomposition of acetylene.

"Now that we know how soot grows," says Dr. Harris, "we can examine how it begins with greater understanding. Then, perhaps our knowledge will be complete enough to suggest better ways to reduce soot."

THE MAN BEHIND THE WORK



Dr. Stephen J. Harris is a Staff Research Chemist at the General Motors Research Laboratories. He is a member of the Physical Chemistry Department.

Dr. Harris graduated from UCLA in 1971. He received his Master's and Ph.D. degrees in physical chemistry from Harvard University. His doctoral thesis concerned Van der Waals forces between molecules. Following his Ph.D. in 1975, a Miller Institute Fellowship brought him back to the University of California, this time at Berkeley, where he spent two years studying laser-induced chemistry. He joined General Motors in 1977.

Dr. Harris conducted his investigation into soot particle growth with the aid of Senior Science Assistant Anita Weiner. His research interests at GM also include the use of laser diagnostic techniques in combustion analysis, with special emphasis on intracavity spectroscopy.

Chemical Waste Disposal

"A frightening reality of our time."

The results were disastrous. No one knew what effects, long term or otherwise, would result from the leakage. This situation was the first of its kind--very political and very unresearched.

by Christina L. Dugan

Chemical waste disposal demands attention. Hundreds of private chemical industries continue to dump toxic chemicals into our land despite our growing knowledge of the dangers. Since the incredible growth of the chemical industry, handling hazardous chemical wastes has become desperately important. The first American community to suffer and deal with the reality was Niagara Falls, New York. In this town the Hooker Chemical and Plastics Corporation dumped 20,000 tons of chemicals into Love Canal from 1947 to 1952. These chemicals included 82 different compounds; 11 of them suspected carcinogens.

In 1953 Hooker sold his land to the city Board of Education for the sum of one dollar. Subsequently, a school was built on the property and private homes were built in the surrounding area. After heavy rains the Love Canal, originally built in the 1890's to supply water and power, overflowed. Soon after, chemicals such as chloroform, benzene, trichloroethene, toluene, and petrachloroethene began surfacing in the soil and water of the neighboring homes. On August 2, 1978 children up to two years of age and pregnant women were evacuated upon request of the New York State health commissioner. The everyday careless dumping of the Hooker Chemical Company (only one of very many similar companies around the country) became a nightmere for the people of Niagara Falls.

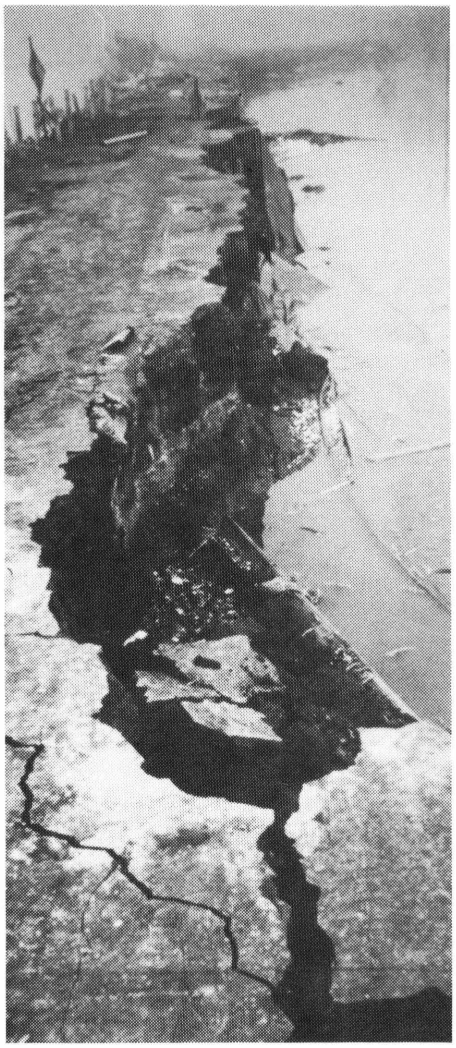
The effects were disastrous: higher divorce and suicide rates, higher miscarriage percentages, and a growing dissent towards all involved. The people were alarmed because they were given neither aid nor answers. No one knew what effects, long term or otherwise, would result from the leakage. This situation was the first of its kind - very political and very unresearched.

Hooker refused to accept sole responsibility for the welfare of the people or the destruction of their land. He also refused to pay the people liability for the possible but not certain long-term effects. One chemical found, dioxin, can lay dormant for two to three years in fatty tissue before surfacing and causing possible birth defects. The government bought unsold land near the canal and gave some families relocation money, but many families had nowhere else to go. They stayed, facing the uncertainties and fears of a contaminated environment. Since Love Canal, more of private industry, the Environmental Protection Agency (EPA), and the public are aware of the dangers. The subject seems under constant debate but the problem is not solved and hundreds of dumps continue to leak hazardous chemical wastes into our land, air, and water.

Soon after the Love Canal tragedy, the Carter Administration passed the Comprehensive Environment Response Compensation and Liability Act and under that came "Superfund". Superfund, originally called the Hazardous Substance Response Trust Fund, is an emergency fund used to clean up toxic waste dumps. The EPA feels that private industry misuses Superfund and that they should be more financially supportive of cleaning up dumps. Involving private industry would be more cost-efficient and the public feels that they are responsible anyway. The EPA's difficulty in putting the entire blame on one chemical company brought about the Joint and Several Act. This act demands the major chemical company involved, if not wanting to pay the whole cost, to bring suit against any other party which it feels is partially responsible. The companies find this incredibly unfair and too harsh since this means suing their suppliers, transporters, and possibly their customers. The EPA feels that the more private industry pays the more attention they will give to the subject: dedicating money and intelligence to researching new methods of waste disposal and better methods of clean up. One aspect that private industry and the EPA worry about is "How clean is clean" and whether in five years the dump site will still be safe.

Endless research still needs to be conducted on all aspects of chemical waste disposal. The EPA hopes private industry will aid in that area since they have been very involved in cracking down on violators of regulations on proper disposal. Despite the relief of some environmental regulations in 1983, many companies still commit flagrant violations. Although the EPA cannot keep track of all chemical companies and their waste disposal procedures, they are involved in an expansion of their criminal enforcement program. Penalties for committing a crime in which the company is fully aware of the violation can be from $25,000 a day and/or one year of imprisonment to $50,000 a day and/or two years of imprisonment. Penalties for a violation of "knowing endangerment" can be up to $250,00 and/or two years in prison. "Extreme indifference for human life" can reach $250,000 and/or five years in prison.

"Destroyed land"

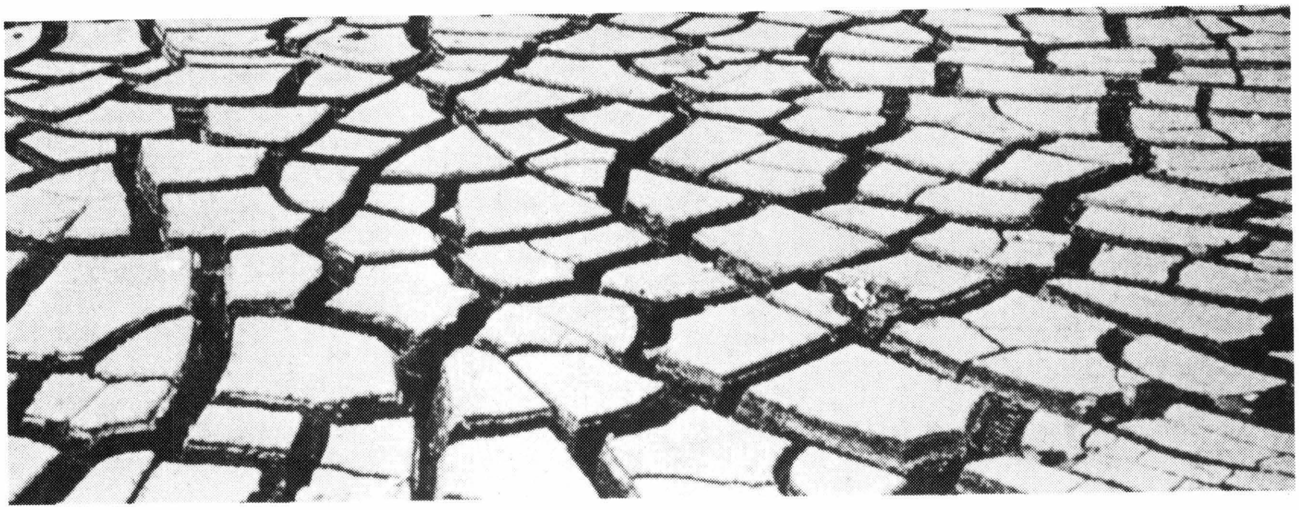


The EPA hopes this will discourage violations, however, the view of many chemical companies is that their crime will go unnoticed due to the exceedingly large number of violations being committed.

The EPA's increased regulations on toxic waste dumps and a growing concern for destroyed land, make other methods for waste disposal mandatory. Presently, many private industries are turning to incineration. Incinerators, although being the most expensive method of disposal offer private industry greater insurance than landfilling. Incineration converts hazardous chemicals into harmless compounds and prevents the worry of possible leakage from toxic dumps thus avoiding unexpected clean up costs.

In the design of an incinerator, the critical characteristics are time, temperature, and mixing. The purpose of an incinerator is to run the hazardous chemicals through a combustion reaction. For the combustion reaction to proceed to completion, sufficient oxygen and high temperature levels are required. Proper mixing ensures that the feed and fuel will be combined with the correct amount of oxygen before entering the reactor. All these specifications need to be upheld so that emmissions can be controlled.

Approval from the EPA for incinerators is less difficult than in past years. The EPA determines, from complete chemical analysis of the materials the company intends to burn, the principal organic hazardous consituents (POHC). They then require a destruction and removal efficiency (DRE) for each POHC of four 9's (99.99%). Test burns must convince the EPA that the unit meets these requirements. Ship incinerators only



Hooker Chemical and Plastics Corporation dumped 20,000 tons of chemicals into Love Canal from 1947 to 1952.

require a DRE if 99.9% since the incineration occurs further away from populated areas. Incineration at sea seems ideal but people living near ports object to having the hazardous wastes stored near their homes before being taken out to sea.

The problem of cost still prevents many companies from investing in incinerators; however, several companies have found ways of reducing their expenses. The California Air Resources Board (CARB) uses the heating value gained from the incinerator in other parts of their chemical processes. Private industries like BFC Chemicals, which is located on property unsuitable for landfills, finds building incinerators of comparable cost when considering the purchasing of additional property. Bofors Nobel cuts prices with a multistage process in which only the organics that have volatized during the pyrolysis of chlorinated solvents will be incinerated.This process substantially reduces the amount of time the burners are being used and therefore reduces cost. Dow Chemical presently incinerates 93-95% of their organic wastes.

In addition to incineration, many researchers are finding cheaper and more efficient methods of waste disposal. Thagard Research has developed a high-temperature fluid wall reactor which reduces the chance of incomplete combustion by rapid heating to high temperatures. In this reactor, electrodes surround a ring of inert gas which encompasses a porous central cylinder. The waste passes through the refractory cylinder and is heated by radiant heat transferred through the refractory cylinder.

Helmut Schulz of Columbia University encapsulates poisonous metal in a glassy harmless sand which can be used as a material in road construction. This technique offers a solution for materials that will not burn up to temperatures of 3,000 F and that are unsuitable for landfilling. This new technology has been labelled Toxiplex.

Chemical waste disposal is still a critical problem, with many difficulties preventing a feasible solution. Some private industries are more concerned with costs and profits without realizing the potential danger of improper hazardous waste disposal. The public prevents and inhibits new technology by complaining that incinerators are eyesores and by not fully understanding or trying to understand the details of the problem. The EPA has difficulty pleasing the public and industry. Their regulations seem too harsh or too lenient. Hazardous chemical waste disposal will understandably encounter problems but all parties concerned need to be aware of the immediate potential risks.

References

1. Nation Enterprises, "Leftover Lives to Live", *The Nation*, May 23, 1981, pp. 624-627.

2. Communication Channels Inc., "New Toxic Waste Technology", *World Wastes*, March 1983, p. 8.

3. United States EPA, *EPA Journal*, vol. 9, no. 3, November 1983.

4. Communication Channels Inc., "Regulatory Reforms, Unwelcome Relief For Some Firms", *World Wastes*, March 1983, p. 28.

5. McGraw-Hill, "Burning Hazardous Waste", *Chemical Week*, October 5, 1983, p. 92-95.

6. McGraw-Hill, "Seeking Ways to Speed the Cleanup", *Chemical Week*, January 18, 1984, pp. 32-36.

7. The New York Times, May 16, 1980, August 2, 1978.

If I'd Only had a CLUE

by Michael E. West

In addition to just plain hard work and dedication, there are many tricks to surviving in the College of Engineering; and probably the most important is knowing what options you have. The information that is in this article can be found in the college catalog.

In order to graduate in the College of Engineering, the senior year, with a minimum of 45 hours, must be completed in residence, or 45 of the last 60 hours must be completed in residence, provided that only apporved elective courses taken in absentia are transferred to complete requirements. A minimum of 204 quarter credits are required for graduation in each Engineering curriculum, including those under the cooperation program. For all courses attempted in your departmental major, a minimum QCA of 2.0 is necessary, substituted non-departmental courses are not included. Semester hours transferred from another school may be converted to quarter hours by multiplying by 3/2.

Final examinations are given according to a schedule established by the University. Permission to change the established times must be arranged through the Dean's office. Given three exams in a period of twenty-four hours, you can change one exam time. If you have four exams in twenty-four hours, you can change two. Professors must give final examinations according to the University schedule, except for those students with conflicts as stated above. No exams, conflict or otherwise, can be given before the first day of the exam week, except for in laboratory courses.

If you receive an "I" (meaning "Incomplete") in a course the "I" will be counted as an "F" unless or until you promptly make it up. A grade of "I" may be given when the requirements of a course other than the final exam have not been completed due to illness or extenuating circumstances beyoud the student's control. The "I" grade is the prerogative of the instructor. No fee will be charged.

To remove an "I" grade, lecture course requirements must be satisfied during the student's first subsequent quarter of enrollment. Incompletes are automatically converted to "F's" unless requirements are fully satisfied during the period of time allowed.

The pass/fail grading system has numerous rules. In general, you can only take two courses on the pass/fail option in any quarter, and you are permitted to take up to ten percent of the requirements for graduation completed at Va Tech pass/fail. In the College of Engineering, this figure converts to 21 hours out of the 204 required for graduation. Many departments restrict the pass/fail option to certain courses; i.e. not just any course can be taken pass/fail. To be able to use the pass/fail grading option, you must be an undergraduate and have completed a minimum of 45 credit hours with a cumulative QCA of 2.50 or above. The grade options may be changed to "P/F" until the drop deadline, and to "A/F" until the deadline for resignation without penalty. Once credit has been received for a course taken on the pass/fail basis, the course cannot be repeated under the "A/F" grading system.

If you audit a course, you cannot take an examination for credit later, and you may not transfer to regular status in a class after the last day to enter organized classes. Students are not allowed to register for credit in any course previously audited.

Graduation is the main objective of all the hard work and mental pain. Candidates for degrees must file a written application at the Registrar's Office at least two months before the degree is to be awarded. When you file for a degree the Registrar's Office will review your transcripts and send you a list of requirements to be completed in order to graduate. If you are a double major, two degrees will not be awarded, but a notation recognizing completion of requirements for the second major will be posted on your transcript. A re-examination may be authorized only when a student is enrolled in the course during the final quarter of his or her senior academic year, and a satisfactory re-examination only in one course would qualify the student for graduation. A re-examination must be approved by the instructor, the department head, and the dean of the student's academic college.

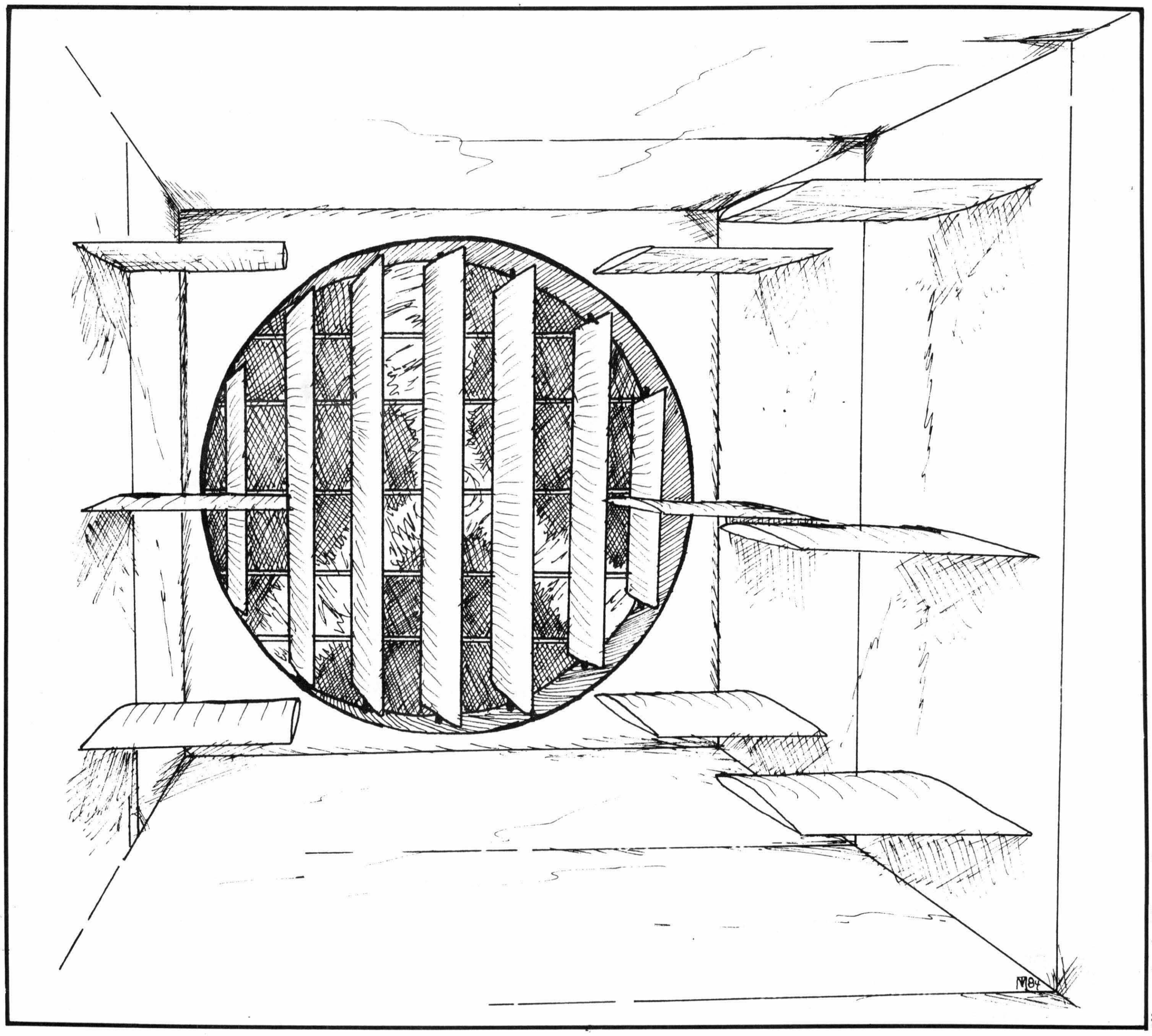


Illustration by Tim Mullin

Renderings of an Engineer: WIND

by Mark Moran

The cleanest building in the county belonged to the regional Sanitation Authority. In accordance, maybe, with human nature, an employee of the Authority would rarely appreciate such trivialities as cleanliness, orderliness, and security. Even I, an engineer of six years standing with the Authority, would gaze now and then out the main office building windows, drapes pulled aside, at the blinding void that would streak the the wind tunnel across the street and see nothing more than an enormous structure flanking the entire eastern face of Anthem's Aeronautical Division Headquarters.

Because maybe what I should have seen was the alternative. It was staring right back at me.

A mere forty-five minutes prior to the episode that - well, enlightened me, Jeffrey and I had gotten together over at Kenneth's Garage to play a few friendly hands of Cutthroat. As Kenneth himself had to leave suddenly (the old man tossing his keys to the place with a restrained hurriedness accompanied by an unintelligible grunt, as though he had to go to the bathroom real quick - although, in retrospect, I believe he was just being the lazy bum he still is to some extent, even ten years now into his marriage, which occured at the age of forty-eight), we two were forced instead to relegate the game into a two-hander. The game was going against me, and also I was thinking about Rhonda Shears, a lady I detested enough to meditate about constantly, so what Jeffrey said to me went in one ear and out the other, for the most part. Eventually,in fact, his naturally booming voice tripped some normally unheard flip-flop buried somewhere in my reticular activating system, and I yelled back at the guy:

"Pipe down, will ya, Jeff? What do you expect from me?"

Which is an odd thing to have said considering what position the events ensuing less than forty-five minutes later put me in. The cold draft in the tunnel that had been merely ghostly a moment earlier was soon building up more and more force at an alarming rate as I leaned there next to the boundary-layer control vanes that rim that section. My ears within seconds were screaming in agony (actually, I was screaming in agony, but for some reason then my ears themselves, as though distinct from myself and intelligent in their own right, were doing the screaming), and when they would completely explode felt like only a matter of time. I simply could not believe what was happening to me. After all, I was not even an aerospace engineer.

For heaven's sake, I was a sanitation engineer!

'Listen is one thing,' was what Jeffrey had replied. He has a liquid, carefree way of speaking: the words just issue forth like a jet of water -- or air.

(You think of the odd, neglected facts when you're faced all of a sudden with the Big Demise itself: like how clean and modern-looking your workplace usually is, and uncluttered, and quiet, and devoid of strong breezes.)

'All right, then; I'll listen.' I said these words smoothly because I had had lots of practice with them that day. 'But keep that siren of yours muted.'

Speaking of which, the noise there in the tunnel had gotten to the point where I could no longer even hear my own asthmatic gasps: it had become a tremendous monotone onrush of sound at the upper limit of hearing, a tremendous whining wall of air. In school, the teachers explain how air--that invisible, intangible stuff you supposedly 'breathe'--has mass and weight too, just like the hefty books you lugged to class. But you fall just shy of appreciating, really appreciating, the simple fact until you're hanging from a boundary-layer control vane in a wind tunnel with virtually no hope of escape, and the air has become a vertical deafening carpet of frozen yogurt upraised and tacked onto the front of a Mack truck that you can no longer, of course, even breathe now despite your being able to feel and taste it, maybe.

'I seen it comin all along.'

'Spades,' I said. 'You said that three times.'

'Ah, spades are lousy. Okay. Well, I cant help the truth. Holt en me both knew what was comin. You see, the first thing that happened was Holt cranked up the tunnel.'

'To what dynamic pressure? Um, double aces, marriage in clubs, two Pinochles, and a dix of trump.'

'Three inches water. Not enough to pop yer ears comin down with it. Still, it was enough. But we seen the writing on the wall almost before the crayon marks dried up. Because the first thing that happened was the pitot-static tubes busted. It's yer lead.'

'They burst?'

'Yup,' he said. 'My jack.'

'But how could the pitot-static tubes burst at three inches water? I dont get it.'

'They didn't burst; I said they busted.'

Surely for the first time in my life, hanging there (only some forty odd minutes later) for dear life somewhat like Gilligan from a tree during a fierce hurricane, I actually longed for a bust at that moment--an honest to goodness, fist flying, pistol discharging bust.

'I dont get it,'I said. 'Uh, I thought you trumped hearts.'

'Neither did me or Buddy. You know him. The guy who stops by the Authority every odd Thursday. No, en I trumped diamonds. See? Buddy, uh, came up en took uh holt uh Holt--'

'Took a what uh who now?'

'Took uh holt uh Holt en shook em

en uh, you know what he said? That's my spade.' I aimed the flat of my palm at the ceiling. 'He says tuh Holt, 'You screwy bastard. What have you done to my tunnel. Now just look what you done.' En you know Holt--he 'sclaimed louder than I'm talkin right now,'--At this juncture, I inserted my forefinger in my ear and rotated it for the effect, although, as I remember it, Jeffrey paid no attention--"Rape! Rape!' en took off runnin round the room like some kine of jackrabbit or maniac or maybe some commnation of both. I of course couldnt help but grin, but unfortunately Mr. Charles saw this, en you know Buddy was already in a rotten mood onna count of this en also what happened the other day after he found out his wife was in the fambly way but that's neither here nor there. So,' Jeffrey continued, 'Buddy screwed up that ugly mug of his until you couldnuh hardly fine his eyes more; what I was lookin at appeared to be uh wrinkly ball of somethin maybe like uh piece of rug without dye--or like the dye used to be there, bright even, once, but no more--so he screwed up that viss'ge of his like I'd joined in some conspiracy to wreck his whole lab en hollered, 'Your jobs hinge on that report there do you realize!' en we of course realized because our jobs always hinge on them reports. So I said to him, 'Just cause we aint engineers doen mean we cant have fun too!' Course that got him. That got him.'

I guess I passed out for a second there. Either my head hit the wall and jarred me alert, however, or I was just plain lucky, because the next thing I knew I was staring at a strange red blur just below one of the vanes. My eyes took an incredibly long time to focus.

The words were scrawled awkwardly, askew--and in crimson lipstick. They read, 'I love you, Jerome.'

My name was (and still is) Jerome.

'Yer deal,' he said. 'Anyways, the very first thing that happened--'

> "Every inch of progress forward required all the strength I could muster."

'First?' I said. 'How many times does the 'first thing' happen?'

'Here, let me cut. Me en Holt first dismantled the maw-cup tuh figgur out where the trouble started. That was when the first thing that happened happened.'

'For what, the third or fourth time?' I said.

'Naw, just then. Yuh see, inside the guts of that little maw-cup was that round gadget with the--'

'Strain-gage extensometer,' I interjected.

'Yeah. That. Well, it was all gooed up.'

'Gooed up? You're first.'

'Wet. Like with cinnamon chewing gum or somethin, only it wasnt with chewing gum but somethin different. We figgured it was the oil from the model where them flaps hinged, but then we realized thaint no oil there. Somethin else gooed it all up. So we stracted that extense-thing en took uh look at it. All of uh sudden, while we were standin there, right there inside the test section, it happened.'

'The first thing.'

'No. The second.'

By this time, my grey matter had probably turned indigo. Nevertheless, that curious chicken scratch brought me partly out of my stupor. That someone loved me or thought she loved me I found highly intriguing. Who would it be? I asked myself and found no answer. Was she someone from work? But there were only three females from work, and one of them was married. The other two, Rhonda Shears and Jane Grimes, seemed unlikely candidates. And then, suddenly, a horrible thought crossed my mind.

Was I hallucinating?

'Anyways, just after we found this reddish gick, all of uh sudden we felt uh chill--the kine you feel when you just go into the test section tuh ack-sess the models. My hair was damp, yuh see, and so I could feel it good. So could Holt. Holt jumped bolt upright from where he was kneelin (not like he was prayin, yuh see, although Holt tells me his folks is religious) en gave me this bug-eyed look just like out of some comic book--you know what I mean?'

'Yes, please get on with it so we can bid.'

'En then he says, 'The fan.' Just two words, yuh see. No verb even tuh take that much more time up. Cause I knew exactly what the guy was talkin about.'

The tunnel contained only one egress, as far as I, a mere sanitation engineer, knew. Somehow I had to maneuver myself around the elbow of the tunnel upstream to the test section. Ordinarily, I probably would never have made it, but the four words I had seen there scrawled in lipstick somehow made a world of a difference to me precisely when I had need of such a difference. What it really gave me was an incentive to try something.

There is a story about a Christian who has been out hiking in the woods for a while and has become lost. Soon darkness falls, and, just as he begins to ascend some path he has just found, he trips suddenly and then tumbles over some kind of ledge. But this fellow is lucky. There he hangs from the branch he has somehow caught himself on--it is pitch black out--and what could be either two feet or some twenty feet below his dangling feet. He tries looking down, but all he is able to ascertain is darkess. So the guy begins to pray, 'Lord, if you can here me, I am in dire need. Please give me a sign. And then, right out of the blue, the man heres distinctly the booming words 'I am here, my son,' from above his head. Of course, hope quickly returns to the man. With tearing eyes, therefore, he addresses the sky with the words, 'What do I do, Lord?' The great voice replies, 'Let go of the branch, my son.' Again, the Christian peers below, but he can see no farther than the tip of his nose. Shifting his weight on the branch, then, he looks up once more and says, 'Can I have a second opinion?'

I felt very much like that man as I released my grip to tumble, maybe, albeit sideways, to my death.

'Yes. Go on.'

'Sure enough,' said Jeff, 'the fan had started up. All by itself, as far as we could see, too, cause we both knew Buddy Charles left fifteen minutes before. Anyways, you could just look through the window en see nothin was there. There was nobody atall out there. Not a soul. And this whoosh roar was startin up, too.'

'Did you leave the door open?'

'Tell yuh, Jerome--that's the only reason I'm not talkin tuh you from the back seat of a hearse. The roar was really startin, too, as we scrambled out. I guess all the vibration and shaking was caused by that open door; it felt like an earthquake for a second in there.'

'I think so.'

'So we shut the damn thing down. My ears are still ringing.'

'What is it you want me to do about all this? The only thing I know about the tunnel is from being in it two or three times with Holt.'

'Well. Jerome, yer a sanitation engineer. Yer familiar with all kine of gicks. You think you can spare a little time tuh help us out?'

So I clawed my way along the bottom of that contraption. Every inch of progress forward required all the strength I could muster. I would look up or lean back just a tiny bit and that blast of air would at best stop me dead in my tracks or at worst slide me bodily backwards half a foot. I learned quickly to minimize my frontal projection, and from then on I made slow but sure progress.

Finally, I made it to the door. I was astonished, you can imagine, to discover that suction can be a painfully secure

"By this time, my gray matter had probably turned indigo."

lock. An enormous pressure differential was jamming the door shut.

Try as I might, I failed to budge that door.

'No,' I said.

'Why not? I'll even let you out of keeping watch here. I'll mind the store while you take uh look. Here, you give me Kenneth's keys, and I'll give you the ones to the tunnel. Just take uh brief look at it, and that's all.'

'One condition.'

'What's that?'

'If I know Kenneth at all, he'll be back all right--but not for hours. You keep everything going here, and I'll do it.'

'It's a deal.'

'And I'm not comin back today.'

Which almost proved truer than I could have imagined.

And then, just as suddenly as it had all began, I could hear again. The whining roar was diminishing; the tunnel was coming down all by itself.

Eventually, I emerged. You should have seen my hair. The streamlined look. Anyway, I felt frostbitten, exhausted, and sunburnt all at the same time. Somehow, I had survived.

Things weren't over, though. As soon as I regained enough of my ability to hear so that I would not get hit by a car, I left the building and crossed the street. It had been raining hard earlier that day, and, being exhausted, I tripped over a gutter and fell headlong into a fresh mud puddle.

Dont laugh.

Looking somewhat like Godzilla on a morning when he's forgotten to shave, therefore, I sprinted upstairs and negotiated my way to the office of Ms. Rhonda Shears. She was there, too, and I saw her orange mass of hair bob up as she looked at me in surprise. (Surprise is not quite the word.)

'Aren't we looking spiffy today, Jerome!'

'Huff-puff,' I huff-puffed. 'I dont think so, Rhonda. But maybe you can explain to me why we arent'

'What are you talking about, Jerome?'

'Look at me when I'm talking to you.'

'I dont understand. What's happened to you?'

'Can I see your lipstick?'

Finally, it dawned on her. She blushed.

'You saw it.'

'Rhonda, why did you stuff the lipstick in the prototype? Was it because you were in a hurry? Had no place outside to stick it?'

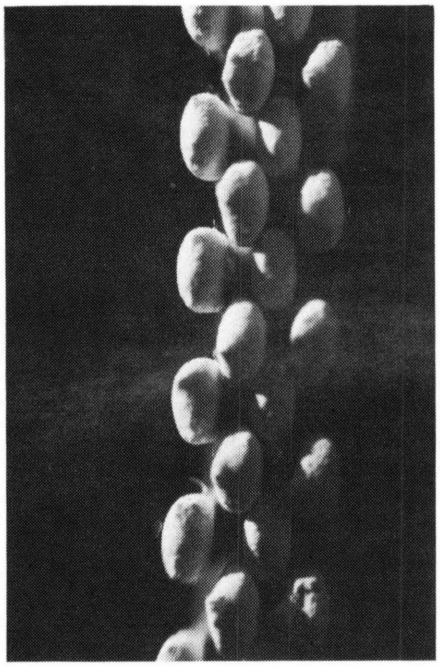
'Jerome--'

'Well, you know where you can stick it now!'

But I made her pay for it. Three years later, you see, I married her. —

PICTURE QUIZ

Can you identify these familiar objects?



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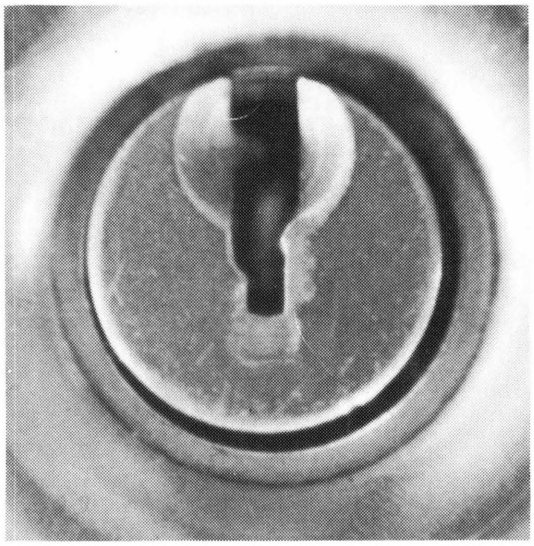

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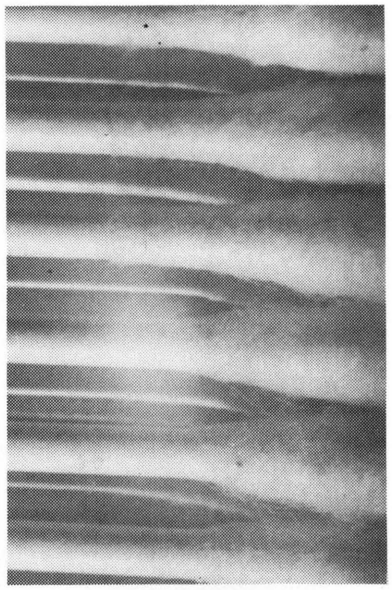

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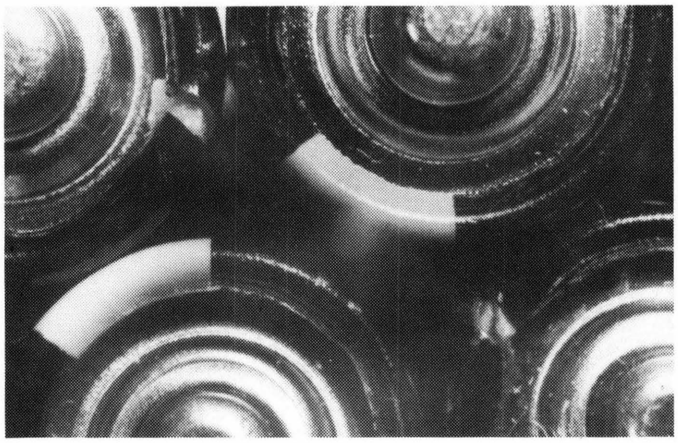

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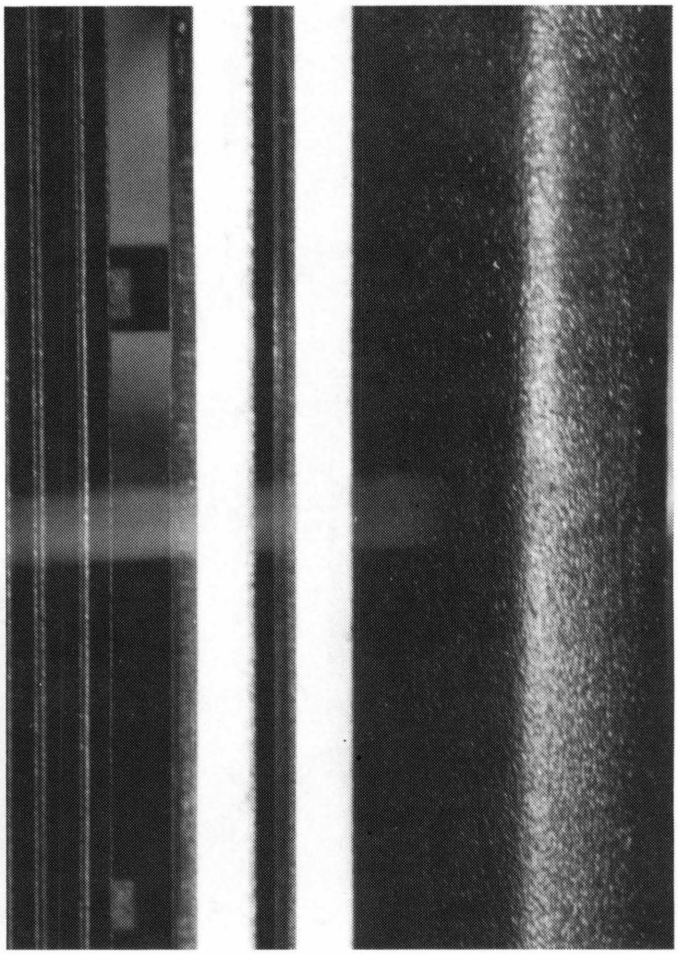

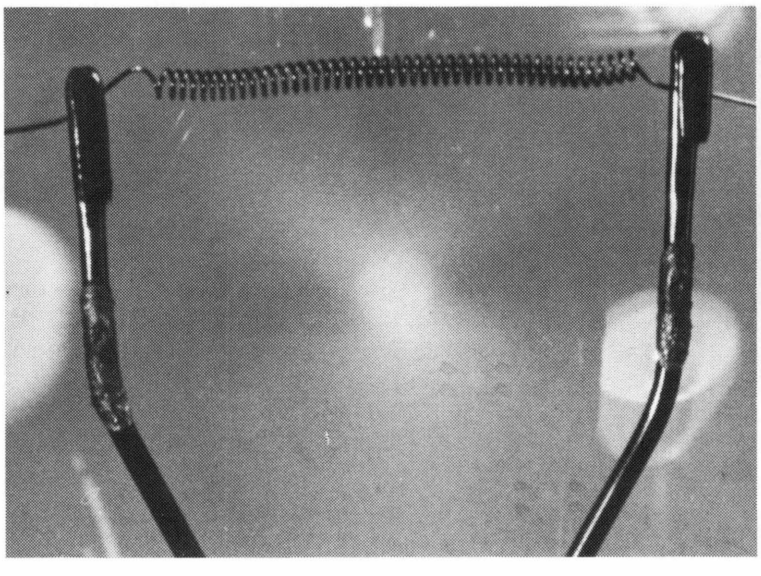

6

Answers: (1)matches, (2)door lock, (3)Q-tips, (4) battery terminals, (5)razor, (6)light filament.

by Mark Hill and Bill Nelson

US Army Corps
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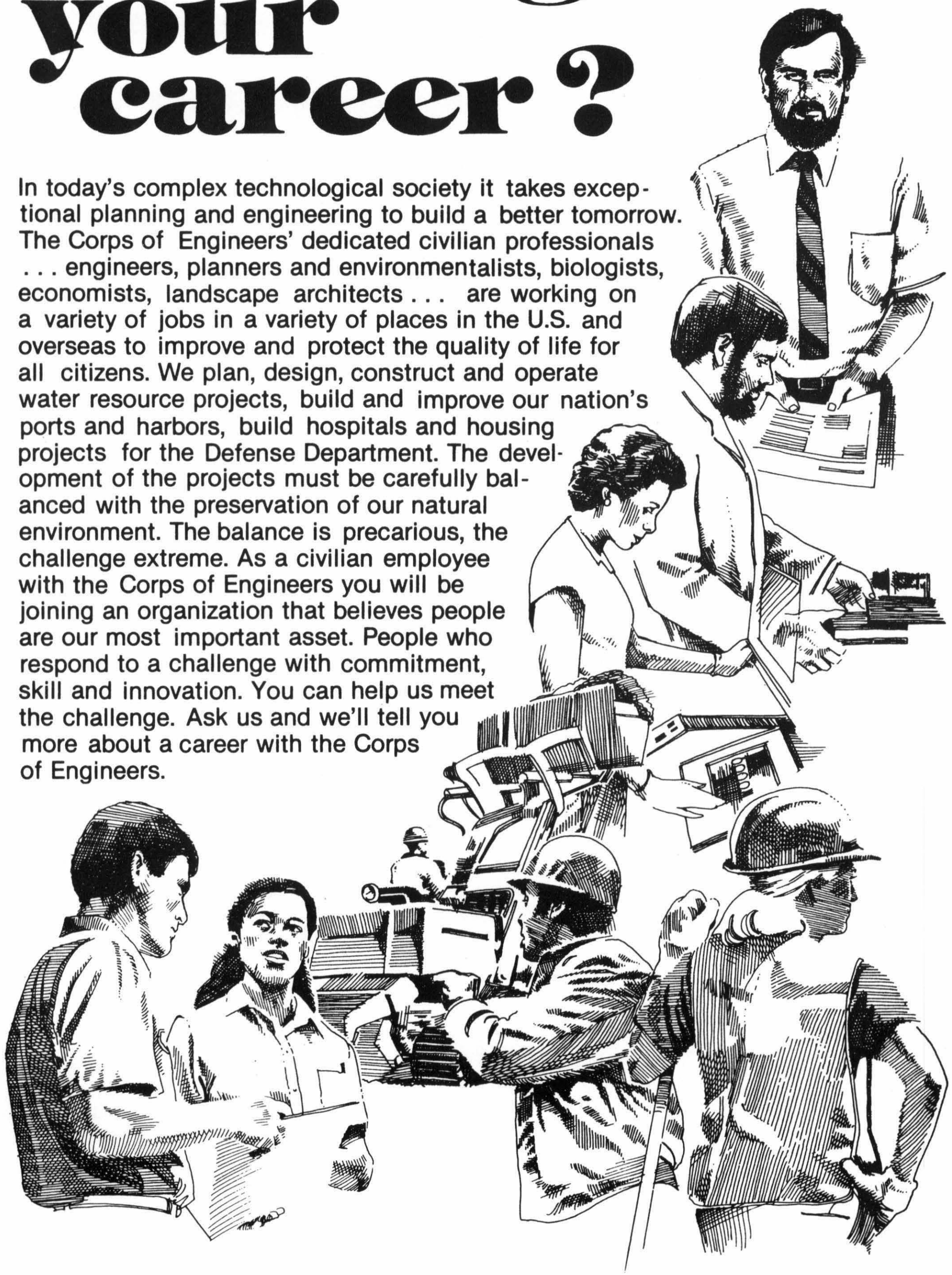

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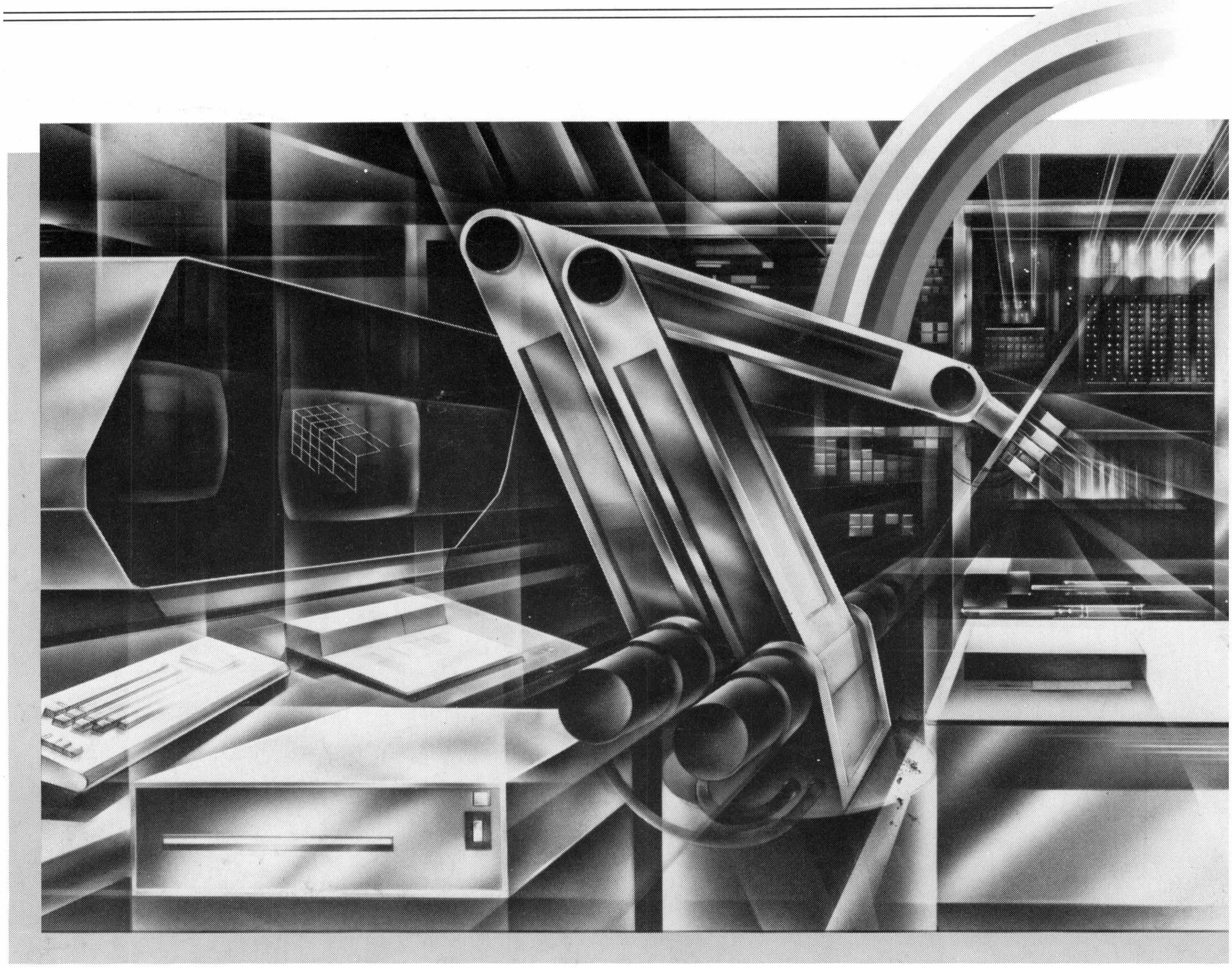

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