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OL. 74, NO. 1

35 CENTS OCTOBER 1969

wisconsin engineer

the population explosion

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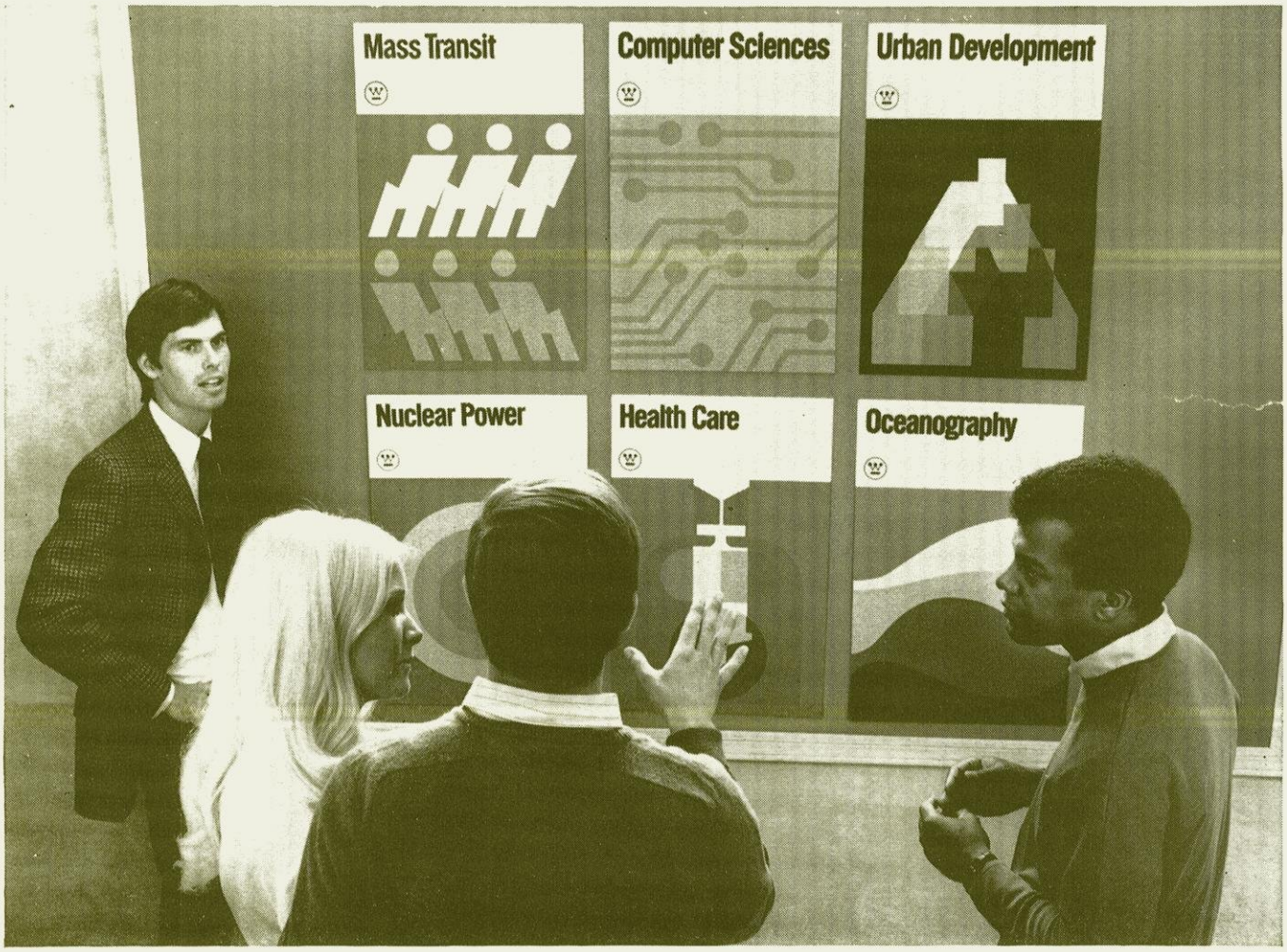

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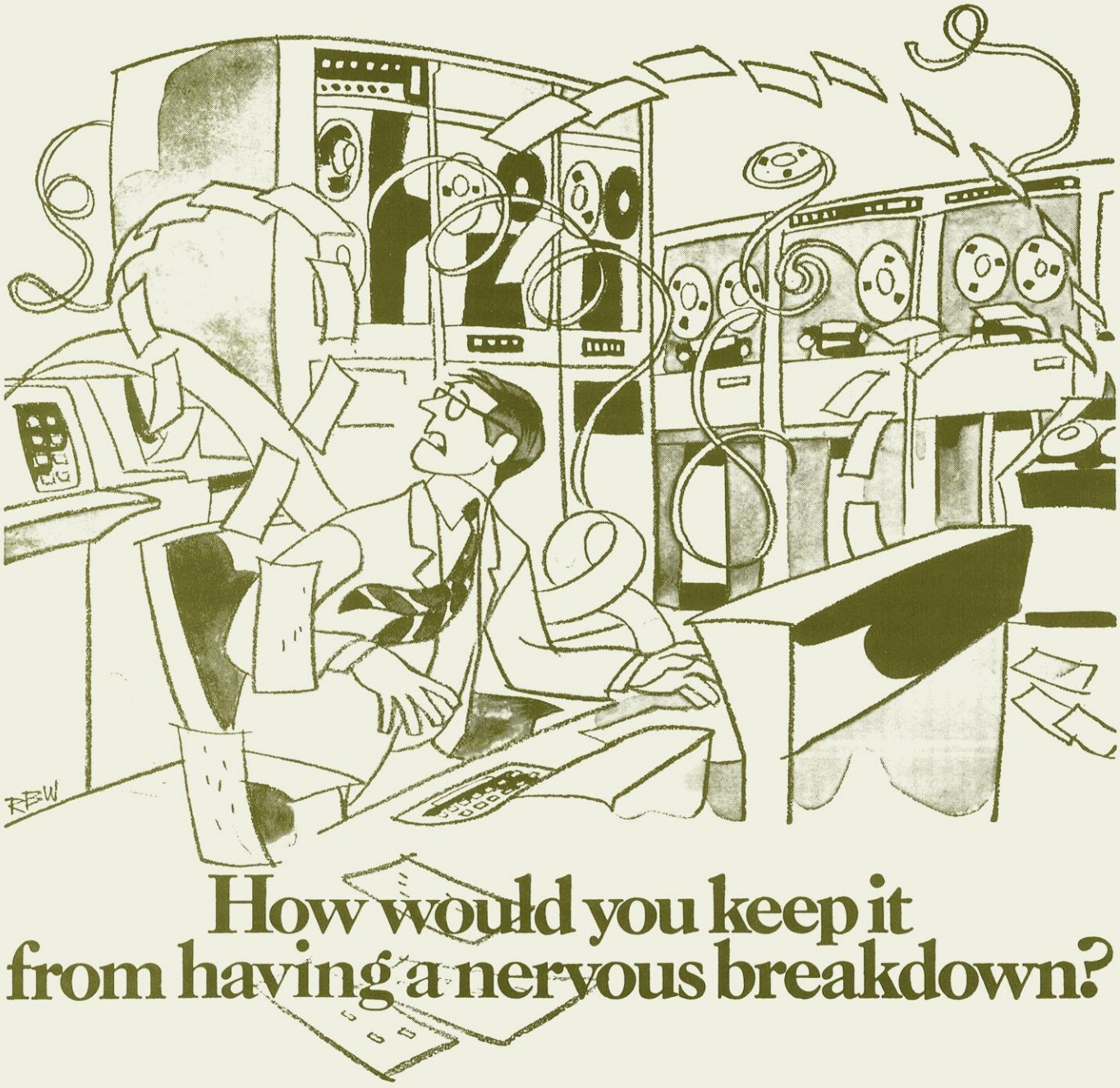

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CONTENTS:

wisconsin engineer

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The *lampyridae* beetle family. Delight of small boys. Biological light bulb. And prime source of raw material for another Du Pont innovation.

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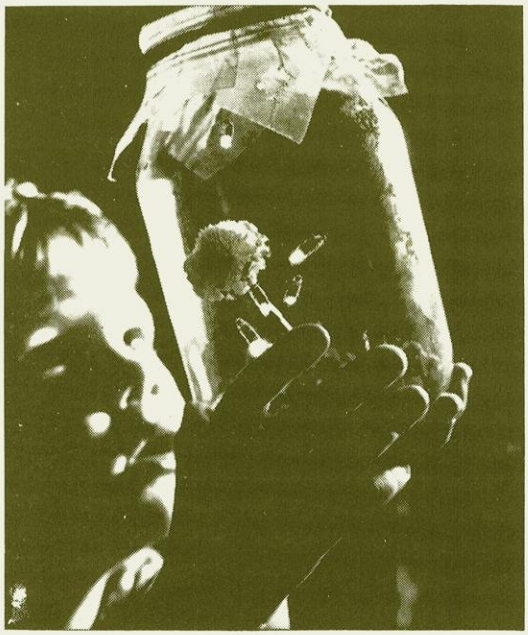

Other potentially lifesaving uses for the biometer are being suggested every day—such as diagnosing metabolic rates, enzyme deficiencies and nerve damage.

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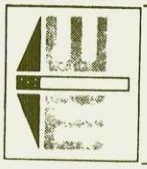

EDITORIAL

Spaceship Logic

Consider the problems of inter-stellar colonization. Inanely dismiss the economic and political ruminations of such perdition and reduce the problem to one of life support, that is, fulfilling the energy requirements of the socially motivated biological mechanism. Nullify the solution of a cryogenic somnambulence and concentrate on the organism's gratification. What are the requirements?

Primarily, a vehicle with an atmosphere to provide shelter from the vacuous environment. The import of generations of time would necessitate replenishment of this atmosphere so that the organism can eat, sleep, and eliminate. Efficient systems would have to be designed to supply continuous nourishment and, considering the finite mass available, regenerative waste disposal. Any toxic by-products would have to be carefully monitored or assimilated into another system. Above all, the participants must place self-imposed limits on their number, in order not to excede their systems' capabilities. Transgression of this rule, by the whole or part, would raise toxicity levels with death as a consequence.

Maintain the perpetual perspective and increase the finite size of the vehicle to the macroscopic earth of man's existence (apropos for the majority).

Consider the problems of intra-stellar colonialism. Insanely discount the more potent political factor of colonialism and digress to the subversive, delicate, ecological balance upon which man's presence hinges.

Man's vehicle, which has graciously provided its own atmosphere, has an efficient biological system which eliminates indigenous poisons. The caloric requirements of nourishment are transmitted through biological food chains. Higher order species enter at increasingly inefficient energy levels. Presently, man has a choice as to where he desires to fare along this chain, future choices will be somewhat more restricted.

Recent placebo: *if* man should ever control the orientation of the building blocks of life, DNA, he could approach these wondrous systems' efficiencies and synthesize his environmental needs directly.

With economic eminence as his desideratum, man plies the industrial arts to a hedonistic degradation. Using the panacea of "An unforeseen technological miracle will save us", he merrily multiplies, violating every rule of spaceship logic.

It becomes obvious that true to the processes of natural selection and lemming logic the human species will inexorably become extinct.

Roy Johnson
(Serpentus Crotalus)

An Open Letter

The University of Wisconsin

COLLEGE OF ENGINEERING
MADISON, WISCONSIN 53706

ENGINEERING FRESHMAN OFFICE
ROOM 22, BLDG. T-24
262-2473, AREA CODE 608

October 10, 1969

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We are also most grateful for the public services performed by many student groups and individuals associated with or enrolled in our college.

For example, we thank Triangle Fraternity for its promotion and support of the annual New Engineering Student Picnic, the annual Freshman Honors Banquet, and Parents' Week-end invitations and tours.

We thank Tau Beta Pi honorary fraternity for the volunteer free tutoring of engineering freshmen with academic problems.

We thank Polygon, its Student Committee for Public Relations, and its engineering societies, for its advice, counsel, and assistance, and for taking the engineering story into the university, and into the high schools.

We exist for students. We are doing our job so much more effectively because of the many students helping us to help their fellow students. To those mentioned, and to all of those not mentioned, we extend our sincere appreciation.

Sincerely,

Kurt F. Wendt

Kurt F. Wendt, Dean

Fred O. Leidel

Fred O. Leidel, Assistant Dean

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UNION CARBIDE

THE DISCOVERY COMPANY

Institutional Inequities

by David Howard and Jim Stevenson

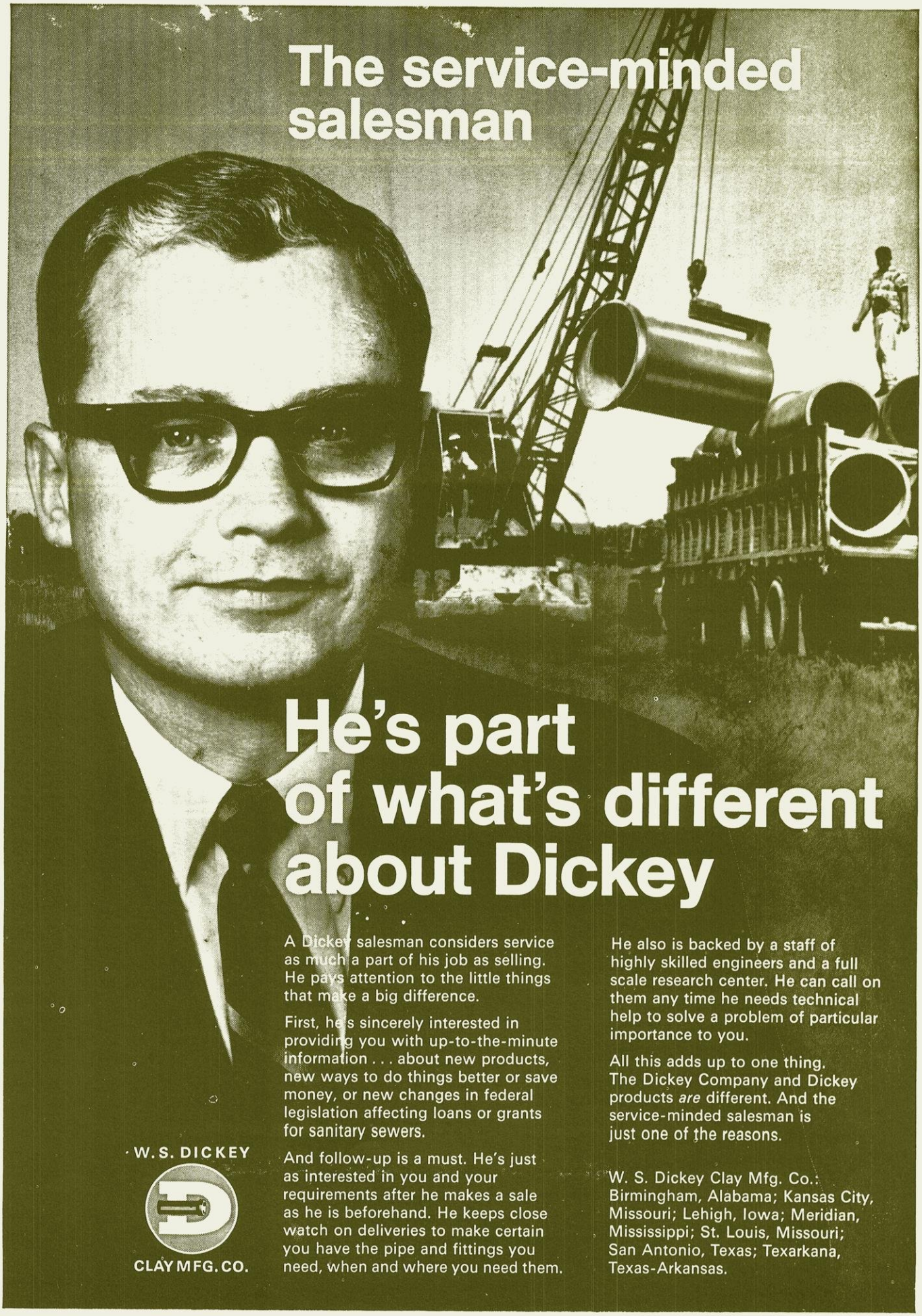
If you're reading this article in boot camp after flunking out of engineering school, console yourself with the thought that your failing grade was probably not statistically significant. Or if you just made the Dean's List, your making it might be more attributable to a statistical fluke than to inspired genius.

A survey of grades during two semesters in an engineering course showed that within 95% confidence limits for the average score of 95 out of 101 undergraduates extended into at least two grade zones. Half of the students could have earned one of three possible grades. (Following quantum mechanics, we will call these degenerate students triplets.) Thirty-five percent of the class (doublets) could have been awarded either of two grades, while six percent (singlets) received an unambiguous grade. Nine percent (quadruplets) could have deserved every grade from A thru D.

Seven of eight measures of student performance were used in this survey during the first semester: six hour-examinations, the homework average, and the class quiz average. Each of these measurements was scaled to an artificial average of 70 and an artificial standard deviation of 15. In this manner each measurement was standardized by the 48 undergraduate students enrolled in the course at the end of the semester. A perfectly consistent student, if graded fairly, would attain the same score on each examination independent of whether the examination was easy or difficult. Variability among an individual's scores was reduced because the lowest score was dropped and the final exam was considered twice as the same score.

During the second semester, performance was measured by four hour-examinations, the homework average, and a final exam. The hour-exams and the homework contributed 16 percent each towards the final score and the final exam contributed 20 percent. Each of these items was scaled in the same manner as described in the preceding paragraph. There appeared to be a somewhat greater multiplicity in a student's grades with the second semester's method of grading than with the first semester's.

From these results we can conclude that the final grade in a single course isn't usually statistically significant, although much other significance is often attached to it. Perhaps grades are taken a little too seriously . . .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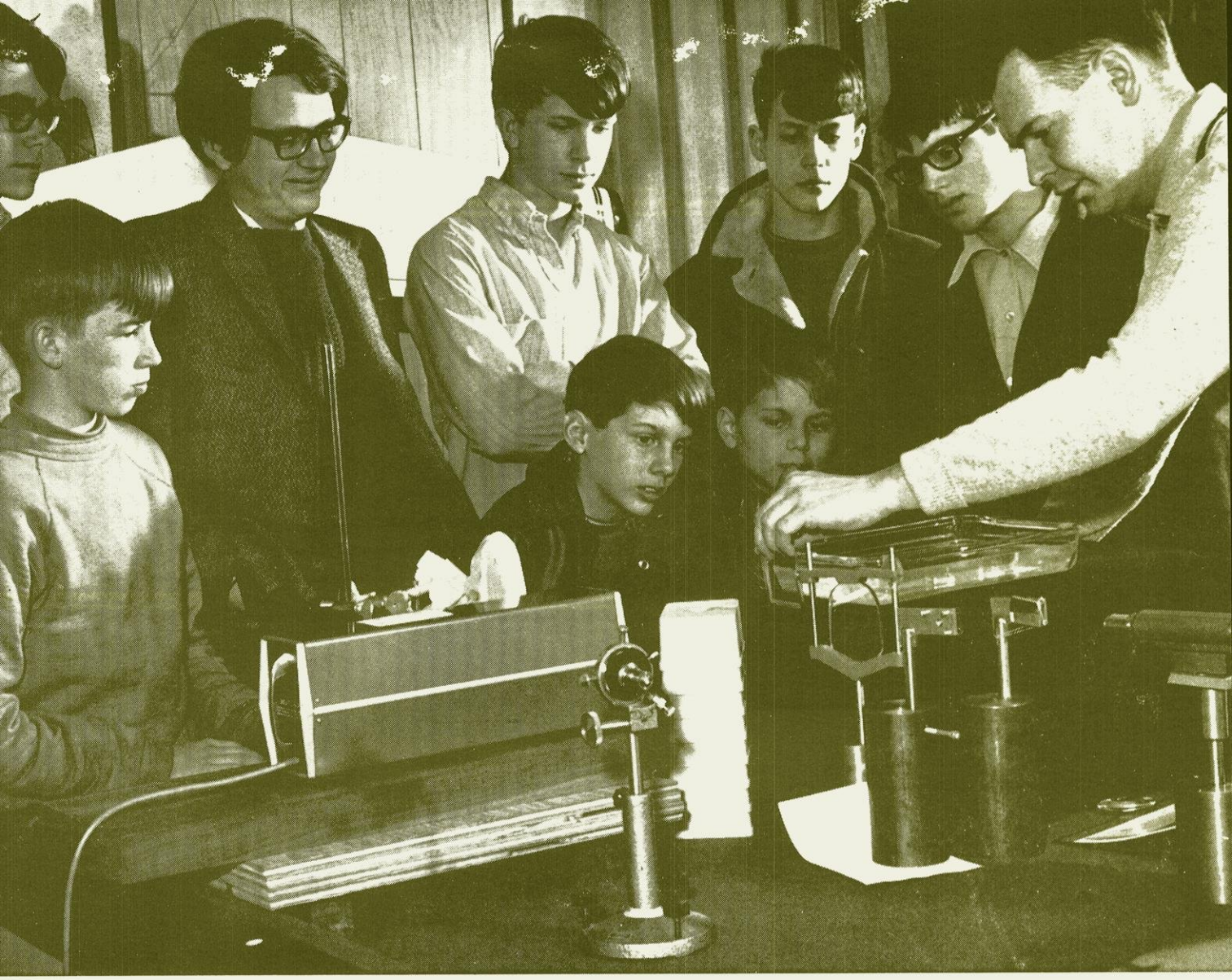

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Among John's other concerns is today's widespread shortage of technical talent. Due in large part, as he sees it, to children's lack of exposure to the excitement of science.

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XEROX

Choice

by Dave Gordon

In the organization of society the basic variable is interaction frequency. The interaction frequency is directly related to and correlates positively with population size. Changes in the societal structure can be predicted by population expansion.

Interaction involves the relations between two beings, yet interaction does not necessarily have to produce a direct active response in the behavior of the percipient. Interaction can be indirect (or unidirectional) as in the case of the reader and the writer of this essay. Obviously, the amount of interaction is constantly increasing as the population expands. Along with this increase are unceasing changes in the structure of world society. The number of interactions through individuals' percipient roles can be related to the total societal organization and its changes.

With the history of the world being one of continual population expansion, we can see that in less populous societies the behavior patterns (generated by a lower interaction frequency) are more complex as opposed to being simple and repetitive. Complex behavior patterns are produced with greater frequency at low levels of interaction, whereas when the interaction frequency is greater, activities become routinized and repetitive.

With high interaction frequency, many simple and repetitive behavior patterns are generated. By extension of this, all interactive patterns eventually become simple and repetitive. The simple and repetitive patterns become dominant as interaction reaches high intensity.

As world population increases, complex behavior patterns are gradually replaced by simple ones and behavior becomes less of a process of change and more persistent as interaction becomes increasingly rigid. Persistent patterns are patterns identical to the immediate previous pattern produced – no change, and no behavior enlargement. Only complex patterns are associated with enlargement and change.

If, in a given interaction, the behavior of the percipient is limited, it is an exercise of power. Power exercise can be seen in many forms, political bureaucrats exercise power, individual policemen exercise power, and bus drivers exercise power, just to name a few. The people who control exercise power to protect their position of control. An obvious example of this is the current conflict between labor unions and the Department of Labor, in which the unions say that to hire an equal (or fair) number of Blacks would "water down" the profession. Their position is based on the notion that the Blacks will put them out of work and that they will lose their positions of social status and power.

Eventually, a society will reach a point of saturation of power. The universities of today are becoming increasingly power saturated. The struggles among peers in the form of sororities and fraternities tend to make free academic progress impossible.

The decline of freedom, academic or otherwise, is marked by the decline in number of alternative actions that are not limited by external forces – another way of saying power exercise. With power exercise increasing as the interaction frequency rises, and increasing power exercise limiting freedom by lowering the number of interactive alternatives, individuals as well as societal institutions loose their diversity.

As interaction becomes more rigid, and individuals continually exercise power over other individuals and are themselves power dominated, they tend to aggress and discriminate against identical victims or identifiable minorities. This is primarily due to the tensions created within the individual as he is power dominated to a great extent and his interactive alternatives become fewer.

As this tension mounts there is a rise in violence. This is primarily because all power generated tension *can* eventuate in violence. It would seem logical, then, that violence mounts while power exercise expands. As Paul Mott puts it, "As the population of a social organization increases, the potential for conflict and friction among the parts also increases."

If we look at the contemporary military tactics we see the replacement of tactical and strategic considerations by essential genocidal goals. Nuclear "overkill" is a good example of this. Warfare today involves the entire population of the world.

It must be stated here that not all violent deaths are the result of aggression, but it cannot be denied that many accidents are really concealed suicides. Some, especially motor vehicle accidents also may be concealed murders. The actual extent of criminal violence is hard to determine from the data furnished by crime reporting.

Violence, because of power-generated tension, still persists, for instance, in race relations. Increasingly, however, meaningless purely activist violence among densely interacting individuals is becoming a way of life. The starvation of Kulaks, and the bombing of Vietnam were still related to political goals in power saturated societies. In Vietnam, the killing of enemies has replaced traditional military objectives.

I don't feel that the real problem of overpopulation is going to be feeding people. We have the potential technological means to solve that problem. The real problem of continued population expansion will be the problem of excessive interaction, excessive power exercise, and excessive violence. This will turn into genocide through mass extermination programs or nuclear war. Some of the violence may also turn inward in a mass wave of suicide. We cannot control the social implications of continued population expansion. The issue at hand is simply do we practice birth control or do we promote genocide?

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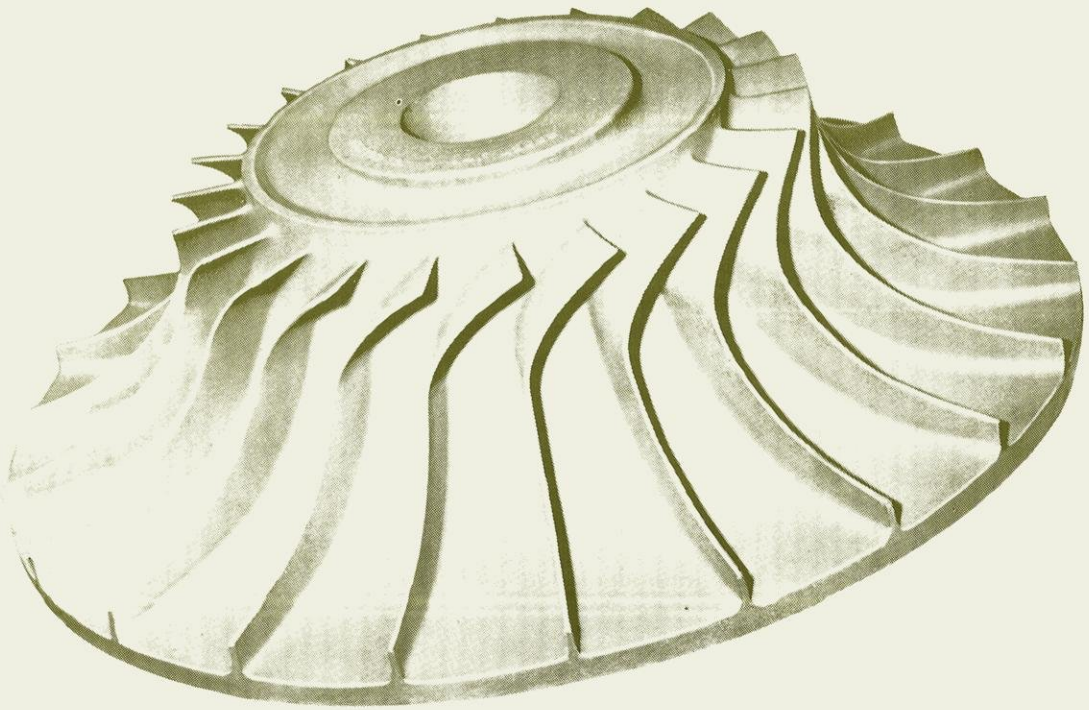

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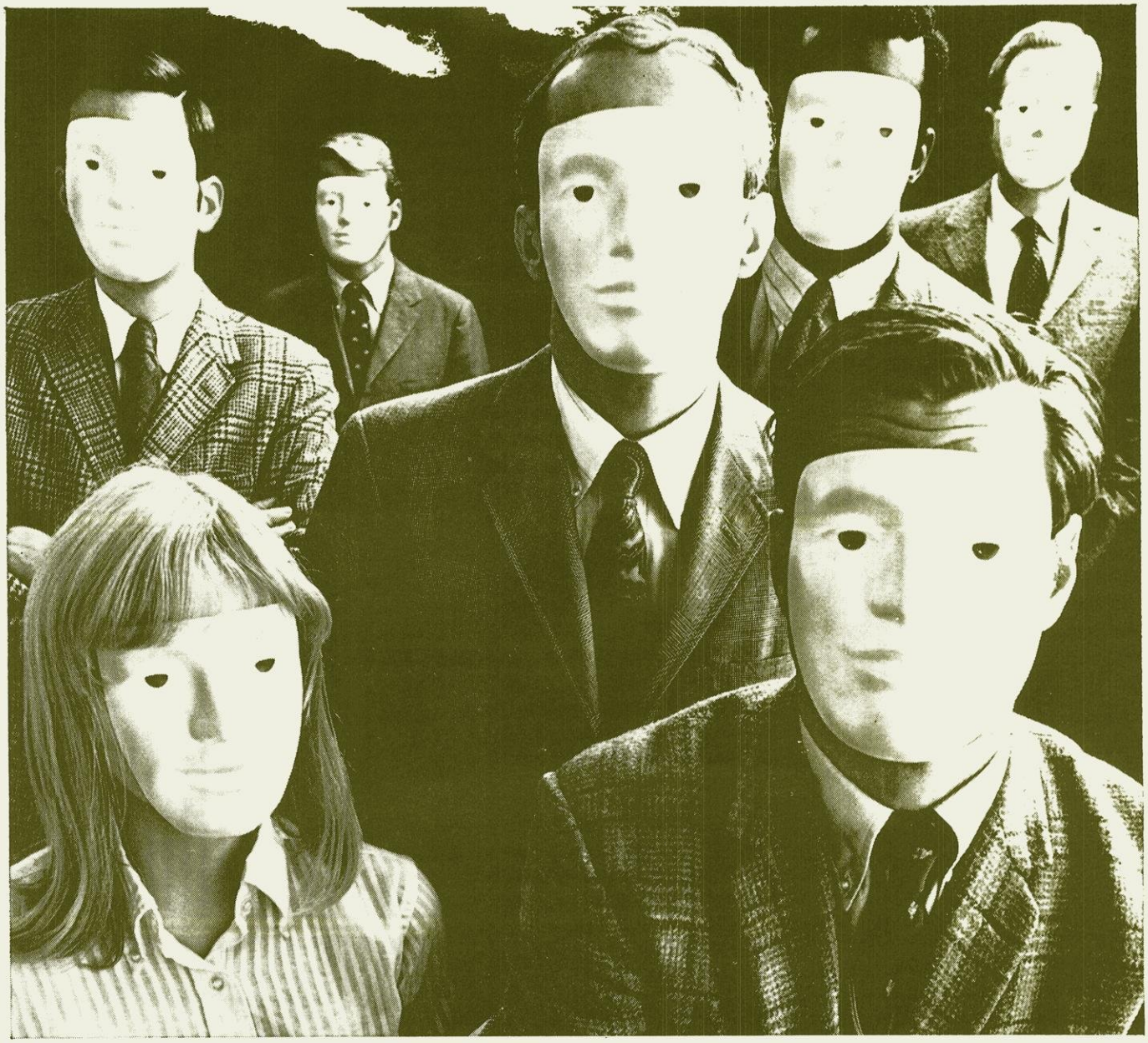

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You've heard the stories:

One big corporation forbids you to wear anything but white shirts.

Another says it wants you to be "creative"—and gives you a 4-pound rule book telling you exactly how to do it.

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"Multiply and Subdue the Earth . . ."

by Susan O'Toole

The undeveloped countries of the world, most of them already overcrowded and horribly underfed, are presently working toward a future infinitely more terrifying than their present unbearable conditions. Every year there are more people and less food to keep them alive. The logical end is mass starvation. Dr. Paul Ehrlich, in his book *The Population Bomb*, predicts that this massive famine will overtake us "probably in the early 70's, certainly in the early 80's." This year alone, a minimum of three and one-half million will starve to death, mostly children. Dr. Ehrlich assures us that "this is a mere handful compared to the numbers that will be starving in a decade or so. And it is now too late to take action to save many of those people."

The facts of overpopulation are surprising, unpleasant, and dangerously underrated. However, they are becoming the matter of more and more concern for biologists and ecologists. In an interview with Dr. Warren Porter of the Zoology Department, I asked him if he agreed with Dr. Ehrlich's prediction. His answer: "It's the prediction of almost any ecologist you talk to anywhere in the world. Primarily this whole business of the population explosion is a numbers game. There are equations which describe the increase in numbers of the population. We know what the population is now, we have a pretty good idea of how fast it is increasing, and from that we can predict quite accurately in many cases, how the population is going to increase."

An interesting but fatal fact of the numbers game is the phenomenon of "doubling time." As the number of people inhabiting this planet increases, the number of years that it takes that population to double decreases. It took the population of 6000 B.C. (5 million people) eight thousand years to reach 500 million people – a doubling time of roughtly 1,000 years. From 1,000 years, the doubling time reduced to 200 years, then 80 years, and the current estimate for our world population is a doubling time of 37 years. However, the doubling times vary in individual countries. While they may be as high as 63 years for the United States or 140 years for the United Kingdom, most of the doubling times for undeveloped countries are below the average of 37 years. Examples are 24 years for Kenya, 20 years for Costa Rica, and 19 for El Salvador.

The living conditions in the undeveloped countries are, of course, far from adequate. Yet to simply maintain the same impoverished level, the food supply, transportation facilities, industrial output, imports, doctors, teachers, and everything else that is necessary for maintaining life must also double at the same rate. Improving the conditions of a country is not simply a

matter of importing more food than a country consumed in one previous year. The surplus will quickly be consumed by the new surplus of people. To effectively raise the standard of living, the new supply of food and products must not only keep up with the increasing numbers of people, but must surpass it. It is not likely that this will happen in most undeveloped countries or even that increase in food and products will keep up with population growth, and the undeveloped countries will sink deeper and deeper in poverty. Obviously what is called for is not the impossible dream of pouring more and more food supplies into these countries, but an effective means of population control.

One factor of the overpopulation issue that is little known is that roughly 40% of the population of the undeveloped countries is under 15 years of age. In one decade this tremendous number of people will reach their reproductive years and there will be a baby boom that is unparalleled in the history of this planet. And all these people must be fed. The optimists among us will say that more people will provide more manpower for growing and distributing food, but the facts give support to a gloomier position. In 1966, while the population of the world increased by some 70 million people, there was *no* compensatory increase in food production. The result of these impersonal facts and figures is, for instance, that 100 infants die *per day* in Colombia from malnutrition.

Providing food for these countries, in the case that anyone cared to or was able to undertake such a project, could only postpone the inevitable, not solve the problem. What is needed is a stable population. A population that remains the same in numbers over a period of time is one in which the birth rate and the death rate are approximately equal. With increasing sanitation and medical advances in many undeveloped countries, disease is claiming fewer victims and the infant mortality rate has often been substantially reduced. While the birth rate continues to soar, medical advances keep more and more people alive, increasing even more the active and dependent members of a population. The implication is not that we need to let more people die, but that we need a means of effectively reducing the birth rate to balance it with our increasingly sophisticated knowledge in reducing the death rate.

This emphasis on the undeveloped countries should not leave the impression that the situation is under control in the industrially developed countries such as the United States. There is no longer any doubt that a great many people are literally starving to death in this country and a walk through the slums of any one of our major cities will give ample evidence of the effects of overpopulation.

The whole issue of population control boils down to a choice that we must make. Either the people of this world must exert a control over nature in the form of maintaining a population that is balanced with our limited resources of food and materials, or nature will exert her logical influence over a crowded planet in the form of war, pestilence, and famine. Studies with animal populations have proved repeatedly that in the face of limited resources, nature puts her brakes on an increasing population, and fewer young survive through one device or another. Man can control nature only to a certain point, and if the human race does not attempt to control its numbers, nature will do it for us.

The effects of overpopulation are not always dramatically evident in the form of starving and crowded populations, but are more subtley shown in the pollution of our lakes, rivers, soil, and even air. More and more people dump more and more trash and pollutant materials into our waters and atmosphere. Dr. Porter cites Lake Mendota as a classic example. Despite warnings, the lake has become clogged with plant growth in the last ten years. It is also an example of the damage done by thoughtlessness that is almost beyond repair by the time we get around to giving some thought to it. Just as the predicted famine of the next decade cannot be prevented even if the most rigorous population control measures are instituted immediately, merely stopping the flow of fertilizer into the lake every year will not automatically solve the problem. "Every year that you add more fertilizer", says Dr. Porter, "you add more to the total fertilizer of the lake and you don't ever lose any. This is the problem. And until we come up with a way of processing water to rid it of the phosphates and nitrates that provide the nutrition of the plants, we will continue to have more and more pollution; because the more people you get, the more waste you are going to get. And unless you go to a fantastic expense, you're inevitably going to have organic material entering the water, and organisms will die."

Ecologists are also concerned with pollution of the atmosphere and its effects on animal and human populations. Dr. Porter, in particular, is currently working with the application of heat transfer engineering to biological systems. He has been interested in the transfer of energy between the physical environment and the animal; in other words, how radiation, air temperature, wind speed, and relative humidity interacting simultaneously at the surface of the animal effect that surface temperature – the heat load or the cold stress on an animal. Starting with a simple engineering model, he is trying to define the multidimensional space that we call the environment and trying to define the limits for individual animals within that multilimensional space. Over and above the scientific questions about animal distribution and survival, one of the practical implications for the future is the problem of thermal pollution. Dr. Porter gives evidence that man is in danger of changing the climate of this whole planet, "in part by the dumping of materials into the atmosphere and changing the absorption properties of the atmosphere – the absorption to both solar and thermal wavelengths. Also the tremendous jet traffic and the contrails they produce, and the projected SST (supersonic transport) and the contrails it will produce at seventy or eighty thousand feet result in the formation of clouds. Now it's conceivable and the danger is present that if enough clouds are produced by these planes flying their patterns over the surface of the earth that this increased cloud cover will reflect more energy away from the earth, and the earth as a result will begin to cool – and it could very well induce something like an ice age..... The glaciers are already advancing at rates which they have never advanced before in our history."

The idea of a new ice age bearing down upon us is not likely to incite anyone to action. Obviously it will not come tomorrow, or if it comes, at least we will not see it in our lifetimes. On the other hand, the famine that is predicted is only one decade away. But human nature tells us to think about tomorrow, not ten years from now. The facts of mass starvation and intolerable living conditions are extremely unpleasant. Consequently, it is

easier for us to simply disbelieve them. Man seems to have a built-in defense mechanism that tells him not to believe or dwell upon those things that do not present immediate danger: those overwhelming facts of death and disaster in the unreal future of a lifetime, or those problems that will no longer concern him after he is gone. In the face of overwhelming evidence, people will say, a little uncomfortably, "It's not really true," to a well-supported theory that is painful to think about, just as the Darwinian theory of natural selection, unpleasant but documented by science, met with reactions of disbelief and repression.

However, even those who are aware of the scope and importance of the overpopulation problem may take it lightly in the face of an unrealistic but determined faith in the indomitable will and technological capabilities of man. How often have you heard, "By the time we reach a population-food crisis, we will have perfected farming from the sea," or, "Surely by the time the human race has filled this planet to overflowing, we will be shipping people off to colonize the moon and the other plants"? Either of these propositions can be reduced to the status of a myth. Dr. Porter feels that farming from the sea is "not a very realistic possibility for several reasons. For one thing, most of the types of farming which could be done require shallow coastal waters, and the amount of our coastal waters and the coastal waters of other countries which are shallow is very limited. Also, if you're going to farm the sea, it requires a tremendous amount of energy,just to move around and harvest the products. If you look at Lake Mendota, for an example of the problem on a very simple scale, we've been trying to harvest weeds from the lake for many years. There have been all sorts of contraptions out there trying to cut down weeds and process them. It requires a lot of energy to move water and anything that's in that water; and it's very difficult to do it economically. That's the point. And unless there are some massive sources of energy available to move about and to harvest the crops in the open seas, it does not seem to be a very feasible thing – at least not for many decades to come."

The idea of shipping people to other planets seems like a suitable alternative to a generation steeped in sciencefiction movies. However Dr. Ehrlich's book contains some interesting calculations about the possibility. Assuming that we can find planets that are habitable, which is unlikely, it would take only about 50 years to populate Venus, Mercury, Mars, the moon, and the moons of Jupiter and Saturn to the same population density as the Earth. It would take another 200 years to fill the other planets of the solar system. After 250 years, we would be forced to push on to the stars. The estimates are here that Americans, by cutting their standard of living down to 18% of its present level, could in *one year* set aside enough to finance the exportation to the stars of *one day's* increase in the population of the world.

Again, this issue tends to drift off into cold, impersonal facts, its subject being hundreds of years, billions of people, and the limitlessness of the universe. It is almost impossible to bring it down to a personal level. Those who read this article are mostly the lucky ones who live in an industrialized nation and because of a decent education will enjoy a comfortable income. The consequences of the population-food crisis may not touch us; our children will not starve. But unfortunately we do not live in ignorant bliss of what is going on in the outside world. News of death in Vietnam and political unrest literally flashes around the world and enters our homes through all the mass media, touching our lives every hour of the day. It does not seem unlikely that we will hear the statistics of mass starvation and see the evidence in the form of the bodies of dead and dying children on the six o'clock news before we have our evening meal. The question for us is not, "Will I live in fear of death by starvation?" but "Can I live with any kind of peace of mind in that kind of a world?"

Even assuming that we find some miraculous way to feed the growing mass of people and prevent starvation on a grand scale, the outlook for the future remains exremely bleak. If growth continues at the current rate, in 900 years we will have some sixty million billion people, or about 100 persons for each square yard. Perhaps we could house all these people in continous, multilayered, concrete apartments. Of course, parks and trees could not be allowed to take up critical space. It seems possible that we have not been able to fully estimate the psychological effects of a life in which seeing or touching a growing thing is an impossibility. Perhaps we do not yet fully comprehend the importance of natural surroundings and a few precious moments of solitude to the mental health of a human being. Dr. Porter, aside from his technical knowledge of the subject, is concerned with the argument of many people that the solution to the problem is simply producing more food to feed the people we are bringing into the world: "These people that make arguments like this seem to consistenly ignore the fact that civilized man is not just one who has a full stomach. He is a man who has had the opportunity to experience many different sorts of things. He has to have a good education, he has to be able to go out and appreciate nature. How are you ever going to appreciate nature if all you've seen are concrete streets and buildings? Civilized man must have an environment in which he can develop, in which he can think, in which he can have some peace. And if all you have around him are honking cars and dirty, smoggy air, then the development of individuals anywhere in the world is certainly not going to be the kind of development we want or that we have had in the past."

The problem of overpopulation, as real and dangerous as it is, seems to be a forgotten thing in our day, perhaps because it is so abstract. It is everywhere and nowhere in particular – too immense and formless to lay hands on and grapple with. However, it is impossible to ignore once the individual has become aware of the dangers. The hope for a solution may lie in this simple fact.

Probably nowhere in the United States today does one find as much proseltyzing about political matters as on a college campus. The concern about international tensions, the war in Vietnam, crime, starvation, poverty, and even reduced sensitivity to natural surroundings is overwhelming. When one feels strongly and sincerely that a problem needs immediate attention, he feels the need to awaken others to the dangers that exist. However, instead of attributing the ills of our world to man's inherently brutal nature or punching at the scarecrow of ineffectual political organizations, some of this immense energy could be redirected to the source from which many of the confounding problems of today spring – too many people fighting a losing battle against nature and themselves.

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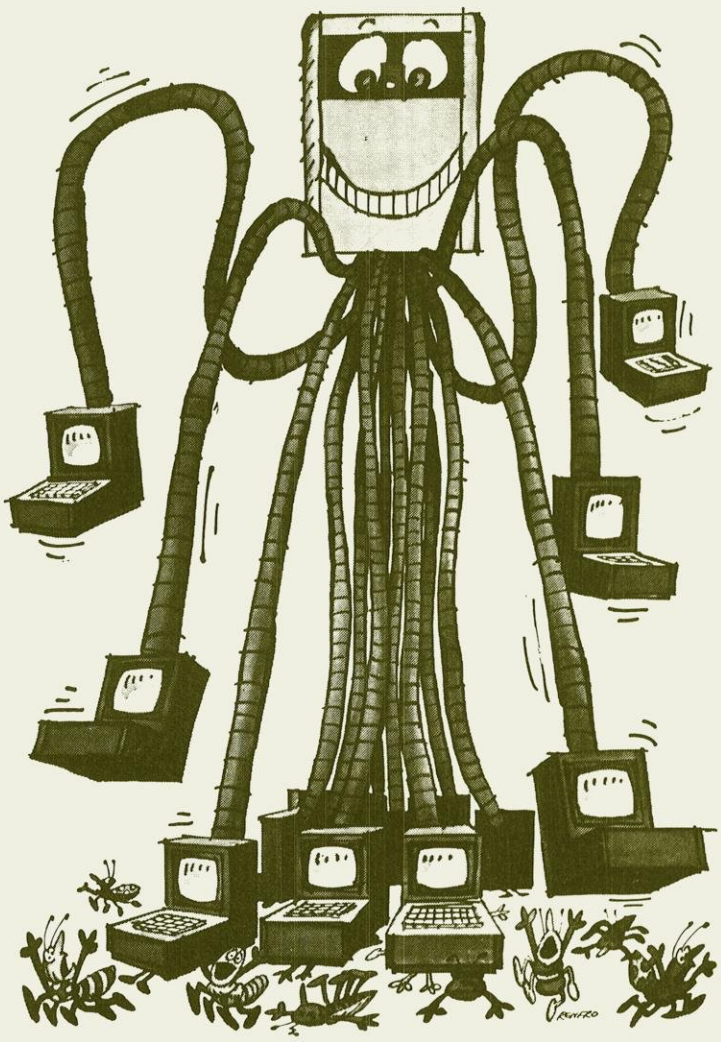


For career information visit your College Placement Office.

by Angus McDonald

I want to be either a yo-yo repairman, a casaba melon tender, an eggplant smuggler, or a malt wafer distributor. What I really am though is the Shadow. Anyway, I used to be. That's what they called me. They still do, except Ray. Ray always did call me Joe, which is my real name.

See the sign? 'Within these confines lurks the Shadow' – my room, of course. Cranston would like it. Cut off doors for slinking under, drapes for no light to get through, black walls. Really, the glow in the dark paint on the sign was a good thing last year. That's when I transformed.

I got this trophy on the mantel in the black room. The only thing in the room – Duncan Yo-Yo, First Place. It's a figure of this man – 3½ feet high or so. Its head is a yo-yo, its hands and feet are yo-yos, and it's standing on a yo-yo yoing – what else? Really, it's 2 feet high. I want to tell you as I see it.

Anyway, there were twenty of us in the finals at the Fox theatre in St. Louis – a statewide deal. Christ, big? They have this organist in residence, Wiley Henston, who came booming out of the floor playing this 1000 stop, multi-keyboard organ with combinations that wouldn't quit. He kept pounding away as he demised back into the floor. Then they turned out the lights so that all you could see were the yo-yos glowing in the dark – just for the warm-up though. They turned the lights on when we started the tricks. The audience had to see who the hell we were and what we were doing.

We all got through the easy stuff: walkin' the dog, around the world; but after that, guys started dropping out. Anyway, only me and this other kid could do a four leaf clover, but that was the last trick the announcer had. He thought we would have copped out by then. Just one first place trophy, so we couldn't tie. Anyway, the announcer stalled and talked to some guys offstage, told everyone to buy a Duncan glow in the dark yo-yo - everything. So finally he said to make a figure like the trophy – see who does it best. I didn't know what the hell to do. I never tried a person figure before. I spun like hell and then flipped the string around two fingers for the legs – kept wrapping it around – and then around two fingers on my other hand for the arms. Anyway, the yo-yo was about out of string, so I let the spinning yo-yo be the head. See, my fingers were together for the arms and legs. Then I unravelled the mess. It was sorta screwed up, but it looked something like the figure. Anyway, the other guy's yo-yo stopped spinning.

The yo-yo is like part of me. I've got it down, especially the trick that looks like a person figure. I don't practice anymore. Actually, I do very little slinking and less moves with my black velvet cape anymore either. After classes, which I do go to now and then, I sit here halfway up the stairs and do homework and think and stuff. I don't really do homework. I stopped going to classes two weeks ago Monday – except acting. I went to acting class last Thursday to do my midterm performance. The instructor, I mean instructress, told us to choose a soliloquy and get someone to work lights, etc. Well, I didn't feel a soliloquizing or whatever the hell coming on, and anyway, Ray's the only guy I know in the class. Ray, Christ, the pencil neck would be worried about the protocol for my curtain call. Not really. Anyway, I told her I'd do the Vanquished Czar from Malta soliloquy from this Oriental play. I forgot the name of the play I used. Anyway, she thinks I'm so weird that I might have found a soliloquy like I said. She didn't say anything to check me on it. Probably figured me out of the running for a grade by then anyway.

I got up and told them I was going to yo-yo for them. She told me to sit down though before I got to any good tricks, like the man figure trick. I would've just kept on; I mean what could she do? Drag me off the stage with a hook or something? But they were laughing at me, so I relinquished and made a stage left exit threatre move.

That's why I'm getting inducted tomorrow. Bad in school last year; by now, an academic disaster, a fiasco. I just don't like school; it's not helping me. What can I say? Only interesting thing this year was a lock-in. Come one class end, 2000 herded for the doors and zocko! – chained shut. First, abhorence and profanity toward the confinement. Next, mild concern. One guy – 'But break 'em; break out. I gotta test next hour.' One group protested lock-ins. Leaflets were scattered about the corridors extolling the merits of community. 'Form bonds with the bonded.' I thought of escaping through a skylight, but I enjoyed listening to others conversing about no exits and what they should do. Everybody was still meandering about when a sagacious janitor located a tin shears and freed the pack. They never found out who was behind it.

Anyway, I thought I'd flunk the Army physical. Christ, the way the sargeant gave instructions at me – must've thought I'd flunk the mental. Talked like Huckleberry Hound, only retarded. I didn't check out in cape or anything for the physical. The Army wasn't ready for the Shadow. Anyway, I guess I wasn't much of a devout Shadow by then. They treated me bad – a real fiasco, a gahdamn fiasco. I'm very big on the word 'fiasco' lately.

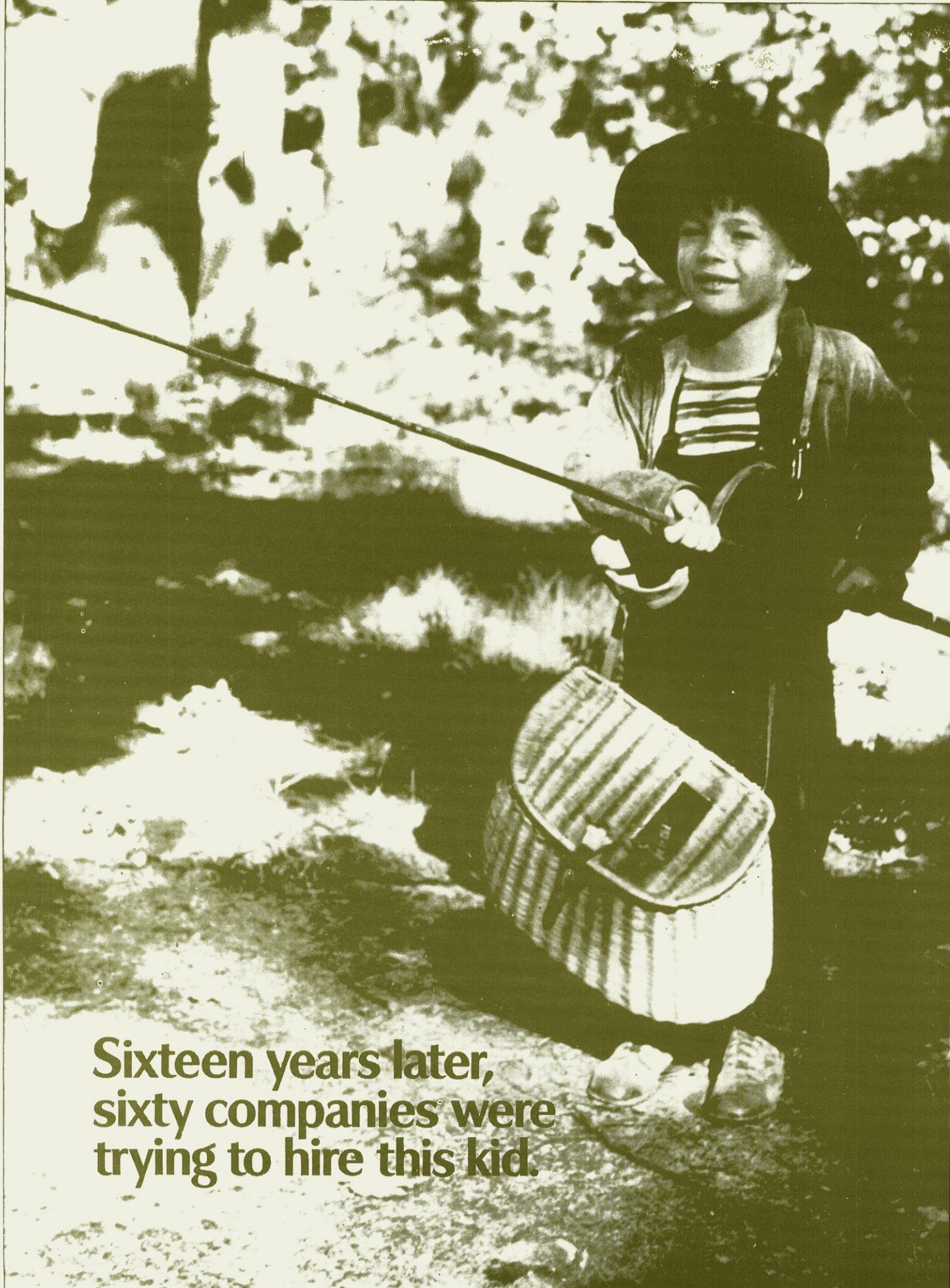
Anyway, I couldn't take a leak for the urine sample, so this guy in front filled my cup. He kept begging for more cups – real desperate like. His cup runneth over. Too bad he didn't have other piss problems. He'd have done some of us a favor. I gave a good blood sample though – about a quart. The nurse, God. 'This won't hurt. Just tense the arm so the vein shows.' Then she jabbed me in the elbow but yanked it out right away. 'This won't hurt. Just tense the arm so the vein shows.' Tense your arm, baby, and I'll put a bubble in your vein.

I was still holding cotton over my wound during the hearing test. I was losing blood – both arms. Anyway, you push this button when you hear a noise. So I'd push it and then quick put the cotton on the wounds. I wasn't too swift, so the operator opens the door of the isolation booth and asks if I'm deaf and if not, could I please get my ass in gear and hold the button down as long as I heard the noise. I should have asked him to shut the door 'cause I couldn't hear with all the outside racket. He'd a karated me to death. I passed the whole test – a fiasco, a gahdamn fiasco.

I was thinking about declaring conscientious objector too, before the physical, but I'm a Methodist, sort of, and anyway, they don't get a C.O. Peace is what I'm for though. Peace through war? That sucks – a fiasco. I mean I'm no authority or anything, but let's face it, it sucks so bad pretty soon the whole world'll be a vacuum. Anyway, if one of the Appeal Board members challenged me, I'd just get ticked and wish I was biting his jugular vein or something. I mean how conscientious is that? Not enough sincerity to get a real hearing you know.

So tomorrow I'm supposed to go. My mother doesn't even know. She thinks I'm on probation for grades and working my ass off. See, I haven't been home since last spring, pre-Shadow time. I

(Continued on Page 26)



Sixteen years later, sixty companies were trying to hire this kid.

While still in kindergarten, science was already moving to make Dennis Twining a hot property.

"By the eleventh grade they launched Sputnik I. The science race was on and I was in it. I started cramming.

"After high school, I had a chance to go to the University of Michigan and work as a research assistant.

"Our project was in a cemetery in case of explosions. Great for dates.

"When I got my metallurgy degree there were sixty companies with jobs for six of us. I checked out the top ten and picked International Nickel. Why?

"Because they gave me the best chance to stay at the front edge of technology and also learn the other half of the equation—business.

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used to go out regularly in my pre-Shadow days. I'd talk to people and tell them 'Hi, I'm Joe. What's the word?' But it wasn't much. I mean it wasn't giving me insights or anything. That's when I decided to be somebody. Just for the hell of it – the Shadow.

I mean you can't see him or anything, but he's real. He's always there just in time to put the word on the non-abiders. 'Len, let's go; I've got the loot. Oh, wait. Arrrgh! Something's strangling me in the Egyptian Crawler. Len, I can't move.' 'This is the Shadow. You cannot escape. You will pay for this crime.' All very good stuff.

Anyway, I descended in cape and gold fez and wore this neat chain with a yo-yo attached, a medalion like, and this neat snake figure walking stick. Decked out for perspicacious movement. I didn't have much class though. People did begin talking to me on the street though.

Something very rare. Told me I was a mental and evil and nefarious, and a dirty insult to youth – the whole thing. Actually, they didn't say nefarious. I just threw that in. One lady asked if I was a beatnik. 'The Shadow, Ma'am, the Shadow.' Then I held out the yo-yo for her to look at.

I was waiting at a corner last month, and I felt this hand on my shoulder – real hard, like the law. It was this guy dressed in skins. I swear to God. Where he wasn't fur, he was painted – yellow, red, purple, orange. Messy though, sticky looking. 'You're the Shadow?' 'Yes.' What more could I say? 'Do you hypnotize people so they don't see you? Metampsychosis? Mass suggestion?' All the time he's got this dead stare. Serious. I swear to God. 'Ah, yeah, ah well, no, they don't see me. If they did, it would be all over, but anyway, I mean my bod goes incognito. But stay straight, and if you can really see me, you don't have to fear the lurking Shadow.' Then I held out the yo-yo for him. He grabbed it. 'Shadow, whatever power you may have, be true to it.' Then he turned and walked away – very deliberate strides. Serious, a serious mental.

Like I said though, I wasn't much of a Shadow. People saw me once, and well, you know. I just wasn't a big thing anymore. 'You're the Shadow, so what?' – that kind of thing. Anyway, I got tired of crawling under the doors in my abode instead of opening them. I mean all along I knew I was just doing it. Everybody has hangups. You know. Anyway, I got tired of being the Shadow.

One day, instead of lurking in the black room, I sat on the stairs halfway up. Now I'm out here all the time. No cape; no medalion; no shadow moves. My fellow boarders were all wise at first. I mean it was different, me sitting halfway up the stairs. Al came by once. His room's at the other end of the hall. Anyway, he asked if I lurked late lately. He was bustin' his ass over what he said and his Peter Lorre voice. I couldn't say anything about not being the Shadow – not to that ass-hole. All the winners kept passing by. Sometimes they'd stop and talk – all bars and broads and highs. No depth; bullshit like pre-Shadow days.

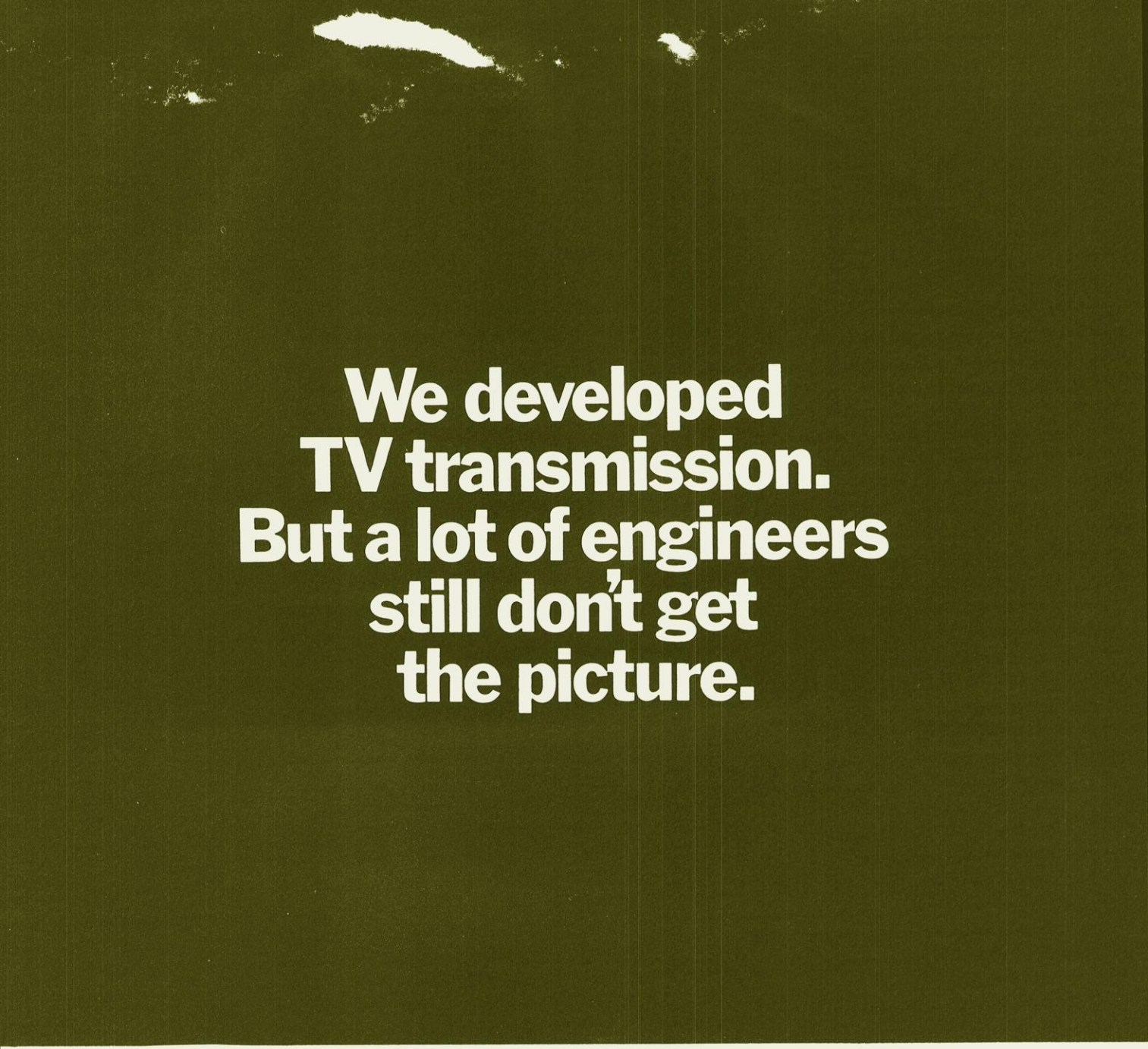
Yesterday Ray came over to see Al about something. They're in some travel club together. Anyway, he asked me about acting class and my not being there. I wasn't learning anything I told him. I wasn't, of course. Nobody was. I added that I had bowed out of the academic community. He investigated about the draft and I told him about tomorrow, the induction and all. I didn't tell him I wasn't going to comply. I thought he'd report me or raise his hand or something. He did seem O.K. though, concerned I mean, about my hang-up with the Army. He said he wished I could've finished the yo-yo thing in acting class and about how college just didn't make itself fit some guys. He wasn't really comfortable saying it. He sorta looked at the bannister and rubbed it and stuff. It embarrassed me really. I mean I wanted him to leave in a way, but I was glad he was talking. He said he was glad to know me. Said once he was going to call me to see this film – that I'd be good to talk to , but he was afraid to. He was afraid to call me. Just didn't know me very well and was afraid to.

That surprised me – what he said. I didn't think he was like that at all. I wanted to tell him about not going for induction and about sitting here because I didn't want to be the Shadow anymore and said 'It sucks' and a lot of 'Yeahs' and stuff. I told him I'd have to do the yo-yo thing for him sometime. Then I just said, 'Thanks for calling me Joe.' I said it when he was about to Al's room, but I think he heard me. Calling me Joe meant a lot to me.

* * * * * *

Well, as you can see, tough times are upon me, but it'll be all right. They'll come and put the word on me about not showing up and eventually I'll go to court. I suppose they'll wind me up and put me where they want, but anything can happen. Even now visions of extending proportions are in my mind's eye – plastic men slurping between bars and quitting the place before they know the identity of who they're trying to keep locked in captivity.

(Editor's Note: "Within These Confines," written while the author was attending Wisconsin State University – Oshkosh, first appeared in "Wisconsin Review." He is currently appealing a 1-A draft classification while working with tenant unions in Frederick, Maryland.)



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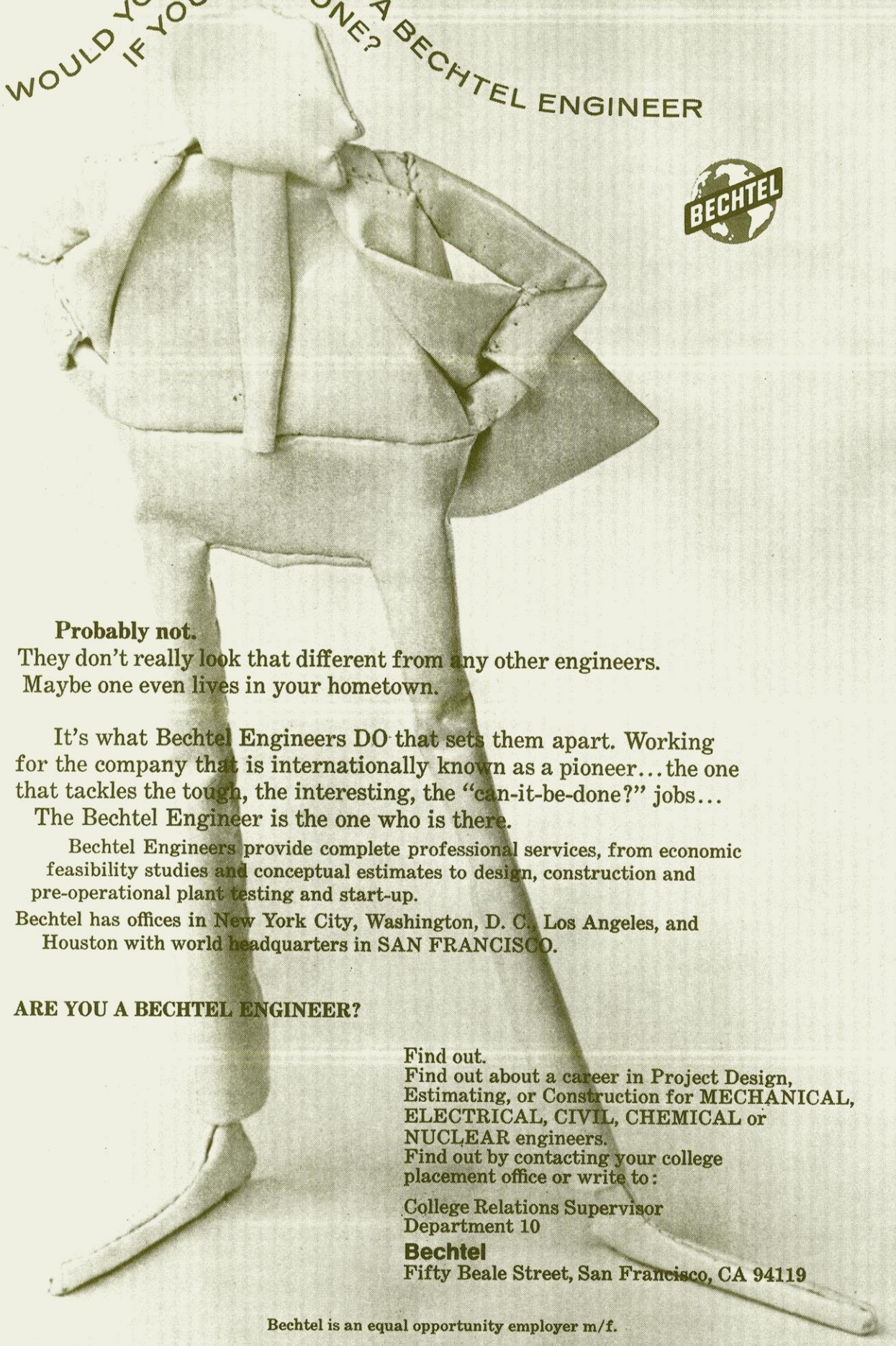

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Chemical and Biological Warfare: Better Dying through Chemistry

by — Jerry Gottsacker

Joe College, soon to be a University of Wisconsin freshman, was anxious to go to school. He had learned much about the "illegitimate underground drug scene" at the university, and fantacized much about, as the hippie down the block put it, "beautifying his mind." Joe worked hard and long that summer in the local cheese factory, earning enough "bread" for college. Joe's story ended shortly thereafter as he was arrested halfway through the first semester for illegal drug use. He was only beautifying his mind.

One of the biggest users of LSD 25 at the University of Wisconsin will never get arrested for illegitimate drug use. He is Dr. Vincent Polidora, a former Associate Professor of Psychology. Dr. Polidora, during his employment at the university, was very much a part of the "underground" drug scene; he was engaged in secret research concerning incapacitating capabilities of LSD 25 performed for and financed by the U. S. Army. The findings of Dr. Polidora's research will contribute only minutely to the colossal library of information and materiel gathered as part of this country's Chemical and Biological Warfare program. Someday Dr. Polidora's findings may be used to kill a human being. He is not beautifying his mind. His use of LSD 25 is "legitimate."

Even after Rep. Richard D. McCarthy's exposition of a capricious Army plan to transport nerve gases across the country for disposal in the Atlantic Ocean, Chemical and Biological Warfare (CBW) remains an obscure concept to most of the taxpayers who foot the bill for the $650 + million program. [1] CBW has been employed as weapons in various forms against enemies, civilians, and nature as long ago as 2000 B.C., when the wars of Ancient India were fought with fume, smoke, and incendiary devices. [2] Phosgene, chlorine, and mustard gases, among others, were used in less ancient World War I. Continued use of those gases and active development of primitive nerve gases (never authorized for use) were accepted programs of both Allied and enemy forces during World War II. The use of certain gases in both World Wars brought about the post-war Geneva and Hague prohibitions of gas warfare.

In this country, development of nerve gases continued after WWII despite Geneva Convention restrictions on their use in warfare. Until recently, development was under the direction of the Army Chemical Corps. Developmental responsibility has since been transferred to various agencies of the pentagon, but the Army maintains a prime responsibility for stockpiling and a secondary commitment to development.

A catalogue of chemicals produced and stored by the Army might well be titled *Beyond Orwell* or *Beyond 1984.* Chemical agents are categorized into five basic areas: Riot Control Agents, Harassing Agents, Incapacitating Agents, Defoliants and Herbicides, and Nerve Gases.

Riot Controls consist of variations on the common tear gas theme: CN, a non-lethal, fast-acting tear gas, and CS, a more toxic tear/nausea gas. Both are used in Vietnam.

Harassing Agents include DM, a pepper-like arsnecal gas which can be lethal in heavy doses. (Evidence submitted to the Mayor's Commission investigating the Mifflin Street disturbance of last spring suggests that CM, or "pepper gas," may have been used by police on students. However, testimony was contradictory and the facts were never exposed.) DM causes such agony that the victim often tries to kill himself. Documented cases include an attempted suicide by gun and another incident in which a man tried to rip all the veins from his neck in a futile attempt to relieve the pain and agony caused by DM. [3] Also included in this group is HD, a refined version of mustard gas which blisters skin and is lethal in heavy concentration.

Incapacitating Agents are used to "psychedelicize" the enemy, thereby disabling his aggressive capabilities. A list of psychochemicals investigated for possible use as warfare agents by the Army sounds like an enumeration of the most-used drugs on campus: marijuana, peyote, mescaline, psilocybin, and LSD and its derivatives (STP, DMT, etc.). Most of these drugs were dropped as serious contenders in their category because they require too large a dose to be effective for military purposes. Only LSD has received continued research attention and it is believed that BZ, the Army's only other incapacitating agent, is a derivative of LSD.

Defoliants and herbicides are responsible for the destruction of over 480,000 acres of crops and the defoliation of over 3,750,000 acres of jungle and other cover growth in Vietnam. [4] Employed for the defoliation of jungle and cover growth is 2,4-D used in combination with 2,4,5-T. 2,4,5-T (trichlorophenoxyametic acid) is somewhat more toxic than 2,4-D (dichlorophenoxyacetic acid) while both possess similar properties. Cocdylic acid is used for crop destruction and contains 54.29 per cent arsenic. It can cause arsnecal poisoning in humans and is used widely in Vietnam against rice crops.

Stockpiled for a potential transition from crop to human destruction are

the nerve gases, some of the most celeterious and efficient killers known to man. In 1954, Lieutenant Colonel S. J. Efnor, former commander of the Rocky Mountain Arsenal, revealed that "A tiny drop of the gas in its liquid form in the back of a man's hand will paralyze his nerves instantly and deaden his brain in a few seconds. Death will follow in 30 seconds." [5] The gases have been refined since 1954; only 1/50th of a drop will kill a man in 1969. [6] Military Field Manual 3-215 describes the symptoms and effects of nerve gas:

> . . . running nose; tightness of chest; dimness of vision and pinpointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea, vomiting, cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These symptoms are followed by cessation of breathing and death. . . [7]

Nerve bases work as acetylcholinesterase inhibitors, that is, they block the chemical action of the enzyme acetylcholinesterase (ACHE). As a nerve impulse is transmitted a chemical known as acetylcholine acts as a bridge across the gaps between nerve endings (called synaptic junctions of which there are millions in the human body.) ACHE clears the synaptic junction after acetylcholine has bridged the gap; it "erases" the neural impulse. Absence of ACHE--the absence of the neural eraser - - allows a constant impulse to be generated, thus preventing proper messages from the brain from getting through to the proper muscle or organ. As an illustration, without ACHE the heart would not beat, it would receive a constant message of either beating or not beating, causing heart seizure. One doctor aptly described the consequences of nerve gas contamination as strangling in one's own vital organs. A nerve gas capable of performing to the above specifications is produced in a plant in Newport, Indiana. Manned by 300 employees, it has been operating 24 hours a day since 1960 [8] The Newport factory produces one of the two nerve gases that the Army stockpiles. Both nerve gases are similar, differing only in volotility. Sarin, known to the military as GB, was derived from a gas, Tabun, which was developed in Germany during WWII. (The man who developed Tabun also perfected Zyklon B, the gas used to exterminate Jews in the chambers of Nazi Germany.) It was decided in the early 1950's that Sarin (CH (C H O) F PO) was best suited for potential military use and was procured as the military's standard nerve gas. [9] Research completed in the late 1960's resulted in the discovery of VX, the military's second nerve gas. VX has the approximate viscosity of motor oil and persists longer than Sarin, which evaporates about as fast as water. Both gases are effective; both gases kill. The highly lethal nature of the gases dictates the precautions which should be taken to ensure their containment - - precautions which are not always taken.

Civilian security, as opposed to military security, is not a militry tradition. Recent military adventures may lead one to conjecture that the military is carrying out an extensive civilian insecurity program of a conspiratorial nature. A train originating at Rocky Mountain Arsenal near Denver, and bound for Earle, New Jersey was scheduled to carry nearly 12,000 tons of nerve gas. The gas was to be shipped for disposal in the Atlantic Ocean. Rep. Richard D. McCarthy stated in congressional testimony "that the reason that the U. S. Army wishes to get rid of these tanks of mustard gas and these nerve gas bombs is that they are leakers- - that is, the containers are either corroded or have become defective."[10] Major General Peter Lane, when queried about the possibility of defusing the bombs answered, "The best way to describe it is 'the bomb was designed to go off.' "[11] The train was to have passed through Indianapolis, Dayton, Knoxville, Cincinnati, Philadelphia, and Elizabeth, New Jersey. Shipping by rail is not wise: there has been an 86 percent increase in railroad derailments in the last six years. Fifteen years ago, the commander of Rocky Mountain Arsenal predicted that "the gas from a single bomb the size of a quart fruit jar could kill every living thing within a cubic mile . . ."[12] That train contained 12,000 tons of nerve gas. One wonders if the Army wasn't merely planning a human experiment similar to the "freak accident" that killed 6,400 sheep in Utah in 1968.

Widely viewed as a dangerous practice, the Army nevertheless stockpiles untold thousands of tons of nerve gas and prides itself in its capability to initiate production of unlimited amounts in a matter of hours. The Army's prime facilities for Chemical Warfare are Edgewood Arsenal in Maryland and Rocky Mountain Arsenal near Denver. According to Denver area Representative Byron L. Johnson, there is enough nerve gas at Rocky Mountain alone "to kill every man, woman, and child in the world."[13] Much of the gas is stored above ground.

Edgewood Arsenal, considered home of American gas warfare, was the first to use human guinea pigs. Few volunteers are given accurate knowledge of the tests to which they submit although administering personnel are bound by national and international codes and ethics which dictate that the volunteer must know the precise nature of the experiment. But then the sheep ranchers in Utah were not informed of the nature of the experiments their sheep underwent.

Few military men are alarmed at "accidents" such as the sheep massacre in Utah. The Strangeloves of the CBW program are quite pleased with such a convincing display of awesome power. They say proof of military might is a deterrent, that it shows we mean business. And it is business we do mean, for we possess the ability and insanity to change the biology of this planet.

Biological Warfare, often called public health in reverse, is defined as "the intentional use of living organisms or their toxic products to cause death, disability, or damage in man, animals, or plants."[14] In short, Biological Warfare is the spread rather than the prevention of disease. Biological agents are grouped into two categories: non-fatal and fatal. Non-fatal agents include Brucellosis, Encephelomyelitis, (both are about 5 percent fatal, the latter permanently cripples), Q-fever, Rift Valley Fever, and Tuleremia. High fatality diseases include Anthrax, Plague (both bubonic and pnuemonic), Psittacosis, and Rocky Mountain Spotted Fever. Most above-mentioned diseases have known medicinal cures, a fact which is currently receiving abundant research attention.

The U. S. Army biological program has a special distinction: it is interested in more than the mere spread of existent types of disease. Since known cures could, conceivably, dampen the effectiveness of an attack with biological agents, Army researchers at Fort Detrick, Maryland are concentrating

efforts on the development of new mutant strains of the diseases. Engineering of mutant strains could - - and probably will - - lead to the development and production of diseases resistant to known medicinal cures. The result: incurable epidemics which would easily kill up to 80 percent or more of a given population. (An interesting sidelight: Fort Detrick, where research into germ agents is performed, has the highest rate of accidental infection in laboratory personnel of any major biological laboratory in the United States. Fort Detrick experiences 9.06 laboratory infections per million manhours of labor annually. The second ranking National Institutes of Health has an annual rating of 3.41. Fortunately, there have been no infections of resistant strains.) [15]

Development of a new weapon always creates the necessity of devising means of deployment for that weapon. Prospective methods of deployment of CBW agents to enemy targets ranged from the Rock Island Line to the ICBM system. CBW agents can fill anything from an insect to a suitcase to a bomb and retain the same relative effectiveness. Considering the dosages necessary for infection or death, precise application or "direct hit" is not vital. Contamination, for the most part, lingers for days, months, and sometimes years (anthrax spores are still alive and very lethal on the Scottish island of Gruinard where experiments were performed during WWII), and as such, contaminated lands remain inaccessible to an enemy force for the contamination period. Were the contaminated land strategic to the enemy, decontamination by the enemy would cost time, money, and material. And in a situation where expediency and efficiency are correlative to victory, the enemy would certainly suffer partial defeat. Considering the merits of the CBW program, one can see that it is probably the most flexible item in the United States' weapons arsenal. But flexibility does not always presuppose desirability just as war does not always presuppose defensible egalitarian ideals.

The stockpiling and potential use of Chemical and Biological Warfare agents is neither politically, socially, or morally feasible. (Perhaps I should qualify the phrase "potential use:" the United States has been using gases in Vietnam for over four years.) The military contends, of course, the CBW is quite feasible, politically, socially, and morally. But a good salesman is not necessarily an honest salesman.

Pentagon salespitch for CBW is standard: it is part of the U. S. military weapons arsenal because it 1) acts as a deterrent, and 2) is valuable and necessary defensively. In alignment with traditional deterrence theory, CBW lessens, says the Pentagon, the danger of an offensive attack by an enemy fearful of equally devastating retaliation. A man with a club will be more reluctant to use his weapon on a victim who also has a club than on one who has no club. One thinks twice when the threat of being beaten exists. In the same way, the Pentagon says, CBW is a valuable defense against an enemy who may, however foolishly, decide to strike first. To examine the issue closely, one must realize that both the theories of CBW as a defense and as a deterrent are - - because of their fallaciousness - - irrelevant to the moral, political, and social import of CBW.

Contrary to Pentagon stance, CBW is primarily an offensive - - a first strike - - weapon, and as such has no place in the United States' weapons arsenal. Since 1956, the sentence "Gas warfare and bacteriological warfare are employed by the United States against enemy personnel only in retaliation for their use by the enemy" has been omitted from military Field Manual 27-10.[16] In congressional testimony, Major General William M. Creasy, Director of the Army Chemical Corps, has inferred that since 1956 official policy has not negated first strike use of CBW.[17] The fear of first strike use - - a decision made militarily, with no consent necessary from either the legislative or executive branches of government - - led Representative Robert Kastenmeier to submit a resolution to congress calling for reaffirmation of a 1943 no-first-strike policy articulated by President Franklin D. Roosevelt. The resolution, submitted to congress on September 3, 1959, was never passed.

If one were to ignore all official indications pertaining the use of CBW as a first strike weapon, and assume Pentagon contentions of the "purely defensive" nature of CBW as true, logic leads to contrary conclusions. Nearly all experts will concede that full Chemical and Biological Warfare would result in as much or more human devastation as nuclear warfare. And in a nuclear war, no side "wins" and no side "loss." There is no defense to nuclear war. In a conflict involving nuclear arms, war degenerates from defense to retaliation. (Denote the fine line: defense infers preservation, or attempted preservation, of what is protected, while retaliation is an attempt to inflict damage on an enemy without regard to protection. Retaliation is mere revenge; retaliation is not defense.) With a definition of defense in mind, one can see that stockpiling of CBW agents is no means of defense. Seymour Hersh illustrates:

> Sweden has been among the world's leaders in defensive preparations for CBW; by 1965 it had developed an automatic nerve gas alarm system and had also stockpiled 1.7 million masks for its civilian population of 7.5 million. The Pentagon told Congress in 1965 that Sweden eventually planned to manufacture enough gas masks for all of its citizens.[18]

The Pentagon has no known civil defense program for CBW. It has no educational programs (beyond the propaganda programs it utilizes to form massive public support for its undertakings) for CBW. It is doubtful whether there are enough gas masks in supply to protect the 30,000 workers in the Pentagon. In the true sense of the work, the stockpiling of CBW agents is no "defense" for the population in an attack of CBW agents. In the true sense of the word, the United States has no defense for CBW.

CBW has been established not only in theory but in practice as an offensive weapon. On March 22, 1965, Saigon news dispatches revealed, for the first time, information about the use of gas by the United States military forces in Vietnam. In Vietnam, the United States was the first to employ gas as a weapon of war. (Had the Viet Cong used gas first - - a situation for which no supporting evidence exists - - the Western media, especially the American press, would certainly have reported such use as a vicious violation of not only the letter, but the spirit of the laws of war and humanity.) The use of gas in Vietnam indicates that both the State and Defense Departments have done their respective Cold War homework: the United States established her willingness to use gas (particularly, gases developed under the CBW program) as an offensive weapon of war. The theoretical threat of first strike is only

amplified by actual offensive deployment; the offensive use of gas in Vietnam set a dangerous precedent for military policy and U. S. diplomacy. But not only is first strike use of CBW a dangerous precedent, it is also in clear violation of international law.

Pentagon spokesmen - - military spokesmen - - have made it clear to the American public that the United States is not a party to any treaty or agreement outlawing the use of gas in warfare. Army Field Manual 27-10, "The Law of Land Warfare" would have it otherwise:

> a. TREATIES TO WHICH THE UNITED STATES IS A PARTY. The United States is a party to the following conventions pertinent to warfare on land:
>
> (2) Hague Convention No. IV of 18 October 1907, Respecting the Laws and Customs of War on Land. .

Article 23 Section A of Hague Convention No. IV reads:

> In addition to the prohibitions provided by special Conventions, it is especially forbidden - -
>
> (a) To employ poison or poisoned weapons. (Note: Consider "poison" in its 1907 context.) [20]

Field Manual 27-10 goes on to point out in considerable detail the importance of customary law. Customary - - written or unwritten - - law binds U. S. military forces to international law which the United States has not formally signed but which is recognized and respected by a majority of nations. (The principle of such a concept is this: while cannabalism is lawful in certain countries, it is recognized as inhumane, inhuman, and uncivilized in a vast majority of nations. Although there may be no specific laws dealing with cannabalism, custom dictates persecution for its practice.) The prohibitions of the use of gas set down in later conventions, especially the 1925 Geneva Protocol, is therefore binding. Germany proclaimed, as did individual Nazis, that customary and written international law was not binding on those who were merely "following orders." The Nuremburg Tribunal decided otherwise. Ignorance is no defense to a prosecution.

The Nuremburg Principles, in reference to CBW, are of supreme importance, CBW, in contrast to most other weapons systems, does not need hierarchical approval for use. As news items pointed out, President Johnson was not consulted prior to the deployment of gas in Vietnam, that it was a routine decision handled by area commanders.[21] One could hardly say an "area commander" has the knowledge and legal insight into the international laws of warfare to make a responsible decision as to the use of CBW agents. Some skeptics would doubt the ability of an "area commander" to make a responsible decision. In any case, ignorance on the part of an "area commander" is, again, no defense to a prosecution; international war crimes in the name of a whole nation, can be committed by an "area commander." The decision-making responsibility on the part of an area commander can be of grave consequence in more than one respect.

In a time when war is often characterized as game and military policy as folly, the wrong weapons in the wrong hands can start a chain of tragic and irreversible events. Even military men concede to the notion of a competitive, as opposed to cooperative, Armed Forces. Former Commandant of the United States Marine Corps, General David M. Shoup, describes the rough and ready: "At the senior command levels parochial pride in service, personal ambitions, and old Army-Navy game rivalry stemming back to academy loyalties can influence strategic planning for more than most civilians would care to believe. The game is to be ready for deployment sooner than the other elements of the joint task force and to be so disposed as to be the 'first to fight.' " Shoup says that readiness and deployment speed, as ends in themselves, present a situation whereby "contingency plans and interservice rivalry appear to supercede diplomacy."[22] Consider the situation: an "area commander" has at his disposal an unspecified but adequate amount of biological warfare material which, like most BW agents, could set nature in an irreversible path. The patriotic attitude of the "area commander" is similar to that of General LeMay or "We'll bomb 'em back to the stone age." Also consider the comments of microbiologist Martin Kaplan in reference to BW agents: "Sudden disbalances in numbers or the insertion of new infective elements into evolutionary unprepared animals of plant life could produce for an indefinite period an unrecognizable and perhaps unmanageable world from the standpoint of communicable diseases."[23] The potentialities and possibilities are obvious. The outlook is grim.

Obivously no matter to be left for condideration by an "area commander," CBW is hardly a matter for consideration by any civilized nation. Possession of CBW agents by any agency, whether it be a national or an "area commander," presents a corresponding potential to completely destroy natural order on this planet. True to Strangelovean notions, CBW represents a colorless, odorless, and tasteless doomsday machine. You may say such warfare is unusually humane: it is also unusually antihuman.

While the effects of all-out Chemical and Biological Warfare are clear, symbolic or limited gas warfare has subtle social and moral implications. Traditional warfare is waged with particular goals in mind: defeat through disablement or elimination of enemy forces. Chemical and Biological Warfare is by no means traditional; its victims are primarily civilian populations and secondarily enemy military forces. Defoliation undertakings in Vietnam (ironically named "Project Ranch Hand") are a good case in point. According to military sources, defoliation attempts to 1) starve the enemy, and 2) expose the enemy by whithering away his protective foliage. Dr. Jean Mayer, Professor of Nutrition at Harvard University, consultant to two research institutes of the U. S. Army, and member of the FAO-WHO joint Nutrition Committee of the United Nations, points out that defoliation fails utterly in its attempt to starve the Viet Cong:

> The point is clear: death from starvation occurs first and overwhelmingly in small children, then in older children and in the elderly. Pregnant women often abort, lactating mothers cease to give milk and the babies die.
>
> Children under five are the most vulnerable of all. In many parts of the world - - including Vietnam - - they are often on the verge of Kwashiorkor (a protein-deficiency disease which often hits children after weaning and before they are old enough to eat "adult" food) and of marasmus (a combination of deficiency of calories and protein). Healthy young men, the part of

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The Elements of Successful Study in Engineering

by Prof. E. F. Obert

The sine qua non for successful study is to realize first that *learning is living* - - that study for the joy of learning marks the difference between man and animals! The beast in the field studies how to obtain food and shelter – and then goes to sleep happily until hunger again arouses his thought processes.

Man is marked by the *desire* to learn that may take many forms: how to build a house – how to bowl or play golf – how to master thermodynamics. *If, by the time you graduate from college, studying engineering or science or mathematics is a constantly disagreeable chore, the chances are great that you are in the wrong field!*

The successful bowler, or engineer, or scientist, or husband *loves* his work, and loves to study problems that arise in his work. (And this "love" has many "quarrels", of course.)

On the other hand, you may be studying a subject in the *hope* that it will fit into your work. At this stage the subject is neutral to you. If you are an undergraduate you may be faced with *seven* courses to be "loved" at the same time! (And we call seven courses at a time, or even five or six, education! Bah.) Or you may be working on a job that requires intense concentration for most of your waking hours. Under such circumstances, it is desirable to first study the art of learning. More generally, to study how to encompass many things into the hours that you have available.

The following presentation should prove to be a useful aid in developing an individual system of study. To obtain maximum benefit, it should be read and re-read. Then it is suggested that the reader prepare a Review Outline which presents the highlights of the article (this might be done simply by underlining). The outline could then be used for (relatively frequent) future reference, to serve as a reminder and check-list.

The necessary elements of fruitful study (not necessarily in order of importance) are:

1. Organization (including methodology)
2. Time Budgeting
3. Concentration
4. Diligence
5. Motivation
6. Rest

The common goal of this set of factors is the *economic* use of time; to elaborate on each of these items:

1. *Organization* for study may be separated into two types:

(a) *Evaluation:* that is, development of "Utilization Plan" for organized use of the available study aids (textbook, lecture notes, homework problems, instructor, discussion section, laboratory, etc.). This should evolve rapidly at the beginning of each course, and then be modified continously as found necessary. At the beginning of a course, for example one must assess whether he should rely mainly on the notes taken from lectures, on the textbook, on reference books, or what-have-you for learning the required material -- "required" by the particular instructor. Also, what is the place of the homework problems in the instruction? Are the problems mainly teaching aids to help understand the theory? Are they mainly illustrations of how the results of the theory are applied? Or are they combinations of these? Another important question: To what extent will the instructor emphasize theory, and to what extent practice, on the examinations? All these things must be evaluated, consciously or subconsciously, in developing a "Utilization Plan" for the course.

(b) *Methodology:* that is, development of a system of study for the course -- a standard sequence to be followed on each major topic. Again, this should evolve early in the course. One obvious arrangement is that problems should not be attempted until one has attained sufficient confidence in his understanding of the theory. To elaborate, and clarify the intent of *sufficient,* after beginning work on a problem set, one should not continue working if he feels as though he is "stabbing in the dark" -- if he is selecting equations from the text (or notes) without really understanding "why that equation", or if he is doggedly following, without understanding, example problems in the text. The essence of these remarks is that a mere answer to the problem is seldom (probably never) the goal. Therefore, one *must* be precise in devising a logical step-by-step procedure for attacking the problem, and he must be precise in illustrating (by pictures, equations, or whatever is necessary) this procedure; precision in numerical answers is secondary.

But how does he organize the remainder of the overall sequence, preceding and following the problem-solving? By answering the following: Does it appear that reading from the textbook should precede attendance at lectures? If so, should this reading be a careful reading, with emphasis on detailed understanding, or should it be of a preliminary (preview) sort ot survey the entire domain, without great concern for understanding of all the details, to be followed after the lecture by careful reading? The latter approach might be wise since the lecture can then serve as a guide to show what parts of the reading are most important -- where detailed understanding is necessary. On the other hand, the student might forego reading completely until after the lecture, using the text as a reference for more detail on the various topics in the lecture. If the

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lecture notes play a predominant role in a particular course, then they should definitely be rewritten in order to polish and organize the class notes. This should be done immediately after class when the lecture is fresh in the student's memory, and so that those comments that were not put on the blackboard and/or were not copied down can be included in the recopied notes. Also, the notes should be recopied in the presence of a suitable array of reference books, perhaps just one book, perhaps many to amplify questionable areas. Before departing from the topic of reading, what are good reading habits for studying of technical (versus liberal) subjects -- whether it be reading of books or notes? First skim the material, then proceed with the *intent* of understanding each step in the development of the material. When a seeming "immovable object" is encountered the following techniques for getting through:

> (1) Try to frame (in writing) a *specific* question for the teacher; in so doing the answer often becomes obvious!
> (2) Review the material preceding and then read one step (or a few) ahead; then, try to fill the gap (perhaps in writing).
> (3) Fight

When the light finally dawns, then quickly review "all" that preceded because during the relatively long time interval that passed during this encounter, much of the preceding material will have faded. (From this discussion, you can see that you should always have a pencil in hand when studying.) Another important and, really, obvious part of a good study sequence is continual review, to all levels. This should be done for many reasons. First, it helps the student to assimilate the different topics -- necessary for complete understanding. Second, it makes reviewing for an examination almost casual. One should never be in the predicament where he must cram; under such conditions the nervous mind cannot assimiliate - things do not fall into place - and the material to be covered seems to be a garbled collection of unrelated "facts". Really, the message of this whole essay on Methodology is that the mind will not be able to organize everything that is fed to it, unless there is a logical sequential approach.

2. *Time Budgeting.* At the beginning of each week, day, and study session the student must plan on how and in what proportions that period of time will be utilized. How much time will be devoted to each course; how will the time for each course be subdivided into reading, doing problems, and reviewing? This scheduling must be continously revised because, almost invariably, more time will be used on some item than that allotted initially. One might ask, "It you admit you are not going to live up to your schedule, why have one?" The answer is that such a schedule keeps before you the work you must accomplish, and the schedule gives goals to be aimed for.

The principle criterion upon which the time schedule should be built is this: "At no time during any course will I get behind." *This is a must.* It means that in preparing the schedule one must foresee events which will disrupt the schedule by requiring a large amount of time -- things like exams, etc. For example, to assure that one does not fall behind in other courses while studying for an exam, he must get *ahead* in all courses so that by the end of the exam he at least breaks even. It is a good idea to get ahead even when no such event can be foreseen, because something unforeseen will occur: "I don't have to study tonight but I think I will because maybe there will be something I want to (or have to) do tomorrow night."

3. *Concentration.* Repeating, all the items in the list of study elements together have a common aim: *economic use of time.* The present item is the first prerequisite for attaining that goal. Without intense concentration on the immediate job, be it studying or anything else, the work drags on and on. We all realize that if we spend half our time "on-the-job" and half our time daydreaming that we can accomplish much less than half of what we would do with complete concentration on the job. So, especially when studying, one should endeavor to reach *complete concentration,* to shorten the task (and allow time for study of other courses and for outside activities). Every minute the mind wanders increases the required learning time by many more minutes.

Today, the "refreshment break" is probably the most abused policy in existence (whether it be company policy or personal policy). It serves as the basis for our most extreme rationalizations. When one is studying, or doing any kind of work, and he feels like taking a break, he shouldn't. Instead, he should choose a *sizeable* amount of additional work with a logical stopping place and say, "When I complete this, *then* I will take a break." The

correct size of this additional work is quite crucial; it should not be so long as to create a frustrating restlessness, nor should it be as short as you would like to rationalize. Another trick to combat this sort of restlessness is a *temporary* change of position, say from the straight chair to a stuffed chair but be sure to keep in mind that this change of position is just for the sake of change, not for a rest. This serves two purposes, it not only avoids wasting time but it also provides motivation (item 5).

Another important factor for successful concentration is appropriate working conditions. The first item that should be mentioned here is *quiet;* noise, always distracting, cannot be tolerated. And the best students realize that, for study purposes, even soft music is distracting. There is only one excuse for having soft music: as a low-level continous sound, in itself pleasing, for disguising unavoidable background noise. This does not admit that soft music is acceptable, only that it is the least objectionable. Not only must noises whose source does not intend them to be distractions be avoided, but so must interruptions be avoided. The study place must be secluded, because interruptions in the middle of a train of thought are frustrating. The whole sequence of logic must be repeated, and somehow it always seems to take longer the second time. Other working conditions to be mentioned are good lighting, a large desk for spreading out material, a good straight-backed chair, good ventilation (and in winter keep the room cool).

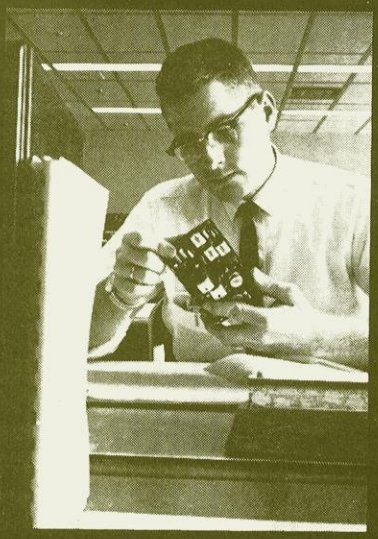
4. *Diligence.* To carry out the procedures indicated by these study elements, one must be dedicated to his studies. He must declare to himself that he will do a complete job of learning the required material, and learn to enjoy it. Once a student experiences mastery of his studies, then he comes to enjoy the intellectual challenge; his ego now gives him the desire to learn. This persistence is not the only aspect of diligence. Another is the resistance of distracting temptations. The good student is unwavered by the beckoning of friends (or relatives, or television) to "take a break." He is able to overcome the fear of being classified as an oddball, or as ambitious, or what-have-*they*, realizing that such classifications are just *their* rationalizations. Too, the temptors are soon trained not to bother.

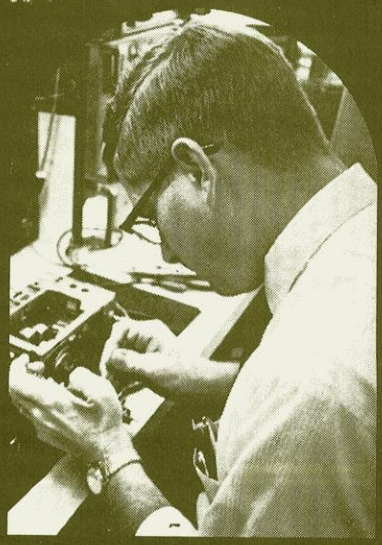
Here is probably the best place to discuss the value of "bull sessions" in learning. In general they are useless wastes of time and result only because everyone *wants* to believe the sessions are useful. Make it a policy to avoid general discussions, unless you have a *specific* question to ask or are approached with a specific question.

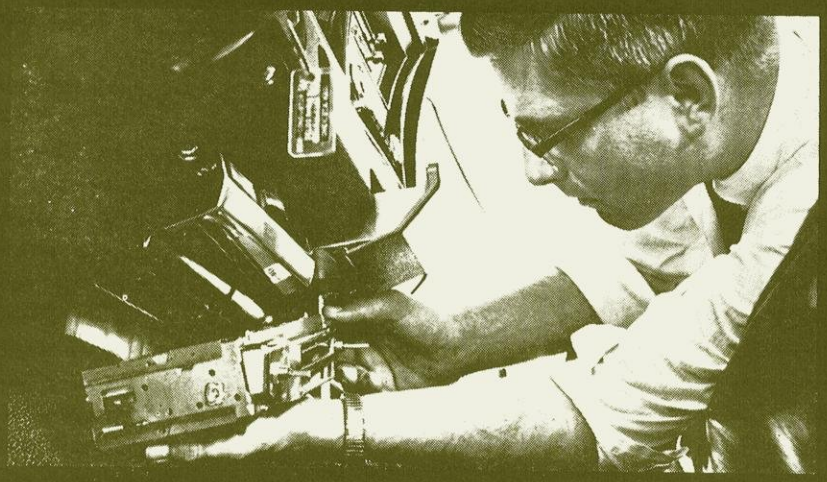
5. *Motivation.* This is believed to be one of the most primary, if not the most, of all the study elements. It works in many ways.

First, human nature being what it is, in order to be dedicated to his studies a person must feel a valid reason for them. Without this, all is hopeless. It can be said flatly that one should not waste his time studying a subject if he doesn't believe there is some good reason to. This reason might vary from one extreme, the realization that the material is fundamentally important to his future undertakings, to another extreme, perhaps only the fact that the course is required in the curriculum being pursued. (If the latter reason is not sufficient to motivate a student to do his best, then he probably should not be in school.)

(Continued on Page 41)







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Just as important as the above overall motivating reason are others, short-term motivations. To provide a reason for accomplishing all the work on this week's, or this day's or this evening's schedule in the allotted time (as closely as possible), these short-term motivations are necessary. Rewards serve as the best short-term motivations. For example, whenever drafting a time schedule there should be no time definitely allotted for extracurricular recreational activities. Rather, while drafting the schedule, the extra time left over should be considered a "cushion." Then, the realization that the extra time not required to serve as a cushion - not required as a supplement to allotted times which proved to be too short - may be used to do "what I darn well please without any qualms about wasting time." This serves as an excellent motivation to be efficient. Such a reward technique is very highly recommended (by *one* of *us);* it works best when one tries to accumulate extra time, say for "a free weekend."

6. *Rest.* It is an absolute necessity for every person to determine the amount of rest that he requires, and then consistently get that much. It is bad economics to short-change oneself on sleep; the work accomplished during those extra waking hours is less than the total work lost in a day because of the resulting decreased effectiveness. Too much sleep is just as bad as too little - worse, because it means sloth. It is easy to mistake boredom for sleepiness. If you feel sleepy at a relatively early hour plan a "break" and do something like (1) have a cold drink of water, (2) splash cold water on the face, (3) open the window and deep-breathing some cold air, (4) exercises or shadow boxing, (5) a brisk walk or run.

The reader has probably already concluded that the principles set forth here are impossible to live by, that such a degree of perfection cannot be attained except by an inhuman machine. Perhaps, but the purpose of this presentation is not to elicit what a person *must do* to be a successful student, but what he *must strive to do*. The purpose is to point out the ways a student must discipline himself. The purpose is to show that a student must continually apply psychology to himself, in a number of different regards: each individual must determine the particular techniques required, for his personality and physical make-up, to live up to the elements listed and discussed herein. The *purpose* is to show that *learning is almost completely a do-it-yourself project, and that it can become enjoyable.* Probably the principal goal of formal education is to teach the individual to be able to make learning *completely* do-it-yourself – especially important for the professional man: obsolescence.

If the reader has concluded that this paper is one of those things that should be taken with a grain of salt, then there is no hope for him unless he changes his attitude. This presentation is for the student's sake; its goal is to make his life easier, not more difficult, by helping him to study more effectively and thereby learn more in less time. Also, do not say it is too late to develop good study habits; some of the best students have been those who "woke up" after high school, after undergraduate college, or even later. If one says it is too late now to learn how to study, he may be burdening himself with a tremendous handicap; learning is a part of living.

In any case, the student should make a conscious effort to employ and perfect all aspects of the elements presented here. He will know he is succeeding when these conscious efforts become more and more innate. If the student cannot improve via these techniques it is because the proper motivation is lacking, not because ability is lacking, and he should change his goals.

Someday soon, a fog disperser may guarantee that you won't lose a single day of Christmas vacation.

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The chairs are lumpy. You get edgy. You develop coffee mouth. You're bored.

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the population forming the membership of any guerilla movement, are apt to be the least affected by the starvation measure supposedly aimed at hurting them.[24]

Failing miserable in accomplishing one goal, defoliation succeeds outstandingly in performance of the second task. Military critics have simply called it "overkill." Cao Van Nguyan, a Vietnamese doctor, relates his experiences following a defoliation operation using cocodylic acid, which is over one half arsenic:

> . . .more than 1,000 inhabitants were affected, a large number of livestock were also poisoned and some of them died. The majority of the poisoned people did not take any food from these crops, nor drink any of the water that had been covered or mixed with the sprinkled farm chemicals. They had only breathed in the polluted air or poison had touched their skin. At first, they felt sick and had some diarrhea; then they began to feel it hard to breathe and they had low blood pressure; some serious cases had trouble with their optic nerves and went blind. Pregnant women gave birth to still-born or premature children. Most of the affected cattle died from serious diarrhea, and river fish floated on the surface of the water belly up, soon after the chemicals were spread.

Aside from the overt affects of defoliation, other objections to the use of herbicides and defoliants include: 1) that it is used in Vietnam in an experimental sense as very little empirical evidence exists pertaining to the chemicals and their use, 2) that soil compounds break down the chemicals into different unknown compounds whose effects are unknown, 3) that varied action of particular defoliants is not completely understood, and 4) that areas to which defoliants are applied in Vietnam are dissimilar to domestic test enviroments.[26] The action of defoliants and herbicides upon civilian populations (whom the chemicals are presumably meant to protect) is extensive and ruthless and in definite violation of international law assuring the safety of civilians in warfare. But graver than the violation of political or social law is the violation of moral law.

CBW is perhaps characterized best as only a symbolic minuscle of the perversions and contradictions so obviously confronting the United States today. The Pentagon proclaims, for instance, that the use of tear gas in Vietnam is unusually humane, but does not go on to state the use of the gas: it is used to flush suspected enemy troops from caves and tunnels into the open so they can be shot dead. That is hardly humane. The Army awarded its Distinguished Service Medal to a Fort Detrick researcher for her part in the development of a rice blast fungus which has repeatedly destroyed Asian rice crops.[27] That is hardly admirable. A corporation named Avco has two biological warfare contracts.[28] An Avco ad reads: "Remember the name, Avco: 35,000 people changing the way you live. You'll be hearing more about us."[29] That, like CBW, is terrifying. And you, Mr. Chairman of the Board, don't you ever say Joe College never had it so good.

FOOTNOTES CONTINUED ON PAGE 47

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(CBW)^n – FOOTNOTES

1. Hersh, Seymour, "Germs and Gas as Weapons," *New Republic,* June 7, 1969, p. 13. Also see, Klare, Mike, "The War Game," *Guardian,* April 5, 1969, p. 11.

2. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969 p. 1.

3. Lando, Barry, "It's a Gas," *New Republic,* June 28, 1969, p. 17.

4. Hill, Hugo, "Chemical Warfare in Viet Nam," *Guardian,* May 3, 1969, p. 17.

5. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969, p. 89.

6. Ibid., p. 1

7. "Military Chemistry and Chemical Agents," Military Field Manual 3-125, Departments of the Army and Air Force.

8. Langor, Elinor, "Chemical and Biological Warfare/II" *Science,* January 20, 1967, p. 302.

9. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969, p. 36

10. Hersh, Seymour, "Germs and Gas Warfare," *New Republic,* June 7, 1969, p. 13.

11. Ibid., p. 15.

12. Ibid., p. 14.

13. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969, p. 89.

14. Department of Health, Education, and Welfare, "Effects of Biological Warfare Agents," July, 1959.

15. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969, p. 109.

16. Department of the Army, "Law of Land Warfare," Military Field Manual 27-10.

17. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969, p. 19.

18. Ibid., p. 157.

19. Department of the Army, "Law of Land Warfare," Military Field Manual 27-10.

20. Reprinted in: *In the Name of America.,* A study commissioned by Clergy and Laymen Concerned About Viet Nam, (Annadale, Virginia: Turnpike Press), 1968, p. 29.

21. Ibid., p. 118.

22. Shoup, Gen. David M., "The New American Militarism," *Atlantic Monthly,* April, 1969, p. 54.

23. "The Dilemma of Chemical Warfare," *Time,* June 27, 1969, p. 21.

24. Mayer, Dr. Jean, "The Rape of the Crops," *Ramparts,* June, 1967, p. 50. Also of interest is an article in the June 19, 1966 issue of *Christian Century* by Drs. Victor W. Siden and Mayer.

25. Hersh, Seymour, *Chemical and Biological Warfare,* (Garden City, N.Y.: Doubleday and Company), 1969, p. 134.

26. Galston, Arthur W., "Only We Can Prevent Forests," *New Republic,* November 25, 1967, p. 19.

27. Langor, Elinor, "Chemical and Biological Warfare/I," *Science,* January 13, 1967, p. 174.

28. Klare, Mike, "The War Game," *Guardian,* February 22, 1969, p. 15.

29. *Scientific American,* April, 1967, advertisement on p. 55.

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DEPARTMENT

HUMOR?

In the beginning God created the earth and He looked upon it and saw that it was good and beautiful.

And God said, "Let Us make man so that he can see what We have done."

God leaned close as man sat up and looked around. "What is the *purpose* of all this?" he asked politely.

"Everything must have a purpose?!" asked God.

"Certainly!" said man indignantly.

"Then I leave it to you to think of one for all this," said God. And He went away.

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