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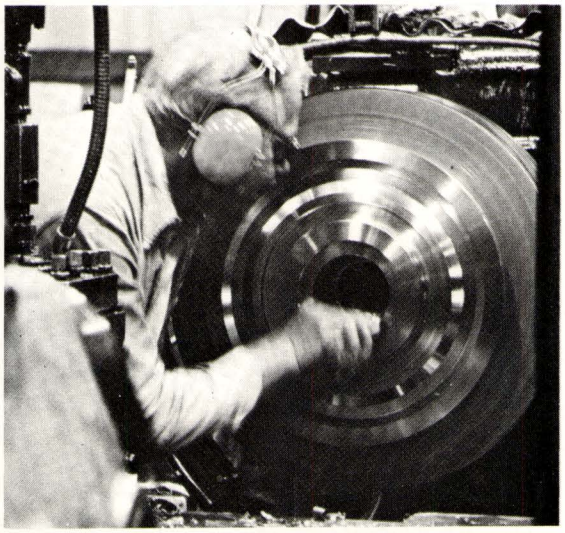
WPI journal

The Future



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The future—what?

QUE SERA, SERA, Whatever will be, will be," went the refrain of the song. But what *will* be ahead in our lifetimes? It sometimes seems as if the world is split into two camps on that issue. On the one hand, we have the prophets of doom, who argue that we will soon run out of food, energy, mineral resources, and that our long-term future on Earth is one of despair and degradation. On the other side, we have those who see that the system has worked well enough for them so far, and why won't it continue? And on each side there are myriad special interest groups pushing their own particular interpretation.

There's even a name for this business of trying to predict the future: *futurology*. What distinguishes these modern-day seers from their predecessors is the basis for their statements: not revelation from on high, nor divination from tea leaves or bamboo sticks, but scientific, educated guessing based on extrapolation of trends and hard data. That no two futurologists agree on what the future holds may be some measure of the "science" involved.

But the questions they ask, and the issues they raise are vitally important. And in all the debates, pro and con, the role of technology is central. To some it is *the* primary evil, responsible for most of our present-day problems; others see it as the one real avenue for solving those problems; still others wonder what the fuss is all about, since they feel technology is merely one part of a complex world.

The problem seems to be in assessing the proper balance between *technology* as it represents the material side of life, and *values*, as they embody the inner needs and yearnings of people. This is hardly a new debate, but it is no less important for that. As a technical institution, WPI is inevitably caught up in that debate, and it is no news to *Journal* readers that with the WPI Plan the college has come out squarely in the middle. Our philosophy embodies the goal of producing technically competent specialists who are aware of and open to the consequences of their actions, the social context of their work, and the ways in which what they do affects other people and the whole of society.

When WPI got ready to open and rededicate Salisbury Laboratories, three articulate speakers were invited to address these questions in public symposium. Two of them are futurologists by profession and one is a concerned and conscientious businessman. Although they have many points of disagreement, each is optimistic about the future and about our ability to surmount present-day problems.

Fletcher L. Byrom is chairman of the board of Koppers Co., Inc., in Pittsburgh. As head of one of the nation's largest manufacturing companies, Byrom insists that responsible corporate citizenship must be a consideration in every major management decision. He is an articulate spokesman for the growing number of businessmen who recognize their responsibility to the world at large as well as to their stockholders and employees.

Navigation chart, engine, and compass: Tools for the management of growth and technology

by Fletcher L. Byrom

YOU MAY BE FAMILIAR with a study made a few years ago reporting that many alumni of a certain university still suffered from a common nightmare, in which they dreamed that they had neglected some of their courses or missed some of their examinations. That nightmare could persist for as much as 40 years beyond graduation.

It has been almost that long since I submitted myself to the joys and terrors of a formal education, but I know the feeling. Therefore, I concluded that I had better do my homework well before speaking at WPI.

In the course of my preparation, I came across something called the WPI Plan. Two aspects of that plan captured my attention and admiration.

One is the requirement that the student complete a major project relating technology to social needs or interests. This is an altogether laudable and much-needed effort, one that I would apply to corporations and other institutions, as well as to students. I could not continue one more day in my job without the constant assurance that what I and my colleagues do serves the needs and interests of society.

The other aspect of the WPI Plan that fascinates me is the requirement that the student pass a competency examination near the end of his curriculum to prove that he has truly learned what he was supposed to learn. A few years ago, I addressed an assembly of school administrators and posed the simple question: "Is anybody learning?"

"I know a lot of people are teaching," I said, "just as there may be intelligent creatures in outer space trying to communicate with us. The question is whether the message is getting through." And then I quoted from a booklet on educational guidelines, as follows:

"Too often and too much, our schools have been input-oriented. Budgets have been devised with an eye to the satisfaction of cold formulations, rather than results. It is as if a team of management consultants, architects and engineers were to create a manufacturing corporation with well-defined staff, office buildings and plants—but with no thought as to the goods to be produced."

Present company excepted, of course. The first products of the WPI Plan are already on the market, and they are outstanding in quality.

I take special pleasure in the happy occasion that brings us here today. The rededication of Salisbury Hall focuses renewed attention upon the need to promote interfaces between science and the humanities if their various disciplines are to serve society. I was far from the campus, in time and distance, when I discovered, pretty much on my own, how much I could learn from the philosophers, the anthropologists, the social scientists, the classic economists. I am still working hard to catch up. Your graduates—those "technological humanists" described in a recent issue of *American Education*—leave here with a running start.

One of the most important issues that will face them as they take their places in the world outside is the theme of this symposium: *People and Technology: A Humane Balance.* Specifically, they will have to consider whether and how the needs and interests of society can be served by technology, and particularly whether and how we should foster economic growth.

> Technology, I'm afraid, is the only tool we have for dealing with the problems that have been created by technology.

My own view is that we have no reasonable alternatives. Someone has defined a wife as the person who helps you through all the problems you wouldn't have had if you had remained single. Technology, I'm afraid, is the only tool we have for dealing with the problems that have been created by technology.

As for growth, it is indispensable to the dreams of millions. Rudolf Klein, a senior fellow at London's Center for Studies in Social Policy, has warned us that for the American economy to stop growing would "simply freeze the existing social and political system in perpetuity." Applied on a global scale, he says, it "would in effect mean condemning the majority of the world's population to poverty for the rest of time."

The real question, therefore, is whether our social and political systems are structured in such a way as to take advantage of the promise of technology in order to promote beneficial growth. I submit that they are not. Neither do I believe that we are yet in a position to begin the monumental job of realigning our priorities and redesigning our systems.

I come to that conclusion from my own experience. I am at least nominally the head of a not-too-small apparatus known as the Koppers Company—not so large as to be carried forward by its own momentum, yet large enough to embody, if only in miniature, many of the structural pains that afflict organizations of greater size, complexity and scope, such as world society at large. If I may be so immodest, I will say that our recent successes in fulfilling our role indicate that we may be doing something right, and therefore an inspection of our methodology may be in order.

Although I must admit that when you're reasonably successful, you're never sure what you're doing right. It's only when you foul it up that you find out what you did wrong.

We proceed in this manner:

First, we determine where we stand today, in terms of our capabilities, our markets, our competitors and other factors.

Next, we determine the mission of the organization.

We then take certain abstractions and make sure they are translated into measurable objectives. *Measurable* objectives.

Only at this point do we lay out an organization to accomplish those objectives, because organizations are the fundamental means by which you set up a communications channel that allows you to implement objectives.

Finally, we establish a sensing system that will tell us whether we really *are* making progress and to steer us continually clear of unpredictable calamity.

To compress these five steps into three tools, we look for a navigational chart, an engine, and a compass: something to tell us where we're going—something to propel us there—and something to keep us continually on course.

None of these steps is taken in the vacuum of our executive chambers. All of them are considered in the perspective of the society we inhabit. We encourage that broader outlook by a number of means. For instance, a few years ago, I instituted an experiment under which three groups of our younger managers would come to my office for a seminar on what might be titled "A General Survey of the Nation and the World, Past, Present and Future, As Seen From the 15th Floor of the Koppers Building in Pittsburgh." Each of the three groups consisted of 10 participants, and each of them met with me once a month.

The program has now been expanded, and we have other officers meeting with other groups. I *think* it has been productive. At least, no one has ever asked me whether I wouldn't like to take a little break for a cup of hemlock.

We proceed from massive reading assignments between sessions—everything from the Club of Rome reports and Michael Harrington's "Socialism" to an article on soybeans from *Scientific American* and whatever Professor Galbraith has published most recently, which is a considerable library in itself. I don't know whether any other company has such a program. I do know that, within 10 years' time, we just might have the most enlightened management team in the country.

It is this background that leavens the Koppers methodology, which I will now try to apply to some of the issues contemplated by this symposium.

SURELY A MAJOR CONSIDERATION affecting our deliberations on technology and growth is a rising concern over our supplies of food, fuel and other resources. I respect the many warnings, and would even add some of my own. For instance, a good portion of my company's activities has to do with fossil fuels, and I have gone on record to say that we cannot afford to burn them for energy much longer, but must restrict them to use as chemical building blocks.

There may be countering arguments, but I am willing to assume that, in terms of the needs of generations to come, many of the resources we now use and for which we have found no substitutes are in short supply and should be allocated to avoid waste. As a private enterpriser, I am amazed to hear myself say so, but I have serious doubts as to whether we can go on using price as the sole means of allocation in times of continuing shortage and inflation. That can only result in placing the greatest burden upon those at the bottom of the economic ladder, who can least afford it.

In assessing where we stand today, we do well to avoid what I call "the nostalgic fallacy," which assumes that life was better in older, simpler times. It was not. More than a century ago, Charles Dickens referred to my home city of Pittsburgh as "hell with the lid off." About half a century before that, the poet Shelley called London "a populous and smoky city," much like hell. Around the same time, Samuel Taylor Coleridge told of how he had counted "two and seventy stenches . . . and several stinks" in his travels, and summed up the hopelessness of the situation with these words:

> *The river Rhine, it is well known,*
> *Doth wash your city of Cologne;*
> *But tell me, Nymphs, what power divine*
> *Shall henceforth wash the river Rhine?*

On the economic front, our concerns may be exaggerated by what Daniel Yankelovich has called a "galloping psychology of entitlement." Daniel Moynihan argues that, "until the dislocations caused by OPEC, things were simply not as bad as they were typically portrayed." "*Things were better than they had been,*" he says, and he underlines those words. But then he adds two words of qualification: "Almost everywhere."

Almost everywhere. In the United States, we have eliminated material poverty to the extent that anyone working full-time has access to disposable income, which was not true in my father's day. Transfer payments take care of others on a scale unprecedented in our history.

Needless to say, this relatively happy state does not prevail everywhere outside our borders, and both rationality and humanitarianism call upon us to seek ways for extending it. To do so will require something more constructive than the bitter railing at advanced nations we have heard in some recent dialogues. Eric Sevareid last year called it "highly debatable" that the rich nations should compensate the poor nations for their supposed exploitation, and pointed out that "many of the new nations insist on starting out with a social welfare society, bypassing the historical period of capital accumulation that characterized the West and Japan."

I repeat this view because it underlies the current debate as to who owns the world's resources and how the riches made possible by those resources should be parceled out. The new catchword is "interdependence," and the concept may mark a milestone in the world's development.

The British scientist James Lovelock has offered us what he calls the "Gaia hypothesis," in which he sees living matter, air, water and land as parts of a gigantic system that seems to "exhibit the behavior of a single organism—even a living creature." This kind of attitude has been underlined by Lewis Thomas in his book, *The Lives of the Cell.*

I believe our interdependence is just that organic, and that if a visitor from outer space ever drops in on us, he may not ask to talk to our leader. Instead, he may wish to talk to our planet, which he—or she—will see as a single, complex organization of entities functioning for the common good.

These are some of the considerations that occupy our attention at Koppers as we survey a world grappling with the problems of technology and growth. Our view is that society has given us a franchise to perform. If we do not perform in useful ways, society can just as easily remove that franchise, and should remove it. It behooves us, therefore, to know what society expects of us.

That leads us to step two—to determine the mission of the organization. For Koppers, it is fairly simple—to take raw materials and translate them into material abundance for the good of society.

Profits are to a corporation what breathing is to a human being: we cannot live without breathing, but breathing is not the purpose of life.

For those who must manage the world's affairs, the challenge is much more complex. We in America are learning from harsh experience that while it may still be true that we can have *anything* we want, we can no longer count on having *everything* we want all at the same time. We must choose.

Others learned that lesson a long time ago. It is time now for all of us, together, to come to some agreement on the practical choices that are available to us. As of today, we do not have any goals on which there is reasonable consensus.

When I argue for consensus, I do not mean to imply that we should rush at once into a Grand Master Plan. At this point in our ignorance, I much prefer a dredging out of alternatives for consideration. I want to read the menu before I order my meal.

My modest contribution to this discussion will be to list some of the options we must consider.

DO WE WANT growth of the kind we have known in the past? I, for one, do not believe that Americans can go on eating an average of more than 100 pounds of feedlot-fattened beef every year when we could get 10 to 15 times as much protein per acre by eating soybeans and grain products instead. We cannot continue to misuse our resources for lifestyles that are self-indulgent at their best and frivolously wasteful at their worst.

I think my position lies close to that set forth by the Club of Rome's *Mankind at the Turning Point*, which distinguishes between organic growth and undifferentiated growth. Certainly, I am not yet ready to join the camp of those who tell us that the answers to all our problems lie in a total curbing of economic growth. I have heard this proposition—mostly from people in rather comfortable circumstances—and I always respond with a standing offer. I say that I will invite them to visit a crossroads in Bangladesh, a slum in South America, a village in Africa. All they have to do is to announce: "Good news, friends! We've just decided on a policy of zero economic growth that will freeze everything just where it is." For my part of the bargain, I will notify their next of kin.

I am persuaded that excessive limitations on economic growth will injure our souls as well as our stomachs. We cannot provide the tools of education unless we first provide the tools of production. We cannot build great colleges and universities unless we first build factories. And for every teacher in the schools, there must be mechanics, farmers, and managers working to create the surplus that makes it possible for us to support and maintain the schools.

Those who attack growth are likely to attack also the technology that makes it possible. I remember a story set down by the late Paul Goodman. "Just the other day," he said, "I listened to a young fellow sing a very passionate song about how technology is killing us and all that . . . . But before he started, he bent down and plugged his electric guitar into the wall socket."

I see technology as a powerful weapon for decency in our social intercourse. It calls for *more* human participation in decision-making, not less. It provides the instant and full communication that is the enemy of covert power. It is moving us toward a time when fewer and fewer people will be needed to produce the necessities of life, so that our chief concern will be whether to cash in this greatly improved efficiency for a new outpouring of material goods or for a further pursuit of leisure, cultural, and educational activities. Being human, we will likely opt for both.

Technology, contrary to what many believe, has not hastened the depletion of our resources. It has made it possible for us to get eight times more energy from a ton of coal than we did in 1900. It has made it possible for the advanced nations to devote less of their gross national product to raw materials and to turn more of their effort toward education and other services that enrich human life. It holds the promise of providing substitutes for those materials that cannot be replaced.

In dealing with the consequences of technology, the choices are not always clear. I will take only one example—the continuing debate over DDT.

It began with what seemed like an unassailable demand by the environmentalists for a total and permanent ban. But when the initial outcry died down, we found unexpected allies coming to the defense of DDT. Two agencies of the United Nations fought hard to preserve its use in dozens of countries. Norman Borlaug, who won the 1970 Nobel Peace Prize for his work in helping to feed the hungry, said, "No chemical has ever done as much . . . to improve the health, economic and social benefits of the people of the developing nations."

What we learn from this and other controversies is that the world is a varied place, and that no single prescription will serve the needs of every patient. Some years ago, I talked with the head of a Latin American country who had his heart set on building a major petrochemical complex. I would have welcomed the business, but I suggested to him that conditions in the area called at that time for a labor-intensive industry to help solve the problem of a huge manpower surplus.

WE MOVE ON to step three—to translate our abstractions into measurable objectives. For a corporation such as Koppers, that is a more subtle procedure than you might think.

Unlike Milton Friedman, I have contended for years that profits are to a corporation what breathing is to a human being. We cannot live without breathing, and a corporation cannot survive without profits. But breathing is not the purpose of life, and profits are not the sole purpose of management.

I spoke earlier of the implicit franchise under which we operate. Its various clauses can eventually be boiled down to measurable objectives. The job is infinitely more complex when it comes to measuring objectives for our world society.

The danger lies in the fact that there is a tendency to concentrate upon phenomena that lend themselves to easy quantification and to slight those that do not. We have not yet invented a way to put numbers to such problems as the despair of an able-bodied man who is comfortably supported by the state, but who has lost self-respect because he cannot find employment.

This is significant because there is a strong body of belief to the effect that, in order to deliver the greatest good to the greatest number, we should direct our social expenditures where they will give us the best return on our investment. I realize that our programs must sometimes respond to immediate need, if only because we are inherently creatures of compassion. But I realize, too, that we will never have money enough or time enough to meet all the demands, and so we will come to difficult choices. Unless we make those choices correctly, we may find ourselves in the position of the worker wasp, which is so frantic about nourishing its young that if it cannot find any other food, it will bite off the back half of the grub and try to feed it to the front.

In any consideration of technology and growth, and of their consequences, we must turn eventually to the prophets among us. We have no shortage of soothsayers who are cheerfully eager to sketch out for us what the world will be like 20, 50, 100 years from now. Yet I remember that in 1933, President Roosevelt called together a panel of distinguished experts to tell us what changes we could expect in the next quarter-century. Missing from their list were such basic things as electronics, antibiotics, rocketry and space flight.

In 1947, the Census Bureau projected a population figure of 160 million Americans by 1970. It said that would rise by 1990 to the incredible total of 165 million, but would fall back to 163 million by the year 2000.

Now, there is nothing more basic to the art of national forecasting than the size of the population. That is what we use when we plan highways, when we make capital investments for telephone service, when we estimate our needs for housing and health facilities, dishes and diapers. I imagine it figured in the decision to commit more than $2 million for the refurbishing of Salisbury Hall.

Let us assume that we are now wiser and more sophisticated than we were three or four decades ago—after all, the early computers were awkward, clanking monsters compared with what we have today—and that we will indeed be able to translate our abstractions into measurable objectives.

Our governmental system does not encourage something like the act of faith that prompts a man to plant a tree when he knows it will not bear fruit within his lifetime.

WE COME THEN to step four—to lay out an organization that can accomplish these objectives. The adventure that first landed astronauts on the moon has been cited as an example of how men can organize their efforts toward a definable goal, but it is notable because it is practically unique. In various degrees, our institutions are less than ideally suited for the functions they are supposed to perform.

I will not exempt the business corporation from that kind of criticism. I happen to view it as a logical form that has developed naturally out of an instinct that drives us to look for ways to make the most efficient use of manpower, energy, resources and ingenuity for the good of humanity. I believe, further, that the private enterprise system under which it operates is the best mechanism yet devised for the constructive exploitation of surplus. I am *not* as sure that the system will work as well in times of scarcity, but when I consider the alternatives, I remember what the Socialist Michael Harrington has written about socialist nations—that in most cases they have succeeded only in the collectivization of poverty.

Of all the things that I have observed about corporations, the most disturbing has been a tendency toward overorganization, producing a rigidity that is intolerable in a time of rapidly accelerating change. I had not been at Koppers very long before I discovered that our organization charts were telling each of us more about what we couldn't do than about what we could do.

The structural problems of corporations are as nothing compared with those of our political institutions, which simply are not geared to deal with the future. Our federal government is a managerial nightmare. It is life a 200-year-old house that has had a succession of new heating plants, new wiring, new plumbing—without ever ripping out the old heating plants, the old wiring, the old plumbing. The basic design is good, but the structure is being destroyed by "improvements."

I don't wish to be too hard on the bureaucrats. They are the victims of a system that motivates our leaders on the basis of short-term performance. In today's technology, it takes eight to ten years to work out our problems. It takes legislation about 20 years from conception to execution. We cope with these conditions through officials whose vision stops at a horizon only two to six years away at most, when they must again face the voters. Our system does not encourage something like the act of faith that prompts a man to plant a tree when he knows it will not bear fruit within his lifetime.

I have seen the problem close up in the field of health care. I have held volunteer posts at two hospitals, two schools of medicine, a regional Blue Cross organization, and the Subcommittee on Organizing and Financing of a National Health Care System of the Committee for Economic Development. I served for a number of years as chairman of a county Hospital Planning Association.

In that last post, I was appalled—I am still appalled—at the fact that we could agree on our mission and we could set our objectives, but then found we were encumbered by an organizational structure that could not function. I was and am appalled at a hospital system that was established for another day and another set of problems, that is now trying to be used to deliver health care in a highly technological society with major changes in demography.

If you combine that, with a deadly penchant for redundancy in medical facilities, is why my enthusiasm for a national health insurance program is tempered by caution. I favor such a program, but I know that if we fund it now, without basic changes in the delivery system, we will cast in concrete a system that cannot do the job.

I MUST ADMIT that I have no precise idea as to how we should restructure our institutions, and I doubt that we should try to do so until we have carried out the first three steps in the methodology I have been discussing. I do know that most of our institutions—private, governmental and humanitarian—are too clumsy to cope with a world in transition. They *react* to stimuli instead of *anticipating* them, and their responses are too slow and too feeble.

I know, too, that in our attempts to restructure our political organizations, we cannot forever tolerate the sovereignty of nation-states. The Rhine, with its two and seventy stenches, begins in Switzerland and flows for 820 miles across the face of Europe to the North Sea. It will remain a sewer until some supranational body, in effect, operates the Rhine river basin under the discipline of cost-benefit analysis, with the authority to impose sanctions upon the sovereign states through which the river flows. Air and water pollution are no respecter of boundaries. The Swedes say that their largest import is polluted air from the United Kingdom. In addition, we are entering an age in which we will explore the ocean depths on a massive scale for fuel, food and other resources. We have as yet no clearly defined rules to ensure that we will do so on an orderly and equitable basis.

I do not go so far as to propose that we submit ourselves to a global government, however benevolent it might be. I see some advantage in political compartmentalization. It permits us to follow different paths of experimentation and then to share the secrets of our individual successes. Just as importantly, it permits each of us to indulge in the pursuit of creative errors, learning from those errors and passing on the lessons without the danger of bringing down all of civilization.

Given all that I have said, we move to the final step, which is to set up a sensing system that will tell us whether we really *are* making progress.

Such a system must detect advances and setbacks more accurately than ever before—and more quickly. We do fairly well with single factors, but when it comes to the interplay of variables, we are often perplexed. For instance, we cannot agree on the environmental economics of using recycled paper—on the relative safety and benefits of nuclear versus conventional power plants—on methods for the disposal of solid wastes—on whether the application of DDT does more harm than good.

In spite of these enigmas—in spite of all the woeful predictions I have been reading lately—I am not a pessimist. I have said that, given our present state of knowledge and organization, it is premature to propose solutions. Nevertheless, the process must begin, and soon. If I observe a man swimming out to sea, I can hope that he will come across a raft, that a ship will spot him and pick him up, or that he will turn around and swim back to shore before he is exhausted. But I know that if none of these things happens, and if the man continues to swim out to sea, he's not going to get to the opposite shore, he will eventually drown.

But—I repeat—I am not a pessimist. I am encouraged by many signs of new vitality in this 200-year-old structure of ours. One of those signs is what you are doing here at WPI to stimulate the creation of interfaces among the various fields of study. Not long ago, George Cabot Lodge, a professor at the Harvard Business School, former assistant secretary of labor, and author of *The New American Ideology*, commented on the need for perception of whole systems. He said, "The old idea of scientific specialization has given way to a new consciousness of the interrelatedness of all things." He spoke of the "long dark tunnels" called disciplines, and concluded:

"The student has come to wonder whether this kind of education is what he needs to understand the world—whether, in fact, what is truly important is not what ties the tunnels together and how they are related to one another."

You might want to invite Professor Lodge to make the short trip over here to Worcester. He would find, as I have found, not a series of tunnels, but a broad highway carrying vehicles (if you don't mind my calling you people vehicles) of every description and leading to a variety of destinations, with every foot of the way illuminated by the beacons of knowledge and inquiry.

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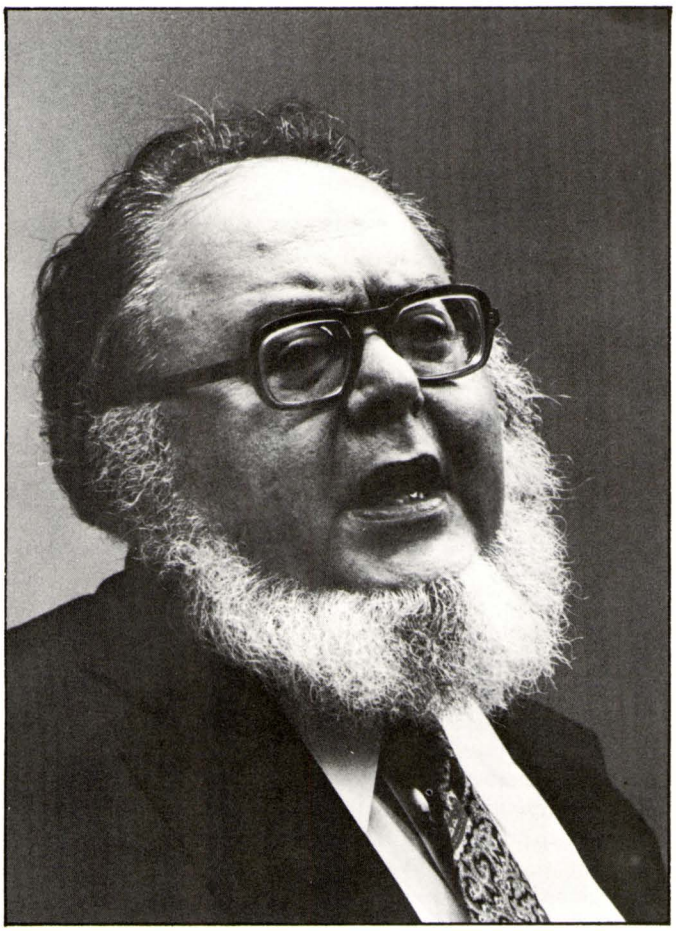

The need for growth

by Herman Kahn

WE TALK A LOT about predicting the future and about getting consensus. I make my living doing that. But like many people who make a living in a given field, I don't believe a word of it.

I could name about ten historic examples of people setting out large programs with clear objectives, and they worked out — Augustan Rome, our own canal system laid out by the Secretary of the Treasury, and so on. You can count them on the fingers of two hands. Almost everything else has grown — and when you grow something, you're not quite sure where it's going to go. You have to trust the system. There's a lot of luck in it, and a lot of internal momentum.

Let's take population predictions as an example. First, let me poll the group here. If you were president of the United States and could somehow actually control future population, how many of you would be in favor of a somewhat increased growth rate for the U.S. population today? How many in favor of leaving it alone? How many in favor of decreasing it? All right, you're a very balanced group, roughly one-third for each alternative.

I was recently in Houston, Texas, to talk to a group of Club of Rome people. I asked them the same questions. They voted about 95 percent in favor of reducing population growth in the United States. I then asked how many of them knew the consequences of their action; that is, how many had a right to an opinion. They all claimed to have done their homework. And then I showed them the following chart. The population growth rate used to be roughly 7 children per family in the United States in 1800. It went down to 2.1, which is the rate which would have led to those 1947 Census Bureau predictions Fletcher Byrom mentioned. Then American women got frivolous, and the rate went up to 3 something. Now it's back to 1.8. If it stays at 1.8, we have a declining population around the year 2005 with mostly old people and relatively few young people. If you decrease the rate, you make that division very sharp. If you decrease it for a while and then increase it, we have an hourglass-shaped population distribution, with old people and young people and no one in the middle. Now, very few people in the United States like the demography with more old people than young people, and so *ipso facto* they don't want to decrease the growth rate. And they don't want to leave it alone, either. They want it to increase and get back to 2.1. My own guess is that the rate is going to get back there, but that's only a guess.

Obviously, it's very difficult to predict anything like this. This is the kind of uncertainty that, by the way, has caused the collapse of almost every demographer in the world who's tried his hand on it. You know how they will issue a high, low, and median? It always comes out lower than low or higher than high. In every case. One moral here is, Don't try to predict population

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in a modern society. It turns out to be unbelievably frivolous and dependent upon fashion.

Second moral: When we had the 7+ rate, a lot of people were predicting one billion, two billion population in the United States by the mid-19th century. But it actually went down, as you know, all by itself. There wasn't a single government program to cause it, which was very unfortunate. If there had been such a program, it would have been incredibly successful, and whoever was in charge would have gone down in history as the man who saved the country. But unfortunately nobody had the idea. You understand, any program at all would have worked, including this speech of mine.

Why did the population growth rate drop so drastically? Benjamin Franklin once made the comment that the easiest way for an American to get rich would be to marry a widow with seven children. Don't try that today. It's a prescription for bankruptcy. Can you imagine buying nine tickets wherever you go? Basically, children changed from being producers to being consumers, to put the situation in its bluntest terms. When I look at my young children I love them, but I don't think of them as economic assets. And people tend to ration themselves in consumer goods.

At the Club of Rome festival in Houston, I commented that on every issue I was going to talk about, most of them were about as ignorant of the facts as they had just showed themselves to be on population. And here I'm talking about resources, energy, food, the whole new style of life — what's causing it and where it's going. This is another reason why I don't like too much planning. Byrom talked a lot about having sensors to see the future. We've actually got an incredible number of sensors, but no one's looking at them. It's all *fashion* in the discussions. Remember fashion — whatever people happen to feel is interesting that month, and it varies. It has very little to do with anything based upon data or sharp observation of the scene.

Let me ask another question. How many of you expect that in the long run, say the next 50 to 100 years, your children will live worse than you, or about the same, or better, because of technology and the defects of technology? I'm asking about running out of food, resources, the whole Club of Rome position. I suspect the betters are going to have it correct. But we don't really know, of course.

Population growth rate dropped because children changed from being producers to consumers, and people tend to ration themselves in consumer goods.

I'D LIKE TO SUMMARIZE 400 years of history. About 200 years ago, mankind was just entering the industrial revolution. Before that, the per capita income — for all its difficulties, that's a useful expression — was generally between $100 and $300. Anybody over $300 was very rich; anybody under $100 was very poor; $200 was sort of normal. In India today the figure is about $150, but that's pretty comparable to the $200 of 200 years ago, so we can think of India as normal. Indonesia is normal. If you ask, Why are Indians and Indonesians poor? it's because for 10,000 years, ever since civilization started, *that's the way people have lived.* It's a perfectly natural phenomenon. As Byrom said, you have to go through a process of capital accumulation and increased productivity. The problem is not in distribution. The problem is in increasing the productivity and the capital in India, not of giving them charity.

In that sense, 200 years ago mankind was everywhere poor, almost everywhere powerless before the forces of nature. Two hundred years from now, barring bad management and bad luck, mankind should be almost everywhere numerous — we're talking about 15 billion people, give or take a factor or two and we won't be annoyed if we miss it. Everywhere rich — about $20,000 per capita, give or take a factor of three. Almost everywhere in control of the forces of nature. This 400-year period should be the most exciting time in man's history. I used to comment that there were only two incidents worthy of notice in the world — the agricultural revolution, which created civilization, and this industrial revolution now underway. The first took about 8,000 years to spread around the world; the second looks like it will be done in 400 years. That's fast!

You've heard of the population explosion. Have you heard of the GNP explosion? Since 1950, gross world product has increased about 5 percent a year. That's a doubling every 14 years. It's growth by a factor of more than 10 every 50 years; more than 100 in a century; and by a factor of 10,000 in 200 years. If that rate were maintained for many decades, you'd have no problem with poverty in the world. And you don't have to worry about distribution. In every country that has gotten rich, the distribution problems have tended to solve themselves, at least in terms of absolute poverty. Relative poverty we'll always have. How many of you, by the way, have felt recently depressed because you don't live as well as a Rockefeller? I asked that once with a Rockefeller in the room, and he was shocked. You people look desperately poor to him. It always looks worse from the top down than from the bottom up. Almost everywhere people worry a lot about gaps, it's from the top down, not the other way around.

I'm not particularly a believer in limits to growth, but I don't believe the gross world product will be 10,000 times larger 200 years from now. And why am I interested in gross world product

anyway? Is it a mindless concern for growth? (You know, the current term is gross national pollution — the effluent society.) People talk about mindless growth a lot. I don't know of a single country where they're not arguing over the distribution of the gross national product. They know exactly what they want it for, and they're arguing about it. I know of no country in the world which is growing mindlessly. They just don't exist. Each of them has a bill of needs they'd like to fill, and they can't unless their gross national product increases.

There's not a total consensus on this. Some people say these needs are silly, and here I want to disagree with Byrom. We don't waste a great deal in this country, if you look at the actual costs and the way people behave. Except for a three- or four-year period when we were putting out really badly designed cars and electrical appliances, I know of very few things in the United States which represent a lot of waste.

Now, you may ask the following question: Why would you put an air conditioner in a car which has enough btu output to cool a small two-bedroom house? Isn't it a waste? Well it just happens that when people go into a car on a hot day they don't want to wait two minutes for it to cool off. Have you ever tried it? They want it cool in 10 seconds. And you know something? They're right, they're absolutely right. They can afford it, and under normal conditions the energy was there. The energy will be there again.

I WANT TO DISAGREE with Fletcher Byrom's comment that we should start thinking of fossil fuels primarily as a base for petrochemicals. Now it is true, the engineer is very upset at that. It's a little bit like using a human being as a horse for pulling something. A human being is a complicated thing, and there ought to be a higher use for it. Hydrocarbons are incredibly complicated substances, and the idea of burning them in a furnace strikes most engineers as somehow rather destructive. Unfortunately, there are so many hydrocarbons left in the world that, if you tried to use them for petrochemicals alone, the exhaustion point, where they get to roughly 50 cents per million btu's, is measured in the hundreds of billions of years. Now, I look ahead . . . but I don't look ahead that far!

As near as I can see, we have enough hydrocarbons to use at a reasonable price for burning purposes — heat — until well into the 22nd century. I think that in the early 21st century we're going to move to more or less eternal supplies of energy, things which are self-renewing, if you will. So we have a 100-year overlap between running out for the purposes of fuel and being able to replace with basically eternal sources. We have about eight alternatives for the eternal source, and they all look like they'll be competitive around the year 2000. At this point, we don't know which one of the eight it's going to be. I have no idea at all. It might just end up being the boiling water reactor we already use, where we will be dependent upon very low-grade uranium ore — what you find off Norway, or in shales or in granite. It might be fusion power. It will almost certainly involve some solar power.

I'm not going to guess; I have no idea. They all look competitive. If somebody tells you he feels we're going to run out of energy, he's either worrying about some extraordinarily remote threat, or he's paranoid or foolish or ignorant. I'd like to make the point just that strong. Now, he might tell you, if we don't invest the capital we won't have any of these things, and there I think he's right. But the capital is being invested, particularly in research and development.

Byrom commented that the price system doesn't work perfectly. That's certainly correct. But we're doing a study called "The Long Term Prospects of Mankind," and we're desperately trying to find situations where we can say the price system there is just wrong, because that will make us look very good and non-ideological. So we're looking hard for any place where we can say, "Don't use the dollar as a signal." And boy, when we find that, are we going to be pleased, and we're going to plaster it all over the world!

What I am saying here is subject to one important *caveat:* that in principle the costs are internalized. In other words, a businessman really has to look at what his profits are, and that really is his guide except for something called decent behavior. But it's terribly important that when he does something which is socially costly, like dumping pollutants into a river, or creating a work environment which is harmful to the people concerned, that he either be forbidden to do that or that he be *charged* for it to discourage him.

So I've made the assumption that we've internalized costs. But this turns out to be very difficult, because we don't know what the costs should be. We have no consensus, and will not achieve a consensus, on what the appropriate value systems are. Take the Alaska pipeline. The delay that the Sierra Club caused the Alaska pipeline can be split into two pieces. The first part, which Governor Hickel says he caused, not them, was due to a badly designed pipeline. That first-year delay was justified, and the pipeline was redesigned and passed the proper reviews. The next five-year delay cost this country at least $25 billion in foreign exchange. My own guess is that the total cost to the country will be well over $50 billion before we're finished. That's a lot for about 12 square miles out of 500,000. I could stick you at random in Alaska, and you couldn't find the pipeline. The caribou love it, it turns out, and the Eskimos approve. One would have thought that $25 billion, maybe $50 billion in costs, is a little excessive for preserving a landscape which nobody really wants preserved. You go to the Sierra Club today, and they'll tell you, No, that was a moral decision on their part. All right, maybe it's moral, but it's also damn dumb by the value system of almost all Americans — but not by theirs. They're entitled to their value systems, but they're not necessarily entitled to thrust them upon the rest of us.

Why are Indians and Indonesians poor? Because for 10,000 years, that's the way people have lived. It's perfectly natural.

I'd even use that argument for things like the extinction of species. Perhaps 20 or 30 billion species have become extinct since world history started. On the face of it, adding a few to that may not be a terrible thing to do. Now, I'd be terribly upset if the whale became extinct, or the grizzly bear or the eagle, because they represent something to my culture. But how do you feel about the passenger pigeon? The last one died in Cincinnati in 1911. Anybody want to mourn it? The skies were dark with them . . . and so was the ground. If you want to talk about pollution, you should live with passenger pigeons.

Byrom was absolutely right when he said there were no good old days. I have talked to high school kids in both Pittsburgh and London. Not one of those kids knew their city was clean. They thought the environment had steadily deteriorated. They had no idea that twenty years ago, in Pittsburgh, you used to change your shirt four or five times a day, depending on whether you wanted to be filthy or just dirty. They had no idea what pollution is. Nobody burns soft coal anymore, and you have no horses. The average horse, by the way, leaves a kilogram of pollutants per mile, 60 percent solid, 40 percent liquid. A very small number of horses on a dry or wet day can create unbelievable havoc. I've been in horse towns, and they're unbelievably unpleasant. There's nothing remotely like it in Los Angeles or New York. And I'm not talking about a lot of horses — just a few for the rich, that's enough.

What I'm trying to say is that much of the discussion is at an incredibly low level. I use the phrase *educated incapacity*. It comes from Veblen, who used the term "trained incapacity." By that he meant many things, among which was "the inability of sociologists and engineers to deal with simple issues they could have handled if they had not had graduate training." Is the concept clear? I give the term "educated incapacity" a larger role. It says, look at the educated elites.

This is not a world-wide phenomenon. It's largely restricted to Japan and what we call the Atlantic partisan culture — Scandinavia, Holland, England, U.S., Canada, Australia, New Zealand. Holland is probably the greatest example I have ever seen. The book *Limits to Growth* sold 500,000 copies there in about eight weeks. There are only 12 million people in the whole country. Each intellectual must have at least three copies! (I'm being a little unfair, because it was sold through the high-school system.) Holland has no Viet Nam, no poverty, the pollution all comes from the outside, and no race problems — and yet it's got all the difficulties we had in the late 60's. It has the dropout kids. It's the only place in the world where they publish the price of marijuana in the newspaper — bid, asked. It has the *provos*, who are more extreme than our Yippie movement, and it's got every nutty fashion I know of. And that tells me something terribly interesting. These fashions have very little to do with the actual historical data, the hard facts of life; they have to do with historical culture. They have to do with the way children are raised and the attitudes their parents have.

For example, almost every prestige school in the United States, from about 1968 to 1975, taught limits to growth, generally in an extreme fashion. The usual picture they gave you was, America is 1/16 of the world's population and is using up 1/3 of the world's resources, and this is the greatest crime in history. It's the greatest *war crime* in history, because it's going to condemn millions of people to death by starvation. (I use the term war crime advisedly. During war you're allowed to do all kinds of things which you can't do in peacetime, but even in war there are very clear limits, depending on the country, as to what you can do. You can't do anything you want. You get punished if they catch you, and then you're really looked upon with absolute contempt.) If all this were true, that would be the biggest war crime in history, and anybody who's not opposing it, as far as I am concerned, would be a war criminal. You're not allowed to stand aside in those circumstances.

They had no idea that twenty years ago, in Pittsburgh, you used to change your shirt four or five times a day, depending on whether you wanted to be filthy or just dirty.

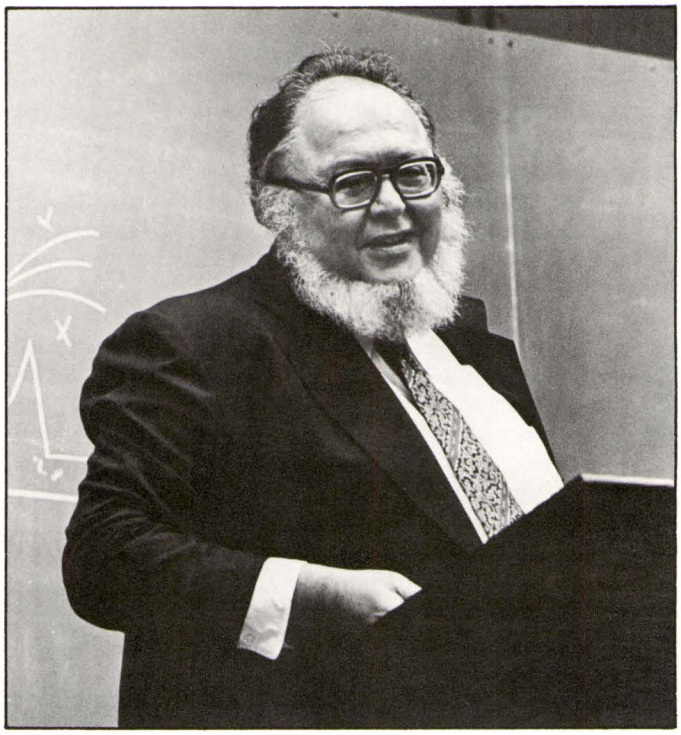
IN FACT, the major reason for the wealth of most of the world is the growth of Europe, America, and Japan. And the major reason for this very high growth rate I'm talking about, 5 percent, is the 4½ percent growth rate of the rich which makes for a 6 percent growth in the poor. It's one of the greatest feats in world history.

Let me just talk about this picture of the world for a moment. How many of you believe that half the world goes to bed hungry at night? You've heard that statement over and over again. And it's not true. It's a mistake in arithmetic made by Lloyd Bodor, head of the FAO. For a long time he refused to admit his mistake, and there was a consequent mistake in understanding the situation. But finally the FAO admitted they were wrong. (And at that point the economists accused the FAO of being a permanent lobby for starvation!) Their more recent calculations are that about one-eighth of the world suffers from malnutrition because of poverty. That seems reasonable. Now, one-eighth is a lot of people; you can't be complacent about it. *But it's not one-half.* It's different.

In fact, the world isn't that poor. About 30 percent of the world lives at $150 per capita or a little bit less — normal, classical poverty. About 44 percent of the world lives at about $600 per capita. The Chinese are at $350, but very well organized. You can't call them poor by any standards. Go to China and call them poor, and they'll kick you in the teeth. They won't stand for it. So 44 percent of the world is middle income — neither rich nor poor. It's growing about 5 percent a year, and rapidly catching up with the 26 percent who are rich. By the end of the century, something like two-thirds of the world will be rich by almost any standard, including the standard of 1950 (not necessarily the standard of today). And roughly one-third will be poor, but not by historic standards. By historic standards most of them will be relatively well off.

Basically the system is succeeding. Like our own country, the 44 percent who are relatively talented in economic development grow very fast in the current atmosphere. And they do so because of the capital, the markets, the technology, and the organization supplied by the rich. The Japanese, who now profess a belief in "balanced" growth (though they're dropping that position), calculate that if they stuck to their guns and grew only 5 to 6 percent a year, the growth rate of southeast Asia would drop 3 points. The growth rate of the poor depends almost entirely today on the growth rate of the rich. That's why I totally disagree with the limits to growth people.

First of all, I disagree with their concept of organic growth. Their basic concept is that we should tie ourselves to India in such a way that if India goes down, we go down too. They think it's an unbalanced situation, that if we get richer, India gets poorer. The last thing in the world we want to do is marry India economically. It just doesn't make sense. First, we would ruin India. Second, India would ruin us.



I believe in what could be called very unbalanced growth. There's no particular reason why the rich should grow richer; as far as I'm concerned they're already rich enough. But there's no particular reason why they shouldn't; it's a matter of taste. To the extent that we let morality enter the picture, because we want to help the poor, we have the rich grow faster. It's not a question of reducing gaps; it's a matter of increasing the income of the poor so they can get someplace. I don't believe there's a single worker or peasant in Latin America, Africa, or Asia who worries about gaps. They want to get rich. I've often asked their governments the following question: Say there are two ways to get rich. One way they triple their income in, say, twenty years, and U.S. income remains constant. The second way they double their income but the U.S. income goes down a little bit, and the gap narrows. Which way would they pick? They tell me they wouldn't give up one penny in income to reduce the gap, to cut U.S. income. They don't love us for being rich — and they don't hate us either. We're far away.

By the end of the century, about two-thirds of the world will be rich by almost any standard.

IN THE LAST FIVE YEARS you've heard a great deal about limits to growth. The Club of Rome people more or less officially changed their position recently in Philadelphia. The original position said you can't grow even if you want to, because there are no resources. The new position is very much married to the so-called new international order. It says the poor should grow (you can't tell the poor they can't grow!), but the rich should not; the rich should stop or slow down. That position is even less satisfactory to me than their original position, because that first position was obviously wrong.

Now, I can make some statements here in the year 1976 which I couldn't have made in 1960, and it's terribly important for you to realize that fact to really understand my position. This is not a gung-ho speech; this is not a speech of *Man Can Rise To The Occasion;* this is not a speech of *Optimism Is Better Than Pessimism.* I want to give you some numbers. I don't believe you can prove many things by numbers, but one of the things you can prove is, the resources add up, because that's an arithmetic question.

I want to take one of the first issues raised in *Limits to Growth,* that we're running out of aluminum. There are some twenty things we're running out of, and they start out with aluminum. Now what they're *really* saying, if you look at it, is we're running out of bauxite. I doubt that, but I can't prove it's wrong. On the other hand, aluminum is 7 percent of the earth's crust! It's sort of obvious even in 1960 that you can't run out of aluminum; but in 1960 if you asked me what I mean by that, I mean Man Is Going To Rise To The Occasion, somehow we'll handle it. Today, however, I mean that I can point out to you the various sources of ore which will substitute for bauxite — if we run out of bauxite — at a roughly comparable price. So don't argue with me about running out of aluminum. If you think we're running out, you're wrong; it's a matter of arithmetic. We actually know where the ores are, and I can show you on a map. This is not being optimistic, and it's not being pessimistic. It's adding up the numbers properly.

If you say we're running out of energy, I'll come back with the same answer. Sure, we have a shortage of energy today. If we're dependent on the Middle East and they turn the faucet off, we're going to run short. I think that if they had not turned off the faucet, Byrom would be right: then the price system would not be a good guide to energy sources. In fact, I think history will record that the act of the OPEC nations in turning off the faucet at that point actually *solved* the energy problem for the medium and long run. There's a rather good chance that if they hadn't done it, we would have run through a very rough ten or fifteen years. Back in 1972 we were preparing a report that said, Let's get the price of oil up to $5 a barrel as fast as possible, for a number of reasons, one of which was to stimulate R&D.

What about air pollution, water pollution? If your standards are reasonable — not health standards but aesthetic standards — it will be achieved in North America, in northwest Europe, in Japan, by around 1985 or soon afterwards. By this, I mean the programs will be in operation. Now what if you really have a very high aesthetic standard? Those who live out in the West know you can sometimes see for 50 miles, and it's beautiful. I don't think that will be preserved for as many days a year as we have now. In other words, we might now have 100 days a year when you can see Catalina Island from the coast, and that may go down to 60 days, or 50. And that's a loss, a real loss. But I suspect the higher income is worth it to most people. They want it. They may be wrong, because they don't need the higher income; they're not dying of starvation. But I think that they will so choose.

I think history will record that the OPEC nations' turning off the faucet actually *solved* the energy problem for the medium and long run.

THERE ARE TWO WAYS in which quality of life will go down. First, you'll never reproduce what I had in Los Angeles as a very poor boy. We were on relief. We'd just gotten off the boat when we went to Los Angeles, and I went to work, and I've worked all my life since I've been about 12. Even when I was going to school I worked anywhere from thirty to forty hours a week. Nevertheless, I bought a car, a Model A, for $75, and I was able to maintain it myself, with no insurance. We used to drive down to Malibu, where we would have the entire beach to ourselves, just two couples. That's where the movie stars are now. If anybody else came, we moved to a beach farther north. We used to go hiking in the high Sierras; and if we met one other couple on the trail, the day was ruined. We used to drive to San Francisco for Chinese meals, and there was no traffic. You couldn't make it today. We used to drive to Mexico for Mexican meals. That's gone, and it can never be reproduced. You know something? My children don't miss it. They're not smart enough to, and I haven't told them. Why should I wreck their lives?

I should make this clear, because it relates to the second kind of loss, where values will disappear. This has been so important a factor in Western culture that for the last thousand years you could make the following observation: The elites would not have liked the culture 100 or 200 years later. If you stopped somebody on the street in 1776 or 1876 and described today's world to him, he would say, "My God, that's awful!" Let's take my own family. We came to this country for freedom, wealth, safety, status, respect. We got all that. Except it was a total failure, according to my grandfather. He walked with God; his degenerate grandson was an atheist at 12. What was the point of the trip? I explained to him that if we'd stayed in Poland, I would have been the same. I might as well be rich, knowledgeable, and so on.

Actually, things are looking better for my grandfather now. I became an agnostic at about 25, a deist at 35. I think I'm going to die a rabbi! But it took a long time.

The mirage of efficiency

by Hazel Henderson

SCIENCE HAS BECOME a religion for all too many of us, while human values and ethical concerns are driven into hiding because they are embarrassingly unquantifiable and "non-rigorous." Most of the incentives in the academic world reward rather narrow, reductionist study and pseudo-rigorous examination of less and less significant phenomena.

Many distinguished scholars have called attention to these "fallacies of misplaced concreteness," as Alfred North Whitehead called such efforts of micro-rigor. They include, of course, the great Werner Heisenberg in physics; Kurt Gödel in mathematics; Oskar Morgenstern, Georgescu-Roegen, Kenneth Boulding, and E. F. Schumacher in economics. The torch is still being upheld in the science-policy arena by Lewis Mumford, Gerald Holton, Margaret Mead, Gregory Bateson, and many others, and there are the vigorous new critiques of reductionist science by Theodore Roszak, R. D. Laing, and William Irwin Thompson.

All these humanists force us to remember that reality is what we pay attention to. The normative nature of science is revealed in the first decision of any scientist: what phenomena to study. This choice then influences our view of reality: where we see ourselves in space-time — perhaps it's a sort of Heisenberg Uncertainty Principle at the macro, rather than the quantum, level.

I believe that human survival now requires an awareness that transcends our very natural anthropocentrism. Each great knowledge explosion in our history has been based on such a new level of expanded awareness, from Ptolemy's view of the sun and stars revolving around us on Earth, to the Copernican revolution which reduced us to a subordinate positon in the universe. Darwin further undermined our proud image with his theories of evolution, and much of today's new knowledge is increasingly shattering our sense of self-importance. And that is so whether we study ourselves as components of living ecosystems, or as the infinitely malleable creatures viewed by behaviorist B. F. Skinner in *Beyond Freedom and Dignity*, creatures whose profoundest emotions are nothing but electrical stimulation, reproducible by brain-probing instruments. Now we learn that two more of our claims to uniqueness are being debunked: dolphins and other mammals have well-developed languages; and many other species use tools, including even the lowly ant, which loads food supplies on leaf fragments and thus multiplies its transport capabilities tenfold.

We are just becoming aware of ecosystems as immanent information. For example, it has been shown that grasses in a typical grazing pasture are capable of growing themselves tougher and more unpalatable by increasing the cellulose content of their leaves in order to drive off excessive numbers of grazing

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animals. In our pride, we tend to overlook these levels of wisdom around us.

But let us not be dismayed by this disturbing new evidence of our need for greater humility. Let's instead relax and enjoy our natural curiosity, and indulge the new burst of imagination and speculation it creates. Imagination, indeed, has always been one of our most important survival tools. We must now employ imagination to help us deal with the perceptual crisis that is upon us, as our species has now multiplied almost to the limits of its ecological niche on this planet.

This perceptural crisis has two aspects. First, we are experiencing an implosion, as space and resources diminish relative to our growing population. We feel the loss of frontiers, the slowing of economic expansion, urban crowding, and the evaporation of many of our historically defined freedoms. And at the same time we are experiencing ourselves getting smaller and less significant as all of the old perceptual boundaries fall away. So paradoxically, as we feel *physically* confined and frustrated, we are also confronted with an expanded *mental* model of the universe. We are again facing the oldest human dilemma: a consciousness that can wander among planets, stars, and millennia, but trapped in a few dollars worth of chemicals which will degrade in a few brief years. In short, we have to again face the fact of our own death and finiteness, as the old games our cultures have provided to shield us from this reality break down and become destructive and inappropriate for the new conditions, leaving us shorn of psychological clothes with which to protect ourselves.

Imagination is already coming to our aid again. As physical forms of growth are foreclosed, we are learning to make some new psychological "elbow room" in diversifying lifestyles and in fashioning new images to help us expand our consciousness for the next evolutionary leap we must now make. We might imagine ourselves as a termite colony, up to now living happily for all of our generations in a beam in the basement of a house. We have developed elaborate social structures and academic disciplines: termite geography, termite mathematics, physics, engineering, and economics. Suddenly our current generation has used up and transformed the beam and emerged at its external surfaces. Not only does this change all the conditions within the colony and its beam, but the roof on the house seems to have blown off and the walls collapsed! Survival now requires the reconstruction of a more appropriate geography, physics, math, and economics to incorporate the new variables and expanded boundaries and contexts.

The entropy state . . . a society that has reached such levels of complexity and interdependence that it has become unmodelable, and therefore unmanageable.

I HAVE OFTEN WONDERED why we are so much better at creating "hardware" than at designing the "software" to go with it. At one level, it is rooted in our fear of death and non-existence. When we build cities, dams, and factories, we provide for our material requirements, but we also affirm our existence and importance. These physical artifacts that are so tangible reassure us of our own reality. Another root of our interest in hardware is that humans love to manipulate their surroundings and enjoy the sense of mastery and control these activities confer, as well as the expression of self in such creation and play. Yet another explanation may be that we would rather project our inner tensions and conflicts onto the objective world than resolve them by examining our own psyches and trying to retool ourselves.

Lastly, I wonder whether this passion for hardware is not a result of a cultural overdose of the masculine consciousness? (I like to call it "macho technology.") The masculine psyche does seem more attuned (either biologically or by cultural conditioning) to manipulating external things and objects, while the female psyche seems similarly more attuned to "software," i.e., interpersonal and social relationships and arrangements.

Technology, defined as knowledge systematically applied to human problem-solving, means software as well as hardware. For example, the social security system and income tax are as much technologies as any hardware system. Lewis Mumford pointed this out a long time ago in *The Myth of the Machine,* and drew attention to our bias toward hardware in anthropology and archeology. He pointed out that when we dig for evidence of earlier cultures, such remains are tangible by definition: in other words, their hardware, whether arrowheads, axes, pots, or other artifacts. We infer from the extent and elaboration of these artifacts their level of "civilization." We often forget that many cultures may have existed without leaving a trace. They could have developed highly refined technologies, but of the software variety: techniques of conflict resolution, supportive interpersonal relationships, production systems based on elaborate barter, reciprocity, and redistribution schemes, as well as myths and taboos to regulate antisocial behavior without the use of jails, clubs, or physical restraints. A culture which elaborated such software techniques would have had little need for spears and arrowheads, and might have had few energies left over to elaborate its tools, and so we might assume too casually that, because there were few tangible remains, it was less "civilized."

In the same vein, I recently visited Japan and talked with a project director at the Japan Techno-Economics Society, who was directing an effort to computer-model the value system of the Japanese people. He pointed out that it was possible to infer from the quantities and configurations of material artifacts and

technologies created by various cultures, a great deal about their value systems. As an example, he mentioned the culture of the Balinese, who create exquisite music, dances, rituals, stories, and clothes, but who are just not interested in hardware. On the other end of the scale are the Americans, who are fascinated with hardware and produce more of it than any culture the world has ever known. We are even unable to enjoy leisure activities such as hiking without an incredible quantity of gear.

Similarly, we know that values are the dominant variables driving not only technological but economic systems. Relationships have been established between Judaeo-Christian religious beliefs and the rise of capitalism and the industrial revolution. E. F. Schumacher described in his book *Small Is Beautiful* the value system that drives Buddhist economics. There labor is an *output* of production rather than an input; it is embodied in the idea of "right livelihood," where work is a valuable mode of self-actualization while the product is of secondary importance.

We again face the oldest human dilemma — a consciousness that can wander among stars and millennia trapped in a few dollars worth of chemicals that will degrade in a few years.

In this culture we may at last be awakening from that altered state of consciousness which Thomas Berry calls "the technological trance," and all the unthinking assumptions that underlie it. The most destructive of these beliefs is that we see innovation and technological progress mostly in terms of hardware, and as continuous. We rarely recognize limits or the concepts of balance and paradox. This technological trance has led us on with a mirage of "efficiency" as its will-o-the-wisp. Our technological consciousness has permitted us to conquer nature (temporarily, at least), expand our ecological niche, and manage more of the variables that affect our existence. But the trade-off is that, as we proceed with this process, the task of managing these proliferating variables becomes ever more complex and onerous, until we find that we need a breakthrough a day to keep the crisis at bay. We lose sight of the fact that some human and natural processes are not susceptible to increases in "efficiency." Women understand this better than men: it still takes nine months to make a baby, and 200 years to grow a hardwood tree. And while human interactions can be increased and made faster with technology, they are rarely made better and sometimes made worse. A companion myth is that new technologies can always be "debugged" if only we wait long enough. My view is, if you put the bugs in at the front end of the cost/benefit analysis, you might have a whole different idea of whether it is worth doing.

Let us look at a few contemporary examples of this mirage of efficiency. A recent one is the effort of officials in the U.S. Postal Service to reduce "inefficient" mail. After reducing the human workforce (adding to the ranks of the unemployed) and investing millions in capital, they find that the machines are ripping, crushing, or destroying an alarming number of parcels. It might have been more socially efficient to add one million unemployed workers to the Postal Service, increasing the care in handling while reinstating the twice-a-day mail service our forefathers took for granted!

Another more somber example is the efforts of electric utilities to seek "efficiency" in larger and larger generating plants, substituting nuclear power for less costly and violent technologies. For this increasingly suspect and evanescent "efficiency," they are willing to assume risks on our behalf and trade social efficiency, since costly and elaborate police and security systems will have to be invented to contain and manage the plutonium wastes, now and for thousands of years to come. This does not mention, either, the additional social costs which must be paid in the loss of many cherished civil liberties. Already, consumers and citizens are in full-scale revolt against these social inefficiencies. Yet another example is the current effort of supermarkets to automate checkout counters in search of greater "efficiency."

You can see as well as I that the word "efficiency" is fast becoming meaningless. We must ask, in all cases, "efficient for whom?" We are now more aware that if the term efficiency is to mean anything, time and space coordinates must be specified. We have to know over what time-frame efficiency is to be maximized: One year, as in corporate balance sheets? Five years? Or sustained-yield, long-term productivity? Farmers understand that; I don't know why economists don't. Similarly, we must know at what system level efficiency is to be maximized: At the individual level? The corporate level? Or do we mean societal efficiency, or ecosystem efficiency? Each of these different time-space specifications of "efficiency" requires totally different policies for their implementation. Indeed, in an economy with nearly 8 percent of the workforce unemployed, corporate efficiency may be served by further automation and capital-intensification, while social efficiency is sub-optimized because taxpayers must foot the bills for unemployment and welfare payments.

Buckminster Fuller uses a similar term in a vacuum. He calls it "ephemeralization." You know, you're going to do more with less, and that's bound to be good for all cases, all times, and all places. There again, you have to break it out. He uses the example of the few pounds of material in the satellite replacing thousands of pounds of copper wire in telephone cables under the Atlantic. Of course, you cannot even discuss the efficiency of doing that without asking the question of how the access to the satellite has been altered by that new configuration. In some cases, it may be efficient to use stone-age technology if the material is readily available to the local people. So let's call people to account when they use these terms loosely.

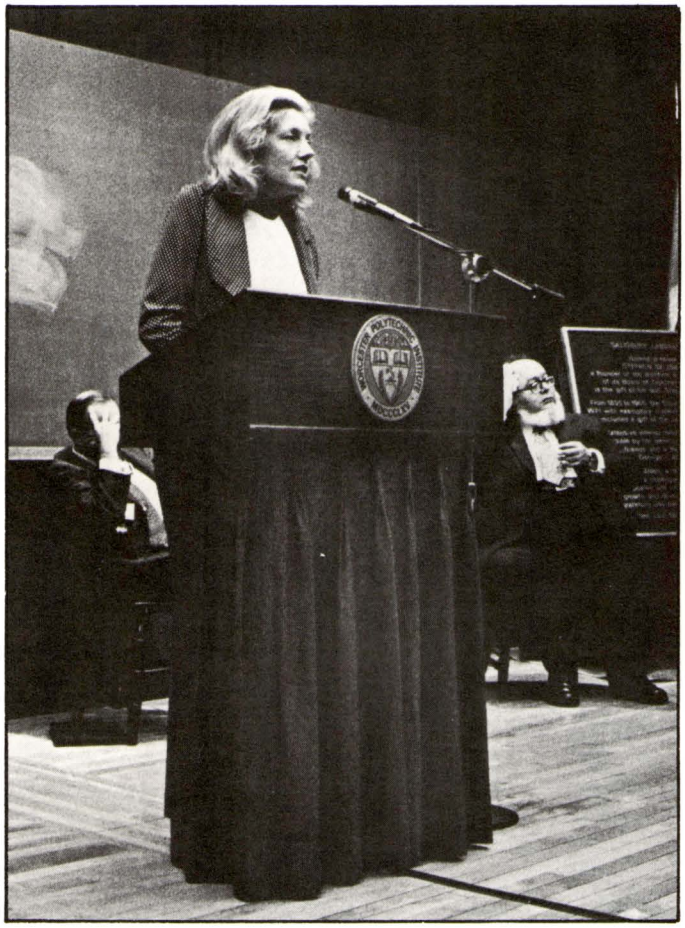
Try this one out on a neoclassical Western economist: Do me a model of a production system where labor is the output, not an input!

I BELIEVE OUR ECONOMY has overshot the mark in its substitution of capital for labor. In fact, I contend that in hundreds of production and service processes, labor has now become the more efficient factor. As natural resources become increasingly scarce, we must employ our human resources more fully. In fact, a resource-conserving economy must, by definition, be a full-employment economy as well as, incidentally, a more environmentally benign one.

I got so angry about the way this debate was going last year that I formed a coalition called Environmentalists for Full Employment. You know, there are a lot of front groups formed by the energy industry, with names like Californians for Jobs and Energy, and Americans for Energy Independence, and so forth. So we're trying to call them to account by saying, jobs producing what? At the substitution of what other public priorities? Jobs at how much capital per workplace? They think all they have to do now, you see, is wave the holy icon of jobs, and they can do the most absurd things in that name. But I think we're now getting beyond that.

On a world scale, this capital/labor ratio has obviously shifted to labor, not only because capital is scarce, but because natural resources are becoming scarce and people are becoming more plentiful. But in our own U.S. economy, the capital/labor ratio has shifted back to labor for other reasons. We have been subsidizing the overuse of capital relative to labor through investment tax credits, while at the same time we have been using linear-extrapolation type projections of labor costs which conceal the fact that labor is now cheaper than capital, materials, and energy in many industries and services.

Another reason we are oversubstituting capital for labor is due to economists' confusion about the concept of "productivity." They measure productivity as output per employee-hour. This is a measure of how much more *capital* has been placed at the disposal of each worker. As economists examine these capital-enriched production processes, they measure these predictable increases in "productivity," case by case, while overlooking the fact that these processes all tend to shake out more and more workers at the bottom of the economy, where *their* productivity falls to below zero and they join the ranks of the unemployed. Therefore, we need additional "average productivity" measures across the whole workforce, including those who are able-bodied but unable to find work.



Indeed, it is the current combination of high unemployment, inflation, and shortages of capital, energy, and materials that are now signalling the limits of macro-economic management. Our society is now negotiating what I have called "the coming economic transition" from a maximum-materials-throughput system based on nonrenewable resources, to a minimum-throughput, recycling economy based on renewable resources and managed for sustained-yield, long-term productivity. In dealing with this difficult transition to the new productive system we must now put into place, we are facing *social* and *conceptual* limits to growth. These social limits are now clearly visible in most industrialized economies, in the backlog of soaring social and environmental costs (dismissed by most economists, in almost a Freudian slip, as "externalities"). These include not only cleaning up after the mess created by mass production and consumption, but dealing with the dropouts from urban complexity and massive, incomprehensible technology: mediating the social conflicts, controlling crime, and attempting to coordinate the whole and maintain social equilibrium.

I have proposed that, far from achieving Daniel Bell's salubrious vision of the post-industrial state, we may well be heading for what I call the entropy state. I define the entropy state as a society that has reached such levels of complexity and interdependence that it has become unmodelable, and therefore unmanageable. Such a society begins generating so many unanticipated social costs that these cumulative "transaction costs" begin growing exponentially, and finally exceed the society's real production. Like a physical system, it winds down of its own weight into a

state of entropic equilibrium, with little further useful potential. I believe that many industrial societies are now exhibiting this syndrome, and many may have already drifted to a soft landing in an accidental steady state, with inflation masking their declining condition. I think Britain is a perfect example. Ironically, since the inadequate formulation of gross national product indicators adds in all these rising social costs as if they were real and useful production, we are further deceived when the GNP rises.

Mature industrial societies reaching the entropy stage seem to generate two additional causes for their increased inflation rates which cannot be understood from the perspective of economics. First are the rising, systemic transaction costs of excessive complexity, a sort of meta-level trade-off between the division of labor and specialization on the one side and transaction costs on the other side. This is perhaps best understood from the vantage point of general systems theory, or you can use a game theory approach, such as James Robertson has done in two recent books. He maintains that a society will only have non-inflationary currency when it is seen by all its members as being just and fair. That's not altruism; it's just game theory.

An additional factor, best measured by thermodynamic analysis, arises when a society on a declining resource base must cycle more of its real wealth back into the process of extracting its energy and materials from ever-more degraded and inaccessible resources, resulting in higher costs and lower net yields. Consequently, although people may be fully employed and economic activity remains high, it is a wheel-spinning process in which fewer real goods and services are produced; and so the currency itself progressively loses its real purchasing power. All of this is viewed through the inadequate lens of economics as a single phenomenon called "inflation" or as a declining productivity of capital and a capital shortage. There is little understanding of the non-economic caused of these phenomena, and that we are now squandering our last precious store of "cheap" capital amassed from easily extracted resources, and that it represents a vital stock of "flexibility," which is as much of a meta-level resource as coal or oil.

The limits to growth issue is a political issue. The point is that if you have already been consuming a vast amount of the world's resources, then it behooves you to pay out a lot of money to get people to justify your continuing to consume, and so you have an awful lot of studies done, and propagated, to say that there is no problem. And if you don't have your face quite so firmly buried in the sand, you tend to be a little worried about when it might all run out. And this is why the Third World countries are now talking about a new economic world order. And I think they understand that the justification of inequality for capital formation, which is the old Keynesian "trickle-down" model of economic development, is going to leave them waiting in the back of the line forever, until all of us have our second houses and third boats. I was recently with a Third World leader, and we were talking about the inevitable subject of the limits to growth. He said: "It's like a tunnel with two lanes of traffic. You go into the tunnel with your car, and you get stuck in the lane that's not moving, and you're not allowed to change lanes. And there is the other lane going by you at a pretty good clip, and you get very frustrated." I'm afraid I disagree with Herman Kahn about this. You *do* see the other lane going by, and you do get very angry about it. And of course, the thing is *we do not have the choice* of whether to marry India. We chose to marry India when we (the industrial nations) extended our global search for materials and resources to support our economies. It was not India's choice; she was a captive bride.

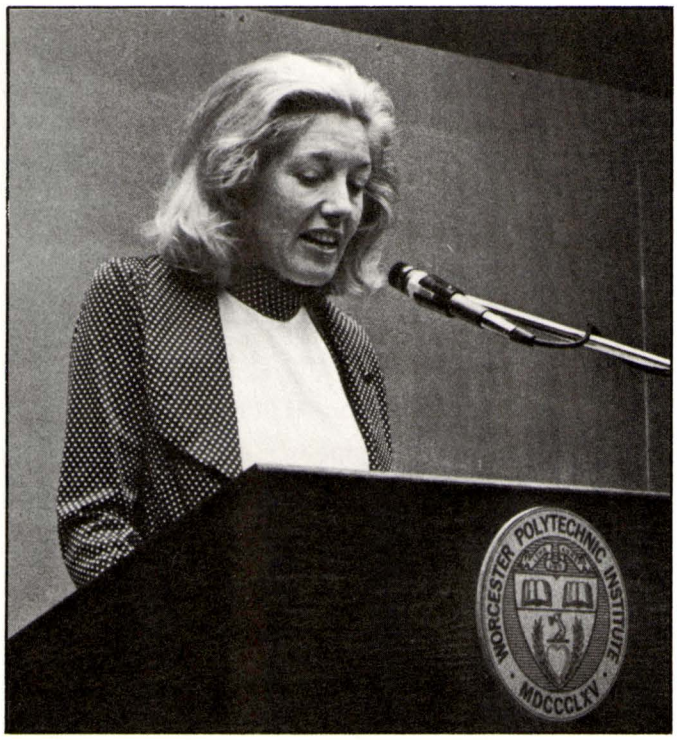
WE NOW REALIZE that we must learn humility if we are to face these complexities we have created. We sense the truth that only the system can manage the system, and we see the airy arrogance in some of our concepts of management and administration. We must examine anew the easy assumptions that sociotechnical systems are even susceptible to manipulation by legislation, just as ancient kings had to learn that they could not affect the behavior of natural systems by royal decree. We marvel once more at the ingenuity of "primitive" cultures, whose most obvious characteristic is the relative absence of government, because social controls have been internalized.

We are indeed at a crossroads, faced with our own sociotechnical complexity. We can take one path — that of further stepping up the computer power to model these complexities — and progress down the road to the computerized Leviathan state of George Orwell's *1984*. Or we can take, not the Luddite's ax, but the surgeon's scalpel, and try to disentangle some of the unnecessary interlinkages and the over-coherent technologies themselves, and by such decentralizing of means try to reduce the number of interacting variables that we must manage.

We also realize that hard choices and trade-offs must now be made, not just as to budget priorities between education, transportation, health, or more private consumption; or between R&D priorities, public and private investments, capital- or labor-intensive production, or energy alternatives. There is a new range of now visible meta-choices, such as between further centralization or decentralization, between maintaining a stock of social flexibility and options versus making current investments which may hard-program society into unsustainable or irreversible patterns. These meta-level trade-offs are visible in every social subsystem, from government and corporate organizations to the educational system, where maintaining capital plant and equipment must be traded off against flexibility and adaptability, while similar choices must be made in teacher training and student curricula.

At the personal level, educators also have to deal with these new trade-offs: whether to specialize further or to expand their horizons into interdisciplinary studies, even at the expense of "rigor" (as academically defined and rewarded), and whether to trade expanded consciousness for greater secular power and emoluments. We see that such goals conflict, because knowledge has become the servant of power in too many cases, and our educational enterprises have too often turned out intellectual mercenaries, whose lances are for hire to justify policies of entrenched bureaucracies and interest groups, rather than to merely search for the truth. Indeed, we should debate whether our incentives to scientific achievement, such as the Nobel Prize, should be redirected. Perhaps we should call a moratorium on giving Nobel Prizes in highly controversial and dangerous research, such as nuclear physics or work on recombinant DNA.

At last we see that science is *not* neutral, nor is technology, and its pretentions to value-free objectivity are now debasing the currency of public debate and preventing us from making adequate social choices. For example, economics is now obscuring the needed debate about what is valuable under the new constraints and conditions we face. Technology now creates its own social configurations, and we must ask to what extent the continued drive toward big-bang, capital-intensive technologies simply concentrates power, wealth, and knowledge in fewer and fewer hands, while making the rest of us poorer and more powerless, and all the while actually increasing overall human ignorance.



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It is now clear that the free market is not working to direct technological innovation to consumer demand, as it should. If it were, we would not now have a debate raging in the political arena about what is "appropriate" to technology, which has spilled out of the market choice arena into the realm of social and political choice. All this was predicted in 1944 by Karl Polanyi in his study of human production and exchange systems, *The Great Transformation.* Polanyi pointed out that leaving resource allocations to a free-market system would merely suboptimize the social system while leading to rapid environmental depletion. He demonstrated that free markets, far from being derived from some natural order or human behavioral laws, as Adam Smith thought, were created by carefully designed human planning and software. The conditions thus created for the operation of free markets were bitterly contested and legislated over many decades. This new package of social legislation, *laissez faire,* which enclosed land so that it might be marketed as a commodity and drove off peasants so as to require them to sell their labor as a commodity, laid the groundwork for the industrial revolution. Here again, this increase in efficiency of production was won at a terrible price in social dislocation and inefficiency. In the larger scale of human history, market systems are a mere blip associated with the rise of industrialism, and have actually been a rare aberration in human societies. As the industrial system has reached its present complexity, I agree with system theorist Todd LaPorte, who asserts that markets can no longer allocate resources where production has indivisible social consequences. So we must now face the paradox: *laissez faire* does not always work, although it does wherever Adam Smith's conditions are met, and then it is the *best* way to allocate resources. And the terrible truth is, we do not know how to plan, and the socialist countries do not know how to plan. I think it would clear the air if we talked about that paradox, that there must be a third way . . . and we are all looking for that third way.

This discussion of market failure is necessary if we are to properly assess technology and try to understand its likely second-order consequences. Each major technological innovation redistributed power, destroys some jobs and creates others, rearranges population patterns, and creates new ranks of winners and losers. Technologies do not arise in a vacuum. There is always a force field of institutional vested interests whose interactions may tend to promote or suppress technologies.

THE REAL JOB over the next ten years is to start retooling ourselves. Herman Kahn asks, Are we worse off? Is the future going to be better? To me that's not the question. We have to redefine what's better and what's worse; we have to redefine what we mean by satisfaction. We can't talk about waste without redefining needs and greeds. There's plenty for our needs, maybe not for all of our greeds.

I hope that eventually some of us will see the advent of the ultimate industrial revolution: the revolution from hardware to software. One day, a problem of production may not automatically trigger visions of a factory, machinery or hardware at all. Instead we may learn to stop and think harder and with more subtlety. We will then scan suitable natural ecosystems for signs of the natural capability we seek, or for useful biological potential that we can tap into or augment. This bioengineering approach is already leading to a design revolution and a rethinking of many problems of production and energy and materials management. For example, many architects are now designing houses with "passive" heating systems — that is, they are constructing and positioning houses to take advantage of natural solar and wind conditions so that they will not need a heating unit at all. Or take the production of nitrogen fertilizers. This does not require factories, but can be approached by recycling animal and human wastes, or by genetically engineering plants to augment their own nitrogen-fixing capabilities. The lowly joruba plant that grows wild in the U.S. southwest desert regions is a rich source of petroleum, while plants "mine" millions of tons of important industrial minerals every year by collecting them from the soil and storing them in their roots, where they are accessible for extraction.

Our planet is more marvelous than we yet understand, and our own capabilities and imaginations will be stretched by the current crises of our dying industrial system. Your program at WPI is helping us in transcending the old system and rising to meet and guide these new levels of human awareness, as are those in so many other fields undergoing creative ferment. Time is short, but we can all do no less than play our part in this human evolutionary struggle.

WPI

Thank you!

Dear WPI Alumni:

It began as an extraordinary year — and it ended as an extraordinary year.

We were faced with the challenge of mobilizing enough volunteers to telephone 8,000 alumni. The year ended with a 30% increase in the Fund and a record total of $282,883.58 having been contributed. The year started with the most elaborate planning, both conceptually and logistically, of any WPI annual drive. The task was to combine the solicitation for the 1975-76 Alumni Fund (gifts used for operational purposes) with the WPI Plan to Restore the Balance (capital purposes).

Our basic premise was one adopted by the WPI Fund Board in 1972 — that every alumnus should be provided an opportunity to take part in the capital fund raising program. Moreover, we had an acute awareness of the disaster resulting from elimination of the Alumni Fund during the capital program in the mid-sixties. At that time, participation in the Fund dropped drastically. Fifty percent of WPI alumni were contributing prior to the capital campaign; whereas, only 25% were making gifts when the Fund resumed in 1967. Our objective in 1975-76 was thus to maintain the strong momentum of the Alumni Fund over the last several years, while also giving every alumnus an opportunity to become involved in the capital program.

Our initial decision was that a personalized door-to-door solicitation program would be neither cost-effective nor labor-effective. We were also aware that general mail solicitation by itself is perhaps the weakest form of fund-raising. Thus, we opted for a combined telephone and mail program and set out to conduct 19 phonothons at sites from New Hampshire to California. The positive response from alumni asked to work was heartwarming, and the end results were exceptional. We had over 600 volunteers who stepped forward to man telephones throughout the country and to work with Anniversary Gift Programs for their classes. The results are a record breaking Alumni Fund which gives the Fund Board and all alumni a lofty target to strive for in future years. It's a pleasure to send you this annual report, and I commend and thank all who were involved either as donors or as volunteers. The final results for the year show:

Cash Received	**$282,883.58**
Number of Donors	**3,686**
Percentage Participation	**31.97%**
Average Gift	**$76.74**

The phonothon was the most ambitious alumni program ever undertaken at WPI. In a period of three weeks, or a total of 12 calling days, we phoned over 50% of our total alumni body. The results certainly justified our initial decision to raise money in this way, for we received in excess of $125,000 through telephone pledges. I was involved in several of these in the eastern New England area and I can say without hesitation that I think all alumni who participated really enjoyed themselves while performing a very worthwhile service for their Alma Mater. I commend Phonothon Chairman Howard I. Nelson '54 of Grafton, MA and his entire Phonothon Task Force for their extraordinary organizational efforts which made this program such a success.

Another highly successful effort has been the Anniversary Gift Program which focuses on the classes celebrating 25th, 40th and 50th reunions. Last year, the classes of 1926, 1936 and 1951 with Milton C. Berglund '26 of Hyannis, MA; George E. Rocheford '36 of Natick, MA; and Robert C. Wolff '51 of Cambridge, NY as the respective chairmen generated almost one quarter of a million dollars for WPI. All three classes restricted their gifts to the renovation of Salisbury Hall. At the reunion luncheon in June, they presented some extraordinary gifts to President Hazzard for the College. For example, the Class of 1926 presented a gift totaling $180,675.90, which included a bequest from a classmate of $125,000 in addition to the $55,675.90 donated by the class and matched in part by corporate funding. The Class of 1936 presented a gift of $24,295.00, and the Class of 1951 contributed $28,867.52. Both of these amounts included corporate matching gifts. I sincerely thank Milt, George and Bob, along with all of their classmates who participated in the program as volunteers and donors. In addition, I extend a very special thanks to Daniel J. Maguire '66 of Stow, MA, an Alumni Fund Board member who served as the national chairman once again last year for the Anniversary Gift Program.

Particularly pleasing to me is the fact that the total for the fund was approximately $67,000 (or 30%) greater than the previous year. As we all know, our Alma Mater has gone through some very dramatic and impressive changes in recent years, and it is tremendously gratifying for me to see alumni of our college come forth in such a generous and helpful way to support these changes.

Finally and imperatively, a very special and heartfelt thanks to each of the Fund Board members. They have made my job as Chairman of the Fund Board exceptionally easy, and it has been extremely enjoyable to work with them. In addition to Mr. Maguire and Mr. Nelson, I extend my profound appreciation to three other gentlemen. The leadership talents of Leonard H. White '41 of Worcester, Chairman of the President's Advisory Council, have enabled the P.A.C. to grow from 17 members four years ago to 90 members currently. Peter H. Horstmann '55 of Holden, MA, Chairman of the Special Gifts Program, has recently completed a major effort in support of the College. And G. Albert Anderson '51 of Gardner, MA is Chairman of the newly-inaugurated Class Agent Program. Without the help of these key individuals, our efforts and even our results might have been smaller and would certainly have been more difficult.

To each and every volunteer — Fund Board members, phonothon callers, anniversary and special gift program people — and to all the donors, I offer my wholehearted gratitude for your generosity and assistance. The students of WPI today are the true beneficiaries of your support. We are pleased that your efforts and the funds we have raised will support so significantly the continuing operations of the College.

Yes, it was an extraordinary year!

Sincerely,

Walter J. Charow

Walter J. Charow '49
Alumni Fund Board Chairman

GIVING BY CLASS

Class	Number in Class	Number of Cash Gifts	Total Cash Gifts	Percent Participation	Average Cash Gift
1890	1				
1895	2				
1896	2				
1897	2				
1900	2				
1901	2				
1902	2	1	$ 25.00	50.00	$ 25.00
1903	6	1	50.00	16.66	50.00
1905	2	1	50.00	50.00	50.00
1906	7	1	5.00	14.28	5.00
1907	8	3	355.00	37.50	118.33
1908	12	5	361.66	41.66	72.33
1909	10	5	350.00	50.00	70.00
1910	15	1	200.00	6.66	200.00
1911	12	1	100.00	8.33	100.00
1912	25	8	505.00	32.00	63.12
1913	26	8	870.00	30.76	108.75
1914	29	10	1,963.55	34.48	196.35
1915	35	8	881.76	22.85	110.22
1916	40	14	1,620.00	35.00	115.71
1917	53	15	1,005.00	28.30	67.00
1918	43	19	1,280.00	44.18	67.36
1919	34	15	4,064.80	44.11	270.98
1920	64	26	2,905.00	40.62	111.73
1921	49	16	1,335.00	32.65	83.43
1922	75	32	3,600.00	42.66	112.50
1923	61	21	3,052.80	34.42	145.37
1924	51	23	2,754.70	45.09	119.76
1925	64	10	625.00	15.62	62.50
1926	102	59	25,422.40	57.84	430.88
1927	74	37	7,000.00	50.00	189.18
1928	84	49	9,346.35	58.33	190.74
1929	81	27	1,935.00	33.33	71.66
1930	114	45	4,373.00	39.47	97.17
1931	114	46	3,010.00	40.35	65.43
1932	105	38	2,391.54	36.19	62.93
1933	118	47	4,745.00	39.83	100.95
1934	111	41	3,440.00	36.93	83.90
1935	132	43	5,095.00	32.57	118.48
1936	101	53	7,028.00	52.47	132.60
1937	107	46	9,909.25	42.99	215.41
1938	134	56	21,789.00	41.79	389.08
1939	140	60	3,870.00	42.85	64.50
1940	151	59	4,361.45	39.07	73.92
1941	154	59	3,600.00	38.31	61.01
1942	161	60	3,905.00	37.26	65.08
1943	141	58	3,501.00	41.13	60.36
1944	153	56	4,425.00	36.60	79.01
1945	141	46	3,964.96	32.62	86.19
1946	314	106	7,065.08	33.75	66.65
1947	79	29	1,450.00	36.70	50.00
1948	188	68	3,563.00	36.17	52.39
1949	242	81	6,275.00	33.47	77.46
1950	211	74	4,598.00	35.07	62.13
1951	194	107	10,926.07	55.15	102.11
1952	173	37	5,300.00	21.38	143.24
1953	184	61	5,868.00	33.15	96.19
1954	157	58	3,530.00	36.94	60.86
1955	148	47	2,545.00	31.75	54.14
1956	163	53	3,155.00	32.51	59.52
1957	229	71	3,305.00	31.00	46.54
1958	235	84	3,502.00	35.74	41.69
1959	277	102	5,310.00	36.82	52.05
1960	297	93	4,800.00	31.31	51.61
1961	315	106	5,252.60	33.65	49.55
1962	284	81	3,520.00	28.52	43.45
1963	264	92	4,085.00	34.84	44.40
1964	320	91	4,205.96	28.43	46.21

1965	323	103	3,842.62	31.88	37.30
1966	344	105	3,831.33	30.52	36.48
1967	352	91	2,918.24	25.85	32.06
1968	447	119	4,775.00	26.62	40.12
1969	354	99	3,125.00	27.96	31.56
1970	390	82	3,010.00	21.02	36.70
1971	460	100	3,063.96	21.73	30.63
1972	351	69	1,760.00	19.65	25.50
1973	540	124	4,372.00	22.96	35.25
1974	478	90	2,202.00	18.82	24.46
1975	467	34	656.50	7.28	19.30
TOTAL	11,530	3,686	$282,883.58	31.97	$76.74

TOTAL COMMITMENT (CASH + OUTSTANDING PLEDGES) = $332,080.43

GIVING BY CHAPTER

Chapter Name	*Number in Chapter*	*Number of Cash Gifts*	*Total Cash Gifts*	*Percent Participation*	*Average Gift*
Berkshire	69	21	$ 1,150.00	30.43	$ 54.76
Boston	1,087	311	28,964.56	28.61	93.13
Central New York	109	53	3,126.25	48.62	58.98
Chicago	141	43	4,630.00	30.49	107.67
Cincinnati	52	16	1,235.00	30.76	77.18
Cleveland	97	35	4,015.00	36.08	114.71
Connecticut Valley	365	130	17,805.50	35.61	136.96
Detroit	110	45	3,040.00	40.90	67.55
Eastern Connecticut	170	57	2,985.00	33.52	52.36
Hartford	713	260	16,055.00	36.46	61.75
Hudson-Mohawk	184	74	4,627.82	40.21	62.53
Los Angeles	278	87	5,541.45	31.29	63.69
New Haven	432	137	7,790.00	31.71	56.86
New York	517	158	13,543.00	30.56	85.71
North Shore	353	121	6,092.96	34.27	50.35
Northern California	199	74	5,560.00	37.18	75.13
Northern New Jersey	475	212	19,885.00	44.63	93.79
Pacific Northwest	50	11	1,105.00	22.00	100.45
Philadelphia	332	118	7,358.00	35.54	62.35
Pittsburgh	85	44	3,690.00	51.76	83.86
Rhode Island	392	112	10,595.06	28.57	94.59
Rochester-Genessee	130	53	3,085.00	40.76	58.20
Southeastern	85	22	1,222.00	25.88	55.54
St. Louis	21	8	290.00	38.09	36.25
Washington	465	205	12,219.62	44.08	59.60
Western New York	85	31	1,529.70	36.47	49.34
Wilmington	107	53	3,780.00	49.53	71.32
Worcester	2,024	540	40,555.71	26.67	75.10
Out Of District	1,601	639	49,923.53	39.91	78.12
Address Unknown	564	2	120.00	.35	60.00
Not Assigned	238	14	1,363.42	5.88	97.38
TOTALS	11,530	3,686	$282,883.58	31.97	$ 76.74

1976 ANNIVERSARY GIFTS

Class of 1926	$180,675.90*
Class of 1936	$ 24,295.00
Class of 1951	$ 28,867.52

*Including a bequest of $125,000

All Anniversary Gifts were applied to the renovation of Salisbury Hall.

The data on which these class notes are based had all been received by the Alumni Association before November 1, when it was compiled for publication. Information received after that date will be used in succeeding issues of the **WPI Journal.**

1912

The second Main Street in Marlboro, Mass., which is expected to be the pivotal point in the redevelopment of the downtown area, has been named Granger Boulevard for **J. Francis Granger,** who has served the city for over fifty years. For thirty-four years he served as Marlboro's superintendent of streets and as city engineer. He was also clerk of the works for Marlboro Hospital. A partner in Granger, Thompson and Liston, he is currently vice president of the Marlboro Hospital board of trustees and chairman of the high school building committee. For many years he has served as secretary of the Massachusetts Highway Association.

1921

Joseph Kushner is a sales manager at Consolidated Brokers, Inc., New Haven, Conn.

1922

A member of the reunion committee and self-appointed spokesman for class president **Wayne Keith, Larry Larson**, reminds the members of the illustrious class of 1922 that their 55th is only months away and to keep the 1977 alumni reunion weekend open. (June 9, 10, and 11)

1933

Leighton Jackson retired from duPont in June after nearly 43 years of service. . . . **Alfred Parker** has been appointed technical director of chemical engineering research at the John Blizard Research Center of Foster Wheeler Energy Corp., Livingston, N.J. Since 1944 he has served as a project engineer, proposal engineer, head of the chemical engineering department, and manager of the chemical research laboratory. He holds several patents and is a trustee of Engineering Index, Inc.

1938

Walter Knapp was selected the 1976 winner of the Durrance Award by the International Fraternity of Phi Gamma Delta. The award is given for leadership within the fraternity.

1939

Walter Longnecker has retired from Gould Inc., Cleveland, Ohio, where he had served as a vice president.

1941

Donald Smith has been recommended as vice president for development and public affairs at Southern Methodist University, his appointment having yet to be formally approved by SMU trustees. Smith, a former alumni secretary at WPI and official at Washington & Lee University, and the University of Rochester (N.Y.), for the past six years has headed Smith, Hazlett & Darcy, Inc., in Rochester. The firm provides counseling services to educational, cultural and health care institutions.

1942

Charles Berry holds the position of eastern sales manager at Kinemetrics, Inc., in San Gabriel, Calif.

1943

S. Bailey Norton, Jr., president of Acme Chain, Holyoke, Mass., has been elected a director of AIM (Associated Industries of Massachusetts). Norton joined Acme Chain in 1950. He has served the company as vice president of manufacturing, and general manager of the Acme Chain division under its new owner, Rockwell International. In December 1975 when the division was acquired by Incom International, he was elected president, with his responsibilities extending to Incom Singapore Pte., Ltd.

1945

Bertrand Mills, vice president of manufacturing at Carrier Corporation, serves on the production editorial advisory board of the Dana Chase publication, *Appliance.* He joined Carrier as president of the Carlyle Compressor Company division in 1970. In 1946 he started his career at GE, holding positions in engineering, manufacturing, and general management.

1946

Clayton Adams is with Bath (Me.) Iron Work Corp. . . . **Donald Ferguson** currently holds the post of corporate vice president of manufacturing at the Singer Company in New York City. . . . **Prescott Grout** has been named adjunct assistant professor of humanities at Nichols College, Dudley, Mass. . . . **Julius Palley** and his brother, Arthur of Commonwealth Stationers, Inc., Worcester, are currently renovating a collection of factory buildings on Union Street built by Stephen Salisbury in 1892. A number of tenants, including a clothing store, are already taking advantage of the complex which will ultimately be landscaped and be adjacent to the proposed Worcester Center Boulevard and a new police station across from Court Hill.

1947

Russell Smith recently attended a meeting of the International Electrotechnical Commission in Nice, France. This commission is charged with the responsibility of setting standards for industrial and scientific apparatus sold in international markets. Russ is the U.S. delegate to the committee developing such standards for locomotives and other electric traction equipment. Presently he is the manager of electric locomotive engineering for the General Electric Company in Erie, Pa.

1948

Currently **Eli Braley** holds the post of president at Hathaway Machinery Co., Inc., Fairhaven, Mass.

1949

Capt. **Bohdan Boluch,** who has retired after 27 years of service with the Massachusetts State Police, was recently honored at a testimonial dinner in Northampton. At his retirement he was commander of Troop B, Northampton. . . . **Francis Carini** is a research scientist at Johnson & Johnson Research in New Brunswick, N.J.

1950

Gov. Ella T. Grasso of Connecticut has named **Robert Stewart** to the University of Connecticut Board of trustees for a five-year term. He is vice president for strategic planning and group vice president for flight systems and equipment at United Technologies. . . . **William Carpenter,** having completed 25 years of service with Foster Wheeler Energy Corp. in Livingston, N.J., currently serves as assistant to the manager of the equipment division, licensing department. He joined the firm in 1951 and since then has been promoted to sales engineer, district manager, and project manager in the contract control department. He is past president and trustee of the Puddingstone Community Club and past president of the Hudson-Mohawk chapter of the WPI Alumni Association.

1951

Peter Groop was recently named vice president of sales at the newly created Rexene Polyolefins Co. located in Paramus, N.J. He worked for the firm for ten years prior to its reorganization. . . . **Don Lewis,** who resigned from Monsanto after 25 years, is now vice president and general manager at Consupak, Inc., Morristown, N.J. . . . **Robert Luce** serves as a process engineer at PPG Industries, Pittsburgh, Pa. . . . **Joseph Thomas** holds the post of director of engineering resources at GTE Sylvania, Stamford, Conn. He is with the GTE consumer products business group, a world-wide activity.

1952

Following graduation from WPI, **Joe Jiunnies** joined duPont. Currently he is assistant superintendent of the reactor and heavy water departments at duPont's Savannah (Ga.) River Plant and Laboratory. . . . **Daniel Stoughton** is manager of the industrial division at Synergo Co., Philadelphia.

1953

David Beach has been appointed a product design manager in the consumer products engineering area at Kodak Apparatus Division in Rochester, N.Y. He started at Kodak in 1953 and has served as an assistant engineer in still camera design, administrative assistant on the management staff at Kodak office, and was advanced to senior supervising development engineer in still picture engineering in 1974. He is a member of the Society of Photographic Scientists and Engineers. . . . **George Crozier** serves as director of project management at Monsanto Enviro Chem Systems, Inc. in St. Louis, Missouri. . . . **Charles Flanagan** holds the post of vice president of the automotive group at Bendix Corp. in Troy, Mich. . . . **Gene Larson** was recently named commissioner of public works in Newton Centre, Mass. Previously he was building commissioner.

1954

William Hills is the author of "Future Trends in Textured Yarn Manufacture" which appeared in the June issue of *Fiber Producer.* For 17 years he was with the textiles and new enterprise divisions at Monsanto. Today he is the president of Hills Research & Development, Inc., Melbourne, Fla. His firm developed the Sahm Super Speed texturing machine on a contract basis. . . . **Paul Wagenknecht** has been appointed manager of corporate engineering at Inland Container Corporation's headquarters in Indianapolis. Previously he was with Westvaco, Rice Barton Corp., and A. P. Wagenknecht Company, a family-owned manufacturing company of auxiliary equipment for the paper industry.

1955

William Johnson operates Wm. Johnson Leather Co. in Madison, Wis. . . . **Robert Kirkpatrick** serves as a senior analyst for Coastal States Gas Corp., Houston, Texas.

1956

Currently an associate professor of management at Southeastern Massachusetts University, Dr. **Howard Brown** has become a partner in University Collaborative. The university was recently organized to enable a group of university and community professionals to deal with needs of individuals and organizations by offering consulting services in a wide range of human-resource-oriented areas, seminars, specially-designed programs, and organization development. . . . Dr. **Raymond Hagglund,** professor of mechanical engineering at WPI, received an award from the American Society for Engineering Education in October. The Western Electric Fund Award, which includes a citation and a $1,000 grant, was presented at a dinner held at the University of Maine in Orono. . . . **Jack McHugh** has been elected president of the Waterbury (Conn.) Exchange Club. He is president of his own firm, the Royal Screw Machine Products Co. and serves on the board of advisors of Waterbury State Technical College. He has also been president of the local Smaller Business Manufacturers Association.

1957

John Atchison recently resigned from E.C.I. in St. Petersburg, Fla. and is now a member of the technical staff at Mitre Corp., Bedford, Mass. . . . Dr. **René Bertrand** is the co-author of "Environmental Aspects of Coal Gasification" which appeared in *CEP-Chemical Engineering Progress.* He is manager of the Fuels Utilization and Conversion Section at Exxon's Government Research Laboratories. . . . **Arthur Sullivan** is a manager for INCO in Bellevue, Washington.

1958

Charles Cushman holds the post of product development engineer at Dunlop Sports Division in Westminster, S.C. . . . **George Walker,** SIM, has been appointed vice president and general manager of Johnson Steel & Wire Co., Inc., Worcester. Previously he was vice president for administration and had also served as plant manager at Worcester. He has been with the firm since 1950.

1959

Robert Berg is marketing manager at American Standard, Inc., Lexington, Ky. . . . **W. U. Pursell, Jr.** serves as plant manager of Hydrils' Tubular plants in Rochester, Pa. and Youngstown, Ohio. He has passed the certification exams given by the American Production and Inventory Control Society. . . . **Bob Sharkey** of Shark's Marine, Keene, N.H. has moved his business out to a main highway and put up a new steel building with about three times more space than the old. He has also increased his line to include chain saws, wood splitters, and Arctic Cats. Bob and his wife, Eve, are part-time farmers and have a steer, pigs, sheep, and chickens. . . . **Ronald Swenson** is manager of corporate engineering systems at Xerox in Webster, N.Y.

1960

Sang Ki Lee has been transferred from the Motorola Patent Department in Phoenix to the firm's patent department in the Chicago area where he will serve as division attorney for the Communications Group, International Division. . . . **Raymond Levesque,** former manager of services in the aerospace structural adhesives division of American Cyanamid, has relocated to the Wallingford (Conn.) plant, where he serves as manager of material services in the plastics and resins division. . . . **William Linke** was recently promoted to junior process engineer at the Bard-Parker plant in Hancock, N.Y. In his new position he will be responsible for process improvement and implementing process development programs. Previously he was an electro mechanical technician. . . . **Norman Mack,** a district agent of the New York/Arden general agency of National Life Insurance Co. of Vermont, has earned membership in the 1976 President's Club. The club recognizes outstanding client services and sales. Mack is located in Great Neck, N.Y. . . . **Edward Russell** has been named general manager of GE's lamp business in Mexico. Formerly he was group strategic planning manager for the firm's consumer products group in Fairfield, Conn. . . . **Richard Tufts** is now with Maryland Casualty Co. in Baltimore.

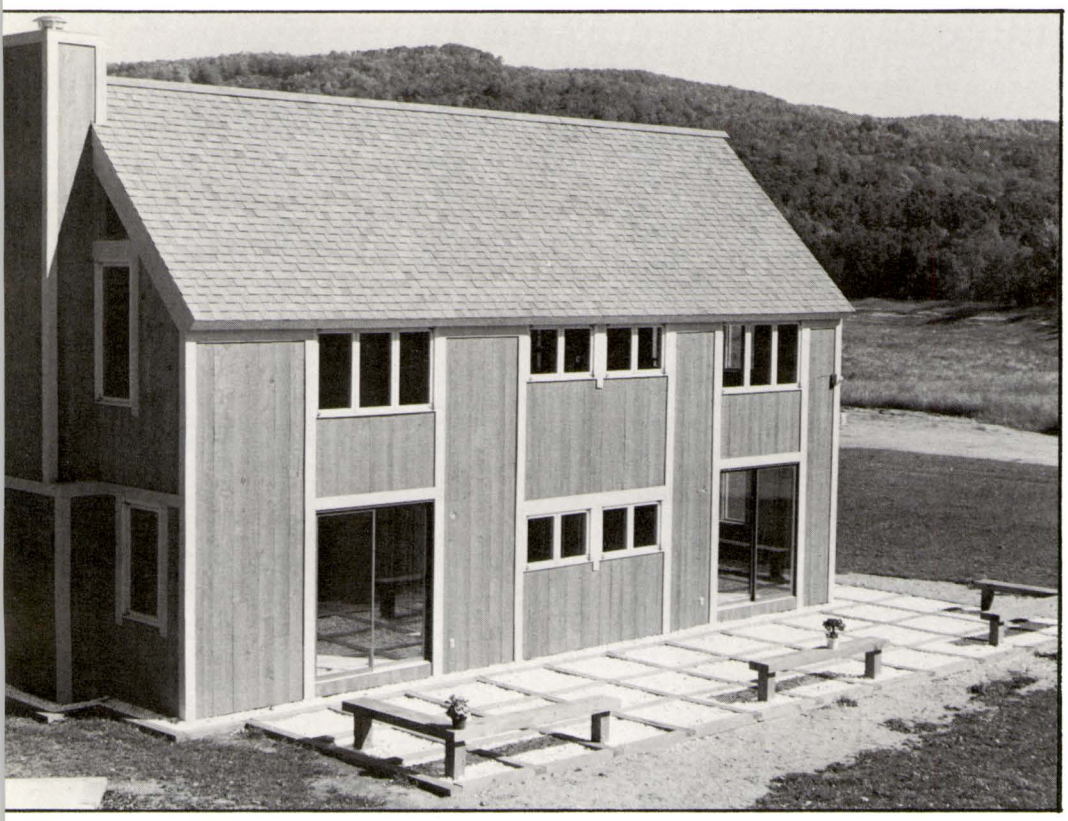
1961

Francis Cichowski owns Industrial Design Company in Southington, Conn. . . . Currently **Richard Davis** holds the post of executive editor at EW Communications, publishers of *Microwave Systems News* and *EW Magazine.* Both are trade-press monthlies for engineers in the industry. Davis is presently located in Los Altos, Calif. . . . **Martin Gordon** has been appointed to the position of marketing manager for Analog to Digital Systems at Analogic in Wakefield, Mass. He will be responsible for the overall marketing efforts for A-D Systems including key account marketing and market and product definition. Earlier he was with Transitron Electronic Corporation and Digital Electronic Corporation. . . . **William Hoduer** is a project engineer at Albany Engineered Systems in Glens Falls, N.Y. . . . Continuing with the American International Group in New York City, **James Tolos** is currently regional engineering manager.

1962

Married: **John Szymanski** and Miss Eileen A. McCook in Osterville, Massachusetts on October 2, 1976. The bride graduated from Boston College and received her MS from Boston University. She is executive director of the Visiting Nurse Association, Central Cape Cod, Inc. Her husband is president of Paradise Travel Service, Inc., Allston, Mass. He received his MBA from B.U.

Joseph Baldasaro has been promoted to the position of material controls manager for Speidel Division of Textron, Inc. He joined Speidel in 1968. Active in community affairs, Baldasaro has held office and served in several civic organizations.



Solar houses in Vermont by Jim Kachadorian, '61

How would you like a three-bedroom solar home that heats and cools itself and costs $30,000? If the prospect sounds inviting, **James Kachadorian, '61,** president of Green Mountain Homes in Royalton, Vermont, can help you make your dream house a reality.

A former planning and scheduling engineer for the Bechtel Corporation at the Peach Botton, Pa., nuclear plant, Kachadorian was the general manager for a home manufacturing operation for a number of years prior to the recent opening of Green Mountain Homes. His wife Lea, a graduate of Middlebury College, does all of the artwork and advertising for the housing firm. Both are pleased with the growing success of Green Mountain Homes.

Kachadorian has made a fresh analytical approach to home design for the seventies. His designs are based on energy conservation, affordability, high quality, and appealing architecture. His products are factory-produced panelized solar homes with design features so flexible that he can meet almost any home builder's requirements. His houses are designed to fill a void in the present housing field for homes which are low in initial cost, energy demands, and maintenance, yet high in quality materials, craftsmanship, and attractiveness.

Kachadorian's solar design is a carefully researched system which he claims yields the highest possible heating or air conditioning savings for the lowest possible purchase price and yearly operating cost. The architectural design and function are unified, incorporating the entire house as a solar collection and storage unit. The houses are built of wood with multilayered roof and walls including extra layers of insulation. Air entrance locks help reduce heat losses. The average heat loss per square foot of living space per degree day is approximately one half that experienced by what was considered to be a well insulated house a few years ago.

Green Mountain houses combine the classic barn shapes of the Vermont landscape with an ingeniously simple solar design, presenting an exciting breakthrough for the housing market. Kachadorian has eschewed the usual collecting panels, liquid-filled roof collectors, and complicated machinery found on other solar buildings. His unique solar system simply uses east, west, and south facing windows to collect heat via the greenhouse effect. According to Kachadorian, windows are the most efficient solar collectors known. A south facing window is about 80 per cent efficient while the best liquid roof collector is between 40 and 60 per cent efficient. Therefore, he needs to use only about one-half the glass area to collect the same amount of solar energy as compared to a roof-mounted collection system. Excess heat is stored within the first floor concrete subsystem — what Green Mountain Homes calls their "solar slab." Stored heat subsequently helps heat the home at night and on cold days by radiation. A hot water preheater is contained within the system. Thermo-shutters, manually operated on the inside of windows and sliding glass doors, further reduce heat loss at night.

The special solar system is particularly complementary to wood burning since the house is designed to redistribute heat generated in an isolated area. For instance, excess heat derived from a wood-burning stove in a family room could be either distributed to other parts of the house or placed in storage.

To reverse the system for summer cooling, night air is put into storage from midnight until four a.m., thereby chilling the solar slab. This prepares the slab to absorb the heat of the day, helping reduce the electrical demand on air conditioning equipment.

Kachadorian predicts his model home's solar system will carry about 40 per cent of the total heat load, based on Vermont's severe 8086 degree-day heating season. The Green Mountain Homes solar concept is being studied by the Central Vermont Public Service Corporation and Dartmouth's Thayer School of Engineering, both of which are monitoring the solar equipped office/model home in Royalton on a 24-hour basis.

The many sizes and designs of Green Mountain Homes allow planning flexibility and growth potential and units may be combined at a later date. All homes can be purchased in kit form.

"We have addressed ourselves to every obvious aspect of the building over which the manufacturer and builder could have control. In every area we have been able to effect cost reductions and at the same time provide functional design," reports Kachadorian. "The initial solar monitoring of the operational model home has shown some exciting preliminary results," he says. "But we do have one problem. The customers have been keeping our men so busy that they haven't had time to finish off the interior of the model house yet!"

WPI

1963

Married: Dr. **Robert M. Desmond** and Miss Cynthia J. Doolittle in Syracuse, New York on July 30, 1976. Mrs. Desmond graduated from Powelson Business Institute, attended Grove City College, and has been employed at the Merchants National Bank. The bridegroom is a professor and head of the mechanical engineering department at Rochester Institute of Technology.

Joseph Mielinksi has been named manager of operations at Alden Research Laboratories. For the last six years he has been an administrative assistant at WPI. Formerly he was with duPont and General Electric. . . .

William Zinno has joined Dresser Clark, Olean, N.Y. as project manager, inventory management. He will design and implement new computer-assisted manufacturing systems and be responsible for a task force representing various disciplines within the division. Previously he had been manager of manufacturing planning and control for Industrial Nucleonics Corp. in Columbus, Ohio. . . . **Robert Magnant,** who recently received his MS from the University of Colorado, is the author of a telecommunications study, *Domestic Satillite: An FCC Giant Step.* He is chief engineer for U.S. Army Communications at Ft. Ritchie, Maryland.

1964

Born: to Mr. and Mrs. **Gerald Tammi** their first child, a daughter Abigail, on March 24, 1976. Gerry is with Fairchild Cameron Instrument in Mt. View, California.

John Camera holds the post of vice president at Camera Construction Co., Inc. in West Hartford, Conn. . . . Dr. **Wayne Keene** is one of four Raytheon Company engineers responsible for the invention of a laser radar system that uses optimum predetection amplificiation for the return signal. The patent covering the invention was recently assigned to Raytheon. Keene is manager of the equipment division's advanced electro-optical techniques section and collaborated on two other projects resulting in patents for an optical scanner and a clear air turbulance detector. He joined Raytheon in 1965. . . . Prof. **Robert Peura** has been named acting director of biomedical engineering at WPI.

1965

Pat Moran now works for Digital Equipment in Maynard, Mass.

1966

Married: **Richard B. Nelson** and Mrs. Sherrie P. Beck on July 10, 1976 in Shreveport, Louisiana. Randy Beck, the bride's younger son, served as best man, with daughter Leslie serving as maid of honor and older son, David, giving the bride away. The bridegroom is an independent oil and gas producer in Shreveport.

Born: to Mr. and Mrs. **Peter J. Kudless** their fourth child, Stephen Paul, on July 31, 1976. Pete was recently promoted to senior construction engineer at Public Service Electric & Gas Company in New Jersey. Currently he has been assigned to the Hope Creek Generating Station in Hancocks Ridge, N.J. Also, he has been promoted to Lt. Cdr. in the Civil Engineer Corps with the Naval Reserve, and is Alpha Company commander for Reserve Navy Mobile Construction 13. Alpha Co. was named honor company recently. Serving with Pete are LCDR **Skip Kuntz,** '66, and Lt. **Phil Clark,** '67.

Joseph Acker holds the post of production manager at FMC Corporation's agricultural chemical division in Middleport, N.Y. . . . Capt. **Howard Braley** (USAF) serves as a project officer for the Space and Missile Systems Office, Los Angeles, Calif. Recently he received the U. S. Air Force Air Commendation Medal. . . . **Don Foley** is vice president of Pattern Analysis & Recognition Corp., Rome, N.Y. . . . **John Gilbert,** who received his law degree from Western New England College, has passed the Connecticut bar exam. He specializes in contract and corporate law. Presently he is still employed at Pratt & Whitney. . . . **Donald McCarthy** is a social worker for the city of Philadelphia.

Hugh McMenamy serves as senior project engineer at Exxon Research & Engineering Co. in Florham Park, N.J. . . . **Donald Mugnai** is now a design engineer in the Electronics Branch at the Naval Surface Weapons Center in Silver Spring, Md. He is a registered professional engineer in the District of Columbia, and recently received his license in electrical engineering. . . . **Lawrence Pihl** holds the post of western regional manager for Omni Spectra, Inc., Merrimack, N.H. . . . **John Sakala,** MNS has been named the new principal at Watertown (Mass.) High School. . . . **Robert Shaw** owns Spoon & Fork Garage in Worcester . . . . **Andrew Warner, Jr.,** serves as a consultant for Southern Consulting Group, Clearwater, Florida.

1967

Married: **Allen J. Ikalainen** and Miss Barbara J. Henwood at Christmas Cove, Maine on September 4, 1976. The bride graduated from Colby College. Both she and her husband are employed by the Environmental Protection Agency, Region I, Boston.

Michael Barr has been named marketing manager for the Metals Recovery Division at M&T Chemicals, Inc., Rahway, N.J. With the firm since 1972, he has served as plant manager and plant engineer. He has an MS degree in industrial management from Newark College of Engineering. . . . **Joseph Goulart** is a customer liaison engineer at Simpson Industries in Litchfield, Mich. . . . **Robert Hellen,** who earned his Ph.D. in chemical engineering from Cornell University, is currently employed by 3M Company, St. Paul, Minn. . . . Dr. **Kenneth Rex** is an assistant professor of physics at St. Bonaventure University. . . . **John Soulliere** was recently promoted to regional sales manager at the Foxboro (Mass.) Company. He had been district sales manager for the power systems division, and a field and home sales engineer. He began work at the company in 1969.

1968

Married: **Roger J. Pikor** and Miss Marilyn R. Moore on October 2, 1976 in West Hartford, Connecticut. Mrs. Pikor, a research assistant in diabetes at the University of Connecticut Health Center, graduated from Drew University, Madison, N.J. Her husband is with Pratt & Whitney Aircraft Division of United Technologies.

Norman Brunell is a division patent counsel for Litton Industries, Inc., Beverly Hills, Calif. . . . **Stephen Davis** works for the aircraft engine group at GE in Lynn, Mass. . . . **Bert Gunter** is with the mathematics department at Beloit (Wis.) College. . . . Presently **Joseph Hilyard** is a full-time graduate student in journalism at the University of Wisconsin in Madison. . . . **John Lunney,** who now resides in Fredericksburg, Va., is a senior field service engineer for GE Ordance Systems of Pittsfield, Mass.

Dr. **Joseph Owens** serves as a research associate in the physics department at Florida State University in Tallahassee. . . . **Ronald Rehkamp** has been promoted to actuarial associate at State Mutual Life Assurance Co. of America, Worcester. He joined the firm's actuarial organization in 1974. Recently he became an associate of the Society of Actuaries. . . . **Douglas Riley** holds the post of construction superintendent at Harvey Construction Co., Manchester, N.H. . . . **Richard Snay** is a geodesist for the Department of Commerce, National Oceanic & Atmospheric Administration, Rockville, Md. . . . **Leo Sprecher** is the senior financial analyst at Mellon National Corp. in Pittsburgh, Pa. . . . **Malcolm Wittenberg** presently practices law with Limbach, Limbach & Sutton in San Francisco.

1969

Married: **Jon C. Anderson** and Judith Weaver on July 10, 1976 in Danvers, Massachusetts. Anderson, who served in the U.S. Army for three years, is presently employed as a construction manager. . . . **Robert L. Simonds** to Miss Ann S. Bainbridge in Chestnut Hill, Massachusetts on October 9, 1976. Mrs. Simonds, an alumna of Colby Junior College and Lake Forest College, is a member of the Vincent Club and is with the Museum of Fine Arts, Boston. The groom is employed by United Engineers and Constructors.

Joel Cehn, a radiological engineer at Boston Edison Co., recently presented a slide and lecture program on nuclear power at the Public Affairs Action Committee meeting held in Easton, Mass. Cehn is responsible for monitoring radioactivity in the environment at Pilgrim Nuclear Power Station, Plymouth. . . . **Joel Greene** has relocated his law offices to 14 Harvard St. in Worcester. . . . Dr. **Roy Johnson, Jr.** is assistant professor in the civil engineering department at Auburn (Ala.) University. . . . After four years of teaching at Holy Name High School, Worcester, **Joel O'Rourke** is now teaching math at Martha's Vineyard Regional High School. He also has served as a computer programmer and a programmer/analyst at the American Optical Corporation in Southbridge. . . . **Tom Starr** (formerly Gwazdauskas) is now working for CTI-Nuclear in Waltham, Mass. He writes that he and **Richard Abrams,** '70 form the process engineering group at the firm. Tom, his wife, and children, Betsy, 1, and Michael, 4, reside in Framingham. . . . **Richard Warren** is a self-employed consultant in Wilton, Conn.

1970

Born: to Mr. and Mrs. **William Hakkinen** a daughter, Erika Lynn, on August 26, 1976.

Gerry Blodgett serves as technical adviser for the U.S. Court of Customs and Patent Appeals in Washington, D.C. He received his Juris Doctor from Suffolk University and is presently enrolled in an L.L.M. program in patent, trademark, and copywright law at George Washington University. . . . **John Cattel** owns and operates Rumble Seat, a singalong pub at 112 Green St. in Worcester. Rumble Seat offers good hot dogs, cold beer, and live music. Formerly, Cattel had worked three years for Riley Stoker Co. . . . **Christopher Cowles** holds the post of systems consultant for Christian Rovsing of Herlev, Denmark. He is consulting for the Civil Service Commission of Kuwait designing a civil registration system and government personnel information system. His wife Patricia works on the same project. . . . **William Ferranti** is a loss prevention engineer at Fred S. James & Co., Boston.

Garrett Graham works as general supervisor for Polaroid in Waltham, Mass. . . . **John Kaferle, Jr.** serves as a senior process engineer at Crawford & Russell, Inc., Stamford, Conn. . . . **P. B. Koradia,** a product research group leader in the chemical process products division at Norton Co., was a co-author of "Molecular Sieves for SO_2 Removal" which appeared in the August issue of *CEP-Chemical Engineering Progress.* . . . The New England Electric System employs **Kenneth Oberg** as a senior budget analyst in Westboro, Mass. . . . **Michael Sullivan** is manager of recovery unit operations at Aztec Engineering in Louisville, Ky. . . . **Paul Wilson** works for Arwood Corp. in Tilton, N.H. . . . **Alan Zabarsky** holds the position of manager of quality assurance at Motorola Corp., Schaumberg, Illinois.

1971

Married: **P. James Allfrey III** and Miss Virginia M. White of Lexington, Massachusetts on August 14, 1976. Mrs. Allfrey, who graduated from Simmons College, is a registered nurse on the staff of Addison Gilbert Hospital in Gloucester. Her husband is with Liberty Mutual Insurance . . . . **Myles H. Kleper** and Miss Judith E. Izen in West Newton, Massachusetts on August 29, 1976. The bride graduated from Boston University and is a research analyst on the psychiatric service staff at Mass. General Hospital. The groom has served in the Peace Corps and is presently a project engineer with the Walden division of Abcor, Inc. Wilmington, Mass. He is also studying for his MBA at Northeastern University.

Married: **John R. Oscarson** and Miss Arlene L. Slifkin in New London, Connecticut on August 8, 1976. Mrs. Oscarson, who graduated from Mitchell College and Quinnipiac College, is a programmer at Mystech Associates, Inc. in Mystic, Conn. Her husband is a laboratory technician at Pfizer in Groton. . . . **David A. True** and Miss Mary Lee Bannister of Point Pleasant, New Jersey recently. The bride graduated from Swarthmore and earned a master's in marine biology from the University of Rhode Island. She is presently employed at Woods Hole Oceanographic Institute. Dave continues with New England Power Co.

Born: to Mr. and Mrs. **John C. Moore III** a son Bradley on June 6, 1976. Moore, now a field engineer for Westinghouse in Minneapolis, Minn., recently spent a year in Spain working on new power plants.

Joseph Bellino is a design engineer for GE in Gainsville, Fla. . . . **Ellen Brueck** teaches mathematics at the Lovett School in Atlanta, Ga. . . . Continuing with Riley Stoker, **Robert Childs** is now a sales engineer for the firm in Portland, Oregon. . . . **John Giordano** serves as a planning officer at Old Stone Bank in Providence, R.I. . . . **Michael Grady** has joined Data Systems Division of ITT Business Systems LTD, London, England. He holds the post of senior software systems engineer. The Gradys and their four-year-old son, Peter will remain in England for three years.

John Gyory is presently enrolled at the University Simon Bolivar, Caracas, Venezuela, where he is in his last year of architectural studies. . . . **Elaine Kowalewski** has been appointed assistant professor of mathematics and statistics at Nichols College, Dudley, Mass. She has also been enrolled in the Ph.D. program at the University of Connecticut. . . . **Richard Lisayskas** is an R&D engineer at Texas Instruments in Attleboro, Mass. This year he received his master's degree from MIT. . . . Having received his Ph.D. in physics from the University of Wisconsin in Madison, **Toh-Ming Lu** has returned to Maylaysia.

Gary Mason, plant manager at Stevens Linen Associates, has been named general chairman for the 1976 United Way campaign of Webster and Dudley (Mass.), Inc. Last year he served as first vice president and as a member of the budget committee. . . . **Tom Mirarchi** is a manufacturing quality engineer at American Optical in Brattleboro, Vt. . . . **Robert Payne** holds the post of research associate at Charles H. Kline & Co., Fairfield, N.J. . . . **Donald Peterson** has joined Northern Telecom, Inc. as manager of analysis, credit and insurance. He will be responsible for defining and solving managerial problems, especially in the areas of finance, control, long range planning and internal operations. Before joining the Nashville-based firm, he was senior investment analyst for State Mutual Life Assurance Company of America.

John Petrillo has received his Juris Doctor degree from Brooklyn Law School. He is employed by the American Telephone & Telegraph Company, New York City. . . . **Abbas Salim** is currently a senior engineer for General Dynamics' Electronics Division in Orlando, Fla. In September he published a paper in the records of the 11th Intersociety Energy Conversion Engineering Conference. . . . **Anthony Schepis** serves as an application engineer in the centrifugal separator department at De Laval Separator Co., St. Louis, Missouri. . . . **Robert Vayo,** SIM has been named plant manager of Reed and Prince's new packaging and plating plant in Jaffrey, N.H. Since joining the firm in 1965, he has served as an industrial engineer and plant manager.

1972

Married: **Robert A. Grant** and Miss Jill Holbrook in Columbia, Connecticut on September 25, 1976. Mrs. Grant graduated from Russell Sage College and is manager of the Weathervane in Burlington, Mass. Her husband is with Salath and Pecci, consulting engineers, Boston. . . . **Bruce M. Szypot** and Miss Judith A. Pond in Rochester, New York on April 24, 1976. **Bill Delphos,** '74 and **Greg Stamper,** '73 were ushers. Mrs. Szypot graduated from Central City Business Institute, Syracuse, and is a secretary for Eastman Kodak. Her husband continues at Kodak where he is an industrial engineer.

Charles Chase is with Consumer's Water Co. in Portland, Me. . . . Dr. **James Colangelo** serves as a medical intern at Hartford (Conn.) Hospital. He received his MD from St. Louis University this year. . . . **Raymond Del Colle,** MNS has accepted a position as a teacher of physics and math at the Whitman-Hanson Regional High School in Whitman, Mass. . . . **James DeVries,** MNS, has been appointed associate professor of mathematics and physical science at Barrington (R.I.) College. He has also been doing graduate work at the University of Pennsylvania.

Alan Dion recently received his master's degree in civil-environmental engineering from the University of Rhode Island. . . . **John Ferraro** has been promoted to the position of engineer in the transmission and substation engineering department at Northeast Utilities in Berlin, Mass. He began as an assistant engineer in the protective relaying department in 1972 and was named associate engineer in 1974. . . . **David Hayhurst,** who received his Ph.D. in chemical engineering from WPI in June, is now an assistant professor in the Chemical Engineering Department at Cleveland State University in Ohio . . . . **William Klein, Jr.** is assistant plant manager in the Boxmakers Division at Rexham Corp. in Pinetops, N.C. . . . **James Lacy** is a senior engineer for Digital Equipment Corp., Marlboro, Mass.

Randall Partridge, a research engineer at Mobil R/D Corp., Paulsboro, N.J., is on a three-year leave of absence while studying for his Ph.D. at the University of Delaware. He also does research at Children's Hospital of Philadelphia. . . . **Thomas Staehr** serves as a field engineer at Stone & Webster, Oak Ridge, Tenn. . . . **Hubert Thompson** works as a technical supervisor for duPont in Buffalo, N.Y. . . . **William Way** is a fire protection engineer at Kemper Insurance Co., North Quincy, Mass. . . . **Ira Weissman** is an associate engineer for Public Service Electric & Gas in Newark, N.J.

1973

Married: **Robert E. Baron** to Miss Carolyn Pulvirenti in Longmeadow, Massachusetts on July 18, 1976. The bride graduated from Westfield State College and received her master's degree from Lesley College, Cambridge. She is a specific learning disability teacher in the Belmont school system. Her husband recently received his master's degree in chemical engineering from MIT. He is associated with MIT's Energy Laboratory. Recently his article, "Synthetic Fuels: Prices, Prospects, and Prior Art" appeared in *American Scientist.* . . . **Michael S. Gipps** and Miss Margaret A. Eldridge in Walnut Creek, California on July 17, 1976. Mrs. Gipps has a BS from the University of Montana. Both she and the groom are chemical engineers at Dow Chemical in Pittsburg, Calif.

Married: **Michael J. Kowaleski** and Miss Sharon A. Leonardi in Worcester on July 18, 1976. The bride, a home economics teacher in Braintree, graduated from Framingham State College. The groom is a field service manager in the computerized building automation systems department at Johnson Controls, Inc., Woburn, Mass. . . . **Michael D. Peterson** and Miss **Carolyn D. Barnard,** '74 in Worcester on August 21. Mrs. Peterson, an accounting supervisor at Mechanics National Bank, is also a student in the evening division at Clark University. Her husband is a candidate for his master's degree at Anna Maria College and a sales coordinator at Valtec Corp., West Boylston, Mass. . . . **Wayne H. Pitts** to Miss Shelley Wright of Scotia, New York on October 18, 1975. Mrs. Pitts is a mag card typist at Ford Motor Company. She is a graduate of Becker and was formerly with the WPI public relations office. Her husband is an environmentalist at Vollmer Associates in Louisville, Ky.

Born: to **Stephen H. Goodwin** and **Deborah Laplante Goodwin** a daughter Tracey on August 30, 1976. Now on maternity leave, Mrs. Goodwin was a scientific computer programmer in the large steam turbine division at GE in Schenectady, N.Y. Recently her husband was named the station's standard engineer for Niagara Mohawk in Syracuse. . . . to Mr. and Mrs. **George Gosselin** their first child, Bryan Marshall, on September 17, 1976.

Presently **Ray Cherenzia** is a civil engineer at Seaboard Engineering in Niantic, Conn. . . . **James Di Milia** serves as an assembly-process engineer at Ford Motor Co., Dearborn, Mich. . . . **Daniel Eide** now holds the post of plant manager at Hammond Plastics in Owensboro, Ky. . . . **Thomas Ferguson,** who was awarded a master of science degree in biomedical engineering from Iowa State University in August, is currently doing more graduate work at the university.

Dr. **John Goulet** has been appointed an assistant professor of mathematics at Colby College, Waterville, Me. He holds MS and Ph.D. degrees from RPI, Troy, N.Y. While at RPI he received the Ralph Huston Award as the outstanding graduate student instructor of mathematics. Previously he was with Youngblood Laminates . . . . **Roger James** is a manager for F. W. Woolworth Co. in Middletown, R.I. . . . **William Mawdsley** was recently promoted to senior actuarial associate at State Mutual Life Assurance Co. of America in Worcester. He has been with the company since 1973. . . . **Frank Kania,** a field cost engineer for Stone & Webster, is presently working on the Clinch River Breeder Reactor Plant Project in Oak Ridge, Tenn. He, his wife, Denise, and son Michael currently reside in Knoxville. . . . **Mark Oleson** is a construction engineer for Stone & Webster and is located in Lycoming, N.Y.

David Pouliot works as an electronics engineer at Naval Surface Weapons Center, Dahlgren, Va. . . . **Stuart Roth,** who is with the U.S. Army, is currently a platoon leader for the 82nd Airborne in Fort Bragg, N.C. . . . **Gary Selden,** a research engineer for GE in Schenectady, N.Y., is also enrolled in the materials science Ph.D. program at RPI. . . . **Stu Wallack** has accepted a sales engineering job with the Torrington (Conn.) Company. . . . Continuing with the Central Vermont Public Service Corp., **David Watts** is now assistant transmission engineer in Rutland.

1974

Married: **Donald W. Campbell** and Miss Diane Botelho on August 28, 1976 in Newport, Rhode Island. Mrs. Campbell graduated from Anna Maria College. The bridegroom is an analytical chemist at Liberty Mutual Research Center in Hopkinton, Mass. . . . **C. Wayne Chistolini** and Miss Kathleen Blake on July 17, 1976 in East Longmeadow, Massachusetts. The bride graduated from Fitchburg State College. The groom is doing graduate work at RPI and is division supervisor of construction and maintenance for Texaco Oil Corp., Albany, N.Y. . . . **William Frazier** and Miss Jean D'Isidoro in Hollis-ton, Massachusetts on October 2, 1976. Mrs. Frazier, a substitute teacher, graduated from Westfield State College. Her husband is with Arthur D. Little Co., Cambridge, Mass. . . . **Robert E. Lindberg, Jr.** and Miss Nancy K. Mon-talbine in Franklin Square, New York on June 12, 1976. **Gerald Buzanoski** and **Michael Kosmo** were ushers. The bride has a BA in special education from Anna Maria College. The groom is a physicist at the Naval Research Laboratory in Washington, D.C.

Married: **Victor Melechow** to Miss Lucia K. Polanik in Worcester on July 18, 1976. Mrs. Melechow graduated from Lowell University and is a music teacher. Her husband teaches science in the Marlboro (Mass.) public school system. . . . **Garry E. Nunes** and Miss Deborah J. Ring on October 23, 1976 in Schenectady, New York. The bride is an alumna of Becker and was employed by the Boston Store in Latham. The groom is with Stone & Webster Engineering in Astoria, N.Y. . . . **Thomas J. Stone** to Miss Bonnie J. Carlson in Southington, Connecticut on Au-gust 14, 1976. The bride, an elementary teacher in the Southington school system, graduated from Central Connecticut State College. The bridegroom is a field service engineer with Excel-lon Automation. . . . **Stephen J. Yankum, Jr.** and Miss Brenda G. Morse on July 17, 1976 in North Attleboro, Massachusetts. Mrs. Yankum graduated from Katharine Gibbs School and is a secretary at Airtek Corp., Newton. Her husband is an assistant actuarial consultant for the Wyatt Co., Wellesley.

David A. Gerth serves as a staff accountant at Arthur Andersen & Co. in Boston. He recently received his MBA from Amos Tuck School at Dartmouth College. . . . **Robert Hodgson** is pursuing an MBA at Tuck School. . . . Currently **David Lapre** holds the post of department man-ager at P&G Paper Products in Mehoopany, Pa. . . . .**Michael Lewandowski** MNS has received his master of education degree with concentration in school administration from Bridgewater State College. An A student, he was commended for receiving one of the highest scores ever given on a comprehensive examination. A member of the science department at Joseph Case High School, Swansea, Mass., Lewandowski serves as vice president of the Mass. Region III science fair committee and is also a member of the State Science Fair executive board.

Russell Naber is a process engineer for Procter & Gamble on temporary assignment at a new manufacturing facility in Greenville, N.C. . . . Lt. **David Nickless,** U.S. Army, serves as com-mander of the 137th Ord. Det. (EOD) at Corpus Christi, Texas. . . . **"Mex" Sanchez,** who has received his MS in biochemical engineering from Virginia Polytechnic Institute and S.U., is cur-rently with Procter & Gamble's product de-velopment department in Mexico. . . . **Richard Takanen** has graduated from GE's two-year manufacturing program and is now foreman of product and process appraisal for GE in Pittsfield, Mass.

Lee Turner serves as senior financial analyst at Baxter Traverol Labs, Inc. in Deerfield, Ill. He recently received his MBA from Tuck School at Dartmouth. . . . **Craig Tyler** works as a field service engineer for Veeder Root Co. in Des Plaines, Ill. . . . **Andrew Wemple** has been promoted to actuarial associate in the actuarial organization at State Mutual Life Assurance Co. of America. . . . **Christopher Williams** is a field service representative at Digital Equipment Co. in Waltham, Mass. . . . Continuing with GE, **Stephen Williams** is now a quality control en-gineer for the company in Ft. Wayne, Ind. . . . **Gordon Woodfall** is production-inventory con-trol supervisor for Texas Instruments in Attle-boro, Mass.

Douglas Briggs serves as a production control supervisor at GE in Wilmington, Mass. Also, he is studying for his MBA at Northeastern University. . . . Also studying for his MBA is **Erik Brodin,** who is at Western New England College, Springfield, Mass. . . . **Thomas Burns** works for GE's ordnance systems division in Pittsfield, Mass. . . . **Steve Dacri,** who received an award from the National Safety Council for his duties as toastmaster at the Annual Safety Awards ban-quet held in Worcester recently, is presently working on a series of "magical" TV public service announcements highlighting child and automotive safety for the Council. In September he starred in a TV special which he wrote and produced on Worcester's Channel 27. In Oc-tober he was a featured entertainer at the Opti-cal Wholesalers of America Trade Show in the MGM Grand Hotel in Las Vegas, following a performance for the Screen Printing Association in New Orleans.

1975

Married: **Christopher E. Danker** and Miss Melody A. King on August 21, 1976 in Water-town, Massachusetts. Mrs. Danker graduated from Anna Maria and currently attends Madison College. The bridegroom is a process engineer at Thiokol Fibers in Waynesboro, Va. . . . **William A. Demers** to Miss Judith E. Marraty on August 28, 1976 in Derry Village, New Hampshire. The bride graduated from Pinkerton Academy and is a teller at Derry Bank and Trust Co. . . . **Wilson G. Dobson** and Miss Lynn LePoer in Petersham, Massachusetts on October 23, 1976. Mrs. Dob-son graduated from Hahnemann Hospital School of Nursing, Worcester. She is a registered nurse at the hospital. The groom is a graduate assistant in the material engineering department at WPI. . . . **Henry Fitzgerald** and Miss Jean M. Tyer on August 28, 1976 in Worcester. Mrs. Fitzgerald is a senior at Worcester State College and is a part-time employee of the Worcester Boys' Club. Her husband works for Gillette Co. in South Boston.

Married: **John J. Fitzgibbons, Jr.** to Miss Michelle A. Plante in North Attleboro, Mas-sachusetts on September 11, 1976. The bride, a graduate of Katharine Gibbs, is a secretary at Regis Paper Co. Her husband is an estimator at H. Carr & Sons. . . . **Ronald E. Gagnon** and Miss Ellen M. Connor on October 2, 1976 in West Boylston, Massachusetts. Mrs. Gagnon graduated from West Boylston Junior-Senior High School and is a secretary at Norton Co. The groom, manager of purchasing and traffic at Kinefac Corp., is also studying at Quinsigamond Community College. . . . **John R. Mason III** to Miss Paula Ann Yurewicz on July 25, 1976 in Paxton, Massachusetts. Mrs. Mason is a graduate of Anna Maria College. She is currently completing an internship in medical technology at Worcester City Hospital. The groom is a candidate for a master's degree in nuclear en-gineering at WPI.

Married: **Frank W. Moitoza** to Miss Linda L. Halliday in Portsmouth, Rhode Island on Sep-tember 25, 1976. The bride, who graduated from the University of Rhode Island, is an in-structor at the YMCA and a substitute teacher in the Newport school system. Her husband is with the Naval Underwater Systems Center. . . . **Peter F. Pombo** and Miss Kristina M. Jamieson on August 14, 1976 in Paxton, Massachusetts. Mrs. Pombo graduated from Anna Maria and teaches special-needs children at Auburn Junior High School. The bridegroom is chief engineer at Syntest Corp. in Marlboro. . . . **Stephen A. Werner** and Miss Kathleen M. Geran on June 19, 1976 in Worcester. Mrs. Werner attended Quin-sigamond Community College and was employed at Wayside Nursing Home. The groom is a nuclear refueling engineer for General Dynamics, Electric Boat Division, Groton, Conn. . . . . **Richard J. Newhouse** to Miss Barbara A. Branau in Centereach, Long Island, New York on July 10, 1976. The bride graduated from Becker. Her husband is employed by Raymond Interna-tional, Inc., in Africa.

George Breece holds the post of vice president at Southern Fluid Controls Corp., Ft. Lauderdale, Fla. . . . **Mark Chevrier,** who was married to Paula Laberge in September 1975, is now project engineer at Monsanto in Bloomfield, Conn. . . . **Robert Martinaitis** is currently employed by the ground systems group at Hughes Aircraft Co. in Fullerton, Calif. He is also studying for his MSEE at U.S.C. on a Hughes Master's Fellowship. . . . **Gregory Miranda** works for the Worcester Foundation for Experimental Biology in Shrewsbury, Mass. as a research assistant. . . . **Mark Candello** has joined Troy (N.H.) Mills, Inc.

Ray Cibulskis serves as applications engineer at the Lee Company in Westbrook, Conn. The firm manufactures engineered hydraulic com-ponents. . . . Presently **Mark Koris** holds a graduate assistantship in biomedical engineering at Case Western Reserve. . . . **Laurence Michaels** is a systems programmer at Whitlow Computer Systems in Englewood Cliffs, N.J. . . . **John FitzPatrick** has joined Exxon Research and En-gineering Co. in Florham Park, N.J. . . . **James Roche** is a research engineer at Gleason Works, Rochester, N.Y.

Vance Rowe holds the post of project en-gineer at Pfizer in Adams, Mass. . . . **Steven Standaher** is a graduate assistant at WPI. . . . **Pat Toomey** serves as a design engineer at Sprague Electric in Worcester. . . . **John Tropeano** is a methods and standards analyst at Sky Chefs, New York City. . . . **Scott Wilson** is a test engineer at Thomas G. Faria Corporation In Uncasville, Conn.

1976

Married: **Bourdillon P. Apreala** to Miss Virginia A. Latimore on July 24, 1976 in Boston. The bride attended Radcliffe College. Her husband is a student at Atlanta University Business School . . . . **H. Scott Bicknell** and Miss Brenda L. Cowles recently in Enfield, Connecticut. Mrs. Bicknell graduated from Becker Junior College and is manager of the Bay State Savings Bank in Worcester. The groom serves as a divisional manager for Bicknell, Inc., in Framingham, Mass. . . . **Jeffrey J. Coderre** to Miss Debra Pinet on April 10, 1976 in Moosup, Connecticut. The bride graduated from Plainfield High School. The bridegroom is with the Linde Division of Union Carbide. . . . **Richard A. Escolas, Jr.** and Miss Maureen D. Hardy on October 17, 1976 in Worcester. Mrs. Escolas graduated from Holy Cross and is assistant manager of Windsor Button Shop, Worcester Center. Her husband is manufacturing supervisor at Texas Instruments in Attleboro.

Married: **George J. Hefferon** to Miss Marguerite L. Dunn in Ridgefield, Connecticut on August 8, 1976. The bride graduated from State University College, Genesco, N.Y. and teaches English at John Jay High School, Katonah. The groom is a doctoral candidate at Columbia University . . . . **Zeses E. Karoutas** and Miss Stephanie A. Tsolas in Haverhill, Massachusetts on August 22, 1976. Mrs. Karoutas graduated from Salem State College. Both she and her husband are attending graduate school in Blacksburg, Va. . . . **Wayne Mandrus** and Miss **Margaret E. Gaby** '79 last May in Springfield, Massachusetts. The groom is a systems analyst at Bay State Gas Co. . . . **Michael J. Miller** to Miss Pamela C. Pearce on May 29, 1976 in Groton, Connecticut. Mrs. Miller graduated from Fitch Senior High School and is employed at the Naval Submarine Medical Center.

Married: **Kevin A. Osborne** and Miss Laurea M. Payette on August 28, 1976 in Greenville, Rhode Island. The bride graduated from Rhode Island Junior College. The groom works as a field engineer for Industrial Risk Insurers of Philadelphia. . . . **Thomas K. Pelis** and Miss Joan E. Holly on August 14, 1976 in Newark, New York. Mrs. Pelis is a graduate of Becker Junior College. The bridegroom is employed by O'Brien and Geer. 2/Lt. **Edward J. Perry II** (USAF) and Miss Mary E. Berry on July 4, 1976 in Southbridge, Massachusetts. The bride graduated from Endicott Junior College and is with the Southbridge Credit Union. Her husband has been assigned to Warner-Robbins AFB, Georgia. . . . Miss **Mary F. Polanik** to Reggie N. Sherman on October 2, 1976 in Shrewsbury, Massachusetts. Mrs. Sherman is a mathematics teacher at Shawsheen Valley Technical High School, Billerica. Her husband graduated from Worcester State College and is presently enrolled in the master's program in psychology and guidance at Assumption College. . . . **Eugene L. Savoie** to Miss Candyce A. Sawyer in East Chatham, New York on August 14, 1976. The bride graduated from Chatham Central School. The groom is with GE in Auburn. . . . **Jeffrey L. Wilcox** and Miss Deborah J. Tessier on August 21, 1976 in Somerset, Massachusetts. Mrs. Wilcox graduated from Bristol Community College and is a medical laboratory technician at Union-Truesdale Hospital. The bridegroom attends the Graduate School of Business at the University of Pittsburgh.

Curtis Allshouse is with the heat treatment department at Corning Glass Works, Corning, N.Y. . . . **Scott Bamford,** a graduate student at the University of Rhode Island's School of Ocean Engineering, has received a research fellowship grant from the university to study in the field of nuclear waste disposal. . . . **Kent Baschwitz** is a marketing representative at Mobil Oil in Scarsdale, N.Y. . . . **Stephen Borys, Jr.** works as a construction and maintenance engineer for Exxon Co., U.S.A., Pelham, N.Y. . . . **Tony Clawson** serves as an associate industrial engineer for Inland Steel Co., East Chicago, Ind. . . . **Mark Coulson** has been employed by General Dynamics, Electric Boat Division.

Jay Cruickshank is involved with safety engineering at Liberty Mutual Insurance Co., West Springfield, Mass. . . . **Joseph D'Alesio** is with W. C. Larsen in Rochester, N.Y. . . . **John Fairbanks** has been employed as a service engineer at Babcock & Wilcox Co., Cincinnati, Ohio. . . . It was erroneously reported in the October issue that **Mark Hoey** was employed by the engineering department of the city of Worcester. Actually, he was named acting city engineer for the city of Holyoke, Mass., a position which he held until the end of October. He is now a field engineer for Daniel O'Connell's Sons, Inc., a construction company located in Holyoke. . . . **Catherine Hogsett** recently accepted a position with GE in the company's manufacturing management program. . . . **Paul Jacques** has joined Eastman Kodak Co., Rochester, N.Y. . . . **Michael Koronkiewicz** works for Sikorsky Aircraft. . . . **Carey Lazerow** is a minicomputer medical systems analyst at Norwalk (Conn.) Hospital. . . .

Richard Lessard is a programmer at First Data Corp., Washington, D.C. . . . **David McCormick** has joined Armco Steel Co., Middletown, Ohio . . . . **Kathleen Morse** holds the post of software engineer at Digital in Maynard, Mass. . . . **James Pinzino** is a marketing representative at Burroughs Corporation, Lexington, Mass. . . . **Charles Putnam** serves as a design engineer for the Ford Motor Co. in Dearborn, Mich. . . . **Jonathan Rourke** is with the Defense & Electronics Center, Systems Development Division, at Westinghouse in Baltimore, Md. . . . **William Ruoff** is general manager of R. H. White Construction Co., Merrimack, N.H.

Ed Sawicki has joined Standard Pressed Steel Co., Jenkintown, Pa. in the sales engineering program. The international company specializes in the manufacture of precision fasteners. Following the training course, Sawicki will assume marketing responsibilities for the firm's Hallowell Division in Hatfield, Pa. . . . **James Sieminski** is with RCA/ASD in Burlington, Mass. . . . **John Smith** is a graduate assistant at Roswell Park Memorial Institute in the Grace Cancer Drug Center, Buffalo, N.Y. . . . **Kenneth Stannard** serves as an R&D chemical engineer at UniRoyal Chemical in Naugatuck, Conn. . . . **Frank Vanecek** has been named as an instructor in computer science at Norwich University, Northfield, Vt. . . . **Joseph Yu** is a project engineer at Mobil Oil in Paulsboro, N.J.

U.S. POSTAL SERVICE

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Required by 39 U.S.C. 3685)

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11. I certify that the statements made by me above are correct and complete.

SIGNATURE AND TITLE OF EDITOR, PUBLISHER, BUSINESS MANAGER, OR OWNER: H. Russell Kay, editor

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39 U. S. C. 3626 provides in pertinent part: "No person who would have been entitled to mail matter under former section 4359 of this title shall mail such matter at the rates provided under this subsection unless he files annually with the Postal Service a written request for permission to mail matter at such rates."

In accordance with the provisions of this statute, I hereby request permission to mail the publication named in Item 1 at the phased postage rates presently authorized by 39 U. S. C. 3626.

SIGNATURE AND TITLE OF EDITOR, PUBLISHER, BUSINESS MANAGER, OR OWNER

PS Form Apr. 1976 **3526** *(Page 1)* (See instructions on reverse)

Raymond A. Haskell, '07 of Sturbridge, Massachusetts died on February 18, 1976.

He was born on August 30, 1884 in Hope Valley, Rhode Island. Following graduation as an electrical engineer, he was with the Long Lines Department of the American Telephone & Telegraph Co. from 1909 to 1949, when he retired.

Donald H. Mace, '07 of Sarasota, Florida, a retired patent attorney, passed away on September 4, 1976.

After receiving his BSEE from WPI, he studied law at National Law School in Washington, D.C., where he earned his law degree. During his career he was with General Electric; Westinghouse; VanEveren, Fish & Hildreth; Texas Co.; Gasoline Products Co.; and Gifford, Scull & Burgess, New York City. He belonged to ATO and Sigma Xi and had served as secretary-treasurer of the Pittsburgh chapter of the Alumni Association.

Richmond W. Smith, '08, a retired executive for Bird Machine Co., passed away at his home in Walpole, Massachusetts on August 24, 1976. He was 90 years old.

He was born on March 10, 1886 in Princeton, Mass. and graduated as a mechanical engineer in 1908. After graduation he was with Hollingsworth Vose Co. and Kendall Co. He retired in 1953 after 30 years as a sales executive for Bird Machine Co., Walpole.

Mr. Smith belonged to Theta Chi and the Masons. He received his MSME from WPI in 1910

Charles A. Bassett, '11 of Naples, Florida died on July 22, 1976.
A native of Taunton, Mass., he was born on August 31, 1887. He studied at WPI and for many years was a self-employed fuel oil broker.

Allen H. Gridley, '13 died at his home in New Rochelle, New York on September 2, 1976 following a civil engineering career which spanned 62 years.

He was born on November 27, 1890 in Springfield, Massachusetts. In 1913 he received his BSCE from WPI, later doing graduate work at the College of the City of New York and Pratt Institute. During his lifetime he was with Hardy S. Ferguson & Co., Alvin H. Johnson & Co., Walter Kidde Constructors, Inc., Lockwood Greene Engineers, Roderick O. Donoghue & Co., Great Northern Paper Co. and National Container Corp. From 1969 until his death he was associated with Velzy Associates.

Mr. Gridley belonged to Tau Beta Pi, ASME, TAPPI, and was a former secretary of the New York chapter of the Alumni Association.

Kirtland Marsh, '14 of Mt. Lebanon, Pittsburgh, Pennsylvania, a long-time employee of the Aluminum Co. of America, died on September 20, 1976.

A native of West Newton, Mass., he was born on February 25, 1891. After receiving his BSME from WPI, he joined Norton Co. for two years prior to service with the U.S. Army in the chemical warfare division during World War I. From 1919 until his retirement in 1957, he was with ALCOA, where he was in charge of the furnace division in the mechanical engineering department.

Mr. Marsh, a Mason, was the father of Herbert W. Marsh of the Class of 1943. He played a significant role in the development of furnaces used in heat treating and fabricating of aluminum.

Clarence F. Alexander, '15 of Tavares, Florida passed away on June 6, 1976.

He was born on April 22, 1894 in Worcester and received his BSEE from WPI in 1915. During his career he was with International Projector Corp. and National Theatre Supply, New York City, retiring in 1958. He belonged to Phi Sigma Kappa.

Joseph M. Chandler, '16 of East Bridgewater, Massachusetts, co-founder and manager of the Chandler Construction Co., died on October 14, 1976 at the age of 83.

An East Bridgewater native, he became a mechanical engineering student at WPI. For many years he served as trustee and president of East Bridgewater Savings Bank. He was also a trustee of Brockton Hospital and a former member of the Brockton Country Club. During World War I he was a flying instructor at Lake Charles, La.

Herman Hollerith, Jr., '17 of Oxford, Maryland passed away on September 1, 1976.

After graduating from WPI as a mechanical engineer, he was employed by the Naval Aircraft Factory. Later he was with John Harrison, Jr. Co., Victor Talking Machine Co., and Mechanical Improvements Co. From 1931 to 1936 he was co-president of Virginia Navigation. In 1961 he retired from Glenn L. Martin Co. as senior materials engineer.

Mr. Hollerith belonged to the American Society of Mechanical Engineers and the Society of Automotive Engineers. He was born in Georgetown, D.C. on September 17, 1892

Richard D. Lambert, '17 of Orleans, Massachusetts, a retired executive secretary of the Central Massachusetts Employers Association, died on July 30, 1976.

A native of West New Brighton, N.Y., he later attended WPI and graduated as a mechanical engineer. During World War I he served with the British Merchant Marine and the U.S. Navy. After the war he was with Elevator Supply Co., General Motors, and GE. Later he joined Norton Co. and then the Worcester Children's Friend Society. In 1934 he became executive secretary of the Central Massachusetts Employers Association, a post he held until he retired in 1965. During World War II he represented New England employers on the wage committee of the Regional War Labor Board.

Mr. Lambert belonged to Phi Sigma Kappa, the Masons, and had served on the executive committee of the Boston chapter of the Alumni Association. He had received a presidential citation for his work with the crippled and handicapped.

Joseph P. Garmon, '18 of Bolingbrook, Illinois passed away on his 82nd birthday, September 3, 1976.

A native of Lowell, Mass., he later graduated from WPI as a mechanical engineer. From 1922 until he retired in 1960, he was with R. E. Runels Construction Co., Inc., Lowell. He belonged to Lambda Chi Alpha, and was a registered, professional engineer.

Rudolph C. Stange, '20, a retired civil engineer, died August 10, 1976 in Los Altos, California. He was 78.

A specialist in fire prevention, he worked for the Navy and the Coast Guard during World War II. Later he became general manager of the National Board of Fire Underwriters in San Francisco.

Mr. Stange was born on June 21, 1898 in Orange, Mass. He was a member of Phi Sigma Kappa, Tau Beta Pi, and Sigma Xi. He also belonged to the Society of Fire Protection Engineers and the Society of American Military Engineers. Formerly he was president of the Northern California chapter of the Alumni Association.

E. Sumner Thayer, '21 of North Grafton, Massachusetts passed away recently.

Born on July 28, 1898 in Worcester, he later graduated as a chemist from WPI. He was with International Paper Co., Falulah Paper Co., Norton Co., and Gro-Lex, Inc. He belonged to the Scottish Rites, A.F. & A.M., the Shrine, and Phi Sigma Kappa. He served as a former vice president of the New York chapter of the Alumni Association.

Dean W. Alden, '22 of Philadelphia, Pennsylvania died on October 9, 1976.

A native of Durham, N.H., he was born on August 12, 1896. He graduated with a BSEE in 1922. From 1922 until 1923 he was with GE. In 1961 he retired as chief engineer from Blackstone Valley Gas & Electric Co., where he had worked since 1923. He was a member of Providence Engineering Society, AIEE, the Masons, and Lambda Chi Alpha. Formerly he was a council member from the Rhode Island chapter of the Alumni Association.

Paul Bradlaw, '22, who served Norwich Free Academy (N.F.A.) for 52 years, died unexpectedly at his home in Norwich, Connecticut on October 9, 1976. He was 76 years old.

Born in Norwich on May 24, 1900, he later studied at WPI with the Student Army Training Corps. He taught printing and industrial arts at N.F.A., where he also served as administrative assistant to three principals. The manual training building was named Bradlaw House in his honor.

In 1941 he was cited for his distinguished service to education by the State Board of Education. A copy of his book, *Observations on the Development of the Alphabet and Printing,* was recently added to the Rare Book and Special Collections Division of the Library of Congress.

Ivan V. Abadjieff, '28, a retired chief engineer for Leland-Gifford Co., died on September 3, 1976 at his home in Worcester.

He invented many machine parts that are currently used world-wide. He also was a consultant and products tester for a number of manufacturers.

Mr. Abadjieff, who was born in Bulgaria in 1900, studied finance and administration at the University of Sofia prior to entering WPI. After graduating as a mechanical engineer, he joined Leland-Gifford where he retired eleven years ago. He belonged to the Worcester County Music Association, was active with the Music Festival and Worcester County Light Opera, and served as president of the Coes Pond Preservation Association. He was also a member of ASME and Chartered American Inventors.

Lyman W. Cross, '28, retired manager of U.S. Envelope Co., died in Laconia, New Hampshire on August 24, 1976. He was 70 years old.

A native of Millbury, Mass., he received his BSME in 1928. He retired in 1970 following 42 years of service with the Kellogg Division of U.S. Envelope Co. in Springfield, Mass. He was a member of Lambda Chi Alpha, Sigma Xi, and the Engineering Society of Western Massachusetts. He was a past president of the Connecticut Valley Chapter of the Alumni Association.

I. Bernard Erkkila, '31 of Fitchburg, Massachusetts died on July 22, 1976 at the age of 66.

After graduating as a civil engineer from WPI, he was with Independent Lock Co. until 1946. During his career he was a general manager for Grant Plastics, Inc., and Ilco Co. A former employee of Iver Johnson Co., Fitchburg, he retired in 1975.

Mr. Erkkila was born in Fitchburg on August 20, 1909 and was a member of the Massachusetts Society of Professional Engineers. He also belonged to Alpha Tau Omega.

Reginald A. Morrill, '36, president of Dominion Fence Co., Worcester, died on October 10, 1976. He was 61 years old.

He was born on January 11, 1915 in Waltham, Mass. A graduate mechanical engineer, he was with Morrill Lumber Co., Worcester and Blackstone (Mass.) Lumber Co. For the past 15 years he was president of Dominion Fence Co. He belonged to Sigma Phi Epsilon, the Masons, and the Worcester Country Club.

Douglas W. Marden, '39, a consulting geologist, died on August 16, 1976 in Garden City, Kansas. He was stricken while on a business trip.

He was born on Jan. 3, 1917 in Oklahoma City, Okla. After studying at WPI, he graduated from Clark University in 1939, later receiving his master's in geology at Johns Hopkins University.

During World War II he was captain of a minesweeper in the Pacific and was cited for bravery in action off Guam in 1944. He owned three companies dealing with geology with headquarters in Evergreen, Colo. He had worked for the U.S. Geological Service and several oil companies prior to forming his own business as a consulting geologist. He held the rank of Lt. Commander, USNR, retired.

Gordon B. Turner, '47, former editor and publisher of the *Nantucket Inquirer Mirror* and circulation distributor for the *Cape Cod Times,* died in Nantucket, Massachusetts on October 8, 1976.

After attending WPI, he took over the operation of the *Inquirer* following his father's death. He sold the paper in 1958, but remained in the graphics department until last year when he retired for health reasons. At one time he was the proprietor of Universal Photo Shop in Nantucket.

A Mason, he also belonged to the Nantucket Historical Association, the Sons of the Revolution, and the Eastern Star. He was born in New Bedford, Mass. on January 22, 1927.

Neil J. Crowley, '50, a civil engineer associated with the construction of several buildings at WPI, died on September 23, 1976 in Worcester. He was 49.

He served as clerk of the works for Daniels, Gordon Library, Goddard, Harrington Auditorium, and Stoddard Residence. Previously he was superintendent at Turner Construction Co. He also owned Crowley Package Store, Inc. at Tatnuck Square.

Mr. Crowley belonged to Phi Kappa Theta, PDE, Skull, ASCE, Tatnuck Island Club, and Aquinas Association. After WPI, he attended Babson Institute. He had been a member of the WPI Alumni Citations Committee, the Nominating Committee, the Alumni Council, and was a former president of the Worcester County chapter of the Alumni Association. A Worcester native, he was also a World War II Navy veteran.

Allan R. Whittum, '63 died on August 29, 1976 in Dillon, Montana after being struck by a car while riding a bicycle on a cross-country trip.

He was born on August 30, 1941 in New Haven, Conn., studied mechanical engineering at WPI, and received his BA from Northeastern in 1967. He was a systems engineer for IBM in Boston. A member of Outward Bound Association of Greenwich, Conn., he also belonged to Community Boating, Inc. of Boston and Ford Hall Forum, Boston.

Among his relatives who attended WPI were his father Gordon Whittum, '33; his cousin, Robert Whittum, '62; and his grandfather, Leonard W. Howell, '08.

Thomas Y. Liu, '67 of Van Nuys, California died on June 26, 1975.

He was born on October 21, 1938 in Honan, China. In 1967 he graduated as a chemical engineer from WPI. During his career he was with American Reinforced Plastics, Los Angeles, Calif.; Armour Industrial Products; and duPont. He belonged to AICE and the American Chemical Society.

Stephen D. Hausmann, '72 died August 6, 1976 in Great Falls, Montana following an accident in which his motorcycle slammed into the rear wheels of a tractor trailer.

He was born in Springfield, Mass. on October 18, 1950. While studying at WPI, he was a member of Phi Kappa Theta. He joined the Air Force five years ago and was a staff sergeant at the time of his death, having been stationed at Malmstrom AFB as a member of the team training branch of the 341th Strategic Missile Wing Headquarters Squadron. A president of Big Brothers, Inc., he was also a member of the Optimist Club.

Paul J. Soares, '75 was fatally injured in an auto accident in Pottstown, Pennsylvania on May 15, 1976.

He was born in Providence, R.I. on August 18, 1953. After graduating as a chemical engineer from WPI, he worked for Firestone Tire & Rubber Co., Perryville, Md. He belonged to TKE.

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