For reasons having to do with the lecture-giving part of his career as writer-publicist-lecturer, Ben Bova asked that we not tape and publish his Alfred Korzybski Memorial Lecture verbatim. He very kindly, however, agreed to allow the publication of a reportage of his lecture and also made available to us two related editorials which he published in Analog: Science Fiction/Science Fact. The reportage follows. It in turn is followed by Mr. Bova's editorials, "Energy Marketplace" and "The Broken Promise." Read together they give not only a fair representation of what was said at the Korzybski Memorial Lecture but a wide-ranging view of one of our most pressing planetary problems. Ed.

BEN BOVA'S ALFRED KORZYBSKI MEMORIAL LECTURE, 1977: A REPORT

Robert P. Pula

Following Lester del Rey's introduction, Ben Bova addressed those gathered at the Warwick Hotel to honor the memory of Alfred Korzybski. His subject: "Energy: How We Lost the Battle But May Yet Win the War." Readers of Manhood of Humanity must have been struck by the reverberations between Bova's tone and subject matter and Korzybski's in 1921: the subject was energy and human values; once again, the focus was on the tension between scientific-technological structures and social structures; know-how vs. what for. Bova demonstrated a keen awareness, derived from many years of contact at the science-society-science-fiction-interface, of the human issues involved in what others might see as merely another spat among the technocrats.

He began by observing that as a society we need to "break free" in our thinking about energy. Much in the mode of Alfred North Whitehead's "A civilisation which cannot burst through its current abstractions is doomed to sterility after a very limited period of progress," Bova stressed that our current energy crisis, very real according to him, is as much a function of attitudes as geo-physical exhaustion.

But the geo-physical factors exist. He listed three particularly acute problems: (1) the easiest to use sources of energy (oil, gas) are the ones most rapidly disappearing; (2) the most likely alternatives (coal and uranium) create serious environmental problems; and (3) climate - temperatures are getting colder but we can't use flight (moving away) as a solution because of population pressures. (Mr. Bova did not discuss whether or not this temperature shift is considered 'permanent' or merely cyclical but more serious now because of population pressures.)

Some other grim expectations were mooted: demand for petroleum will exceed supply in five to seven years; we in the United States will need to import 56,000,000 barrels of oil per day by 1985. This, Bova maintained, is no longer doable. Oil imports have not been simply increasing but are increasing at nearly exponential rates.

But all is not lost -- or at least need not be. The good news, according to Bova, is the magnetohydrodynamic generator. The structure and virtues of this machine (mercifully called the MHD) are fully discussed in Mr. Bova's editorial below, so I won't report all of his discussion on December 7, 1977. I will limit myself to a few important points which bear on the human evaluational aspects of our energy problems.

Former Senator Mike Mansfield of Montana was interested in the MHD because it can burn coal and Montana is short on water which is usually used to generate electricity. Thus Bova emphasized the socio-political aspect of the search for new energy sources. But he felt that even interested public figures were too local and parochial in their approaches. "Decision makers in the United States are not future oriented or, if so, only minimally," he claimed. One result is that even the MHD chance has been missed. As Bova put it, "It's sundown for MHD technology. Even if we do it now, it's too late."

Bova's next direction was to windward. "Regarding energy," he continued, "we are starving to death in the midst of plenty." Winds and the sun were cited as generous sources of energy. The classical hydroelectric approach (waterfalls, dams, etc.) is no longer adequate. Even new approaches to hydroelectric generation such as tide harnessing were despairaged as insufficient to meet expected needs.

Which way to go?

Here Bova entered on his perhaps most controversial task. He set out the argument between the 'hard' technology approach, which maintains that coal and uranium can develop without requiring much social change, and the 'soft' technology stance, which claims that the 'hard' approach is delusory because of pollution hazards.

It was Bova's view that most fears regarding negative effects of atomic (uranium) reactors are "nonsense." 'Softees' argue for use of sunlight and windmills to answer immediate energy needs. But these, Bova pointed out, "... will vastly change life styles." Besides, he went on, the power-energy establishment doesn't favor solar and wind systems -- they "... will reduce Con-Ed's hard technology customers."

From this apparent stand-off, Bova took the leap into 'outer' space. There solar power satellite systems which overcome atmospheric interference can intercept sunlight twenty-four hours a day and can beam energy in the form of microwaves to earth, to 'rectenna arrays' (antenna farms). How safe would this beaming of microwaves earthward be? There would be the need for beaming to unpopulated areas. A great advantage of microwave beaming, however, is that microwaves (very high frequency) can penetrate weather.

Another 'far out' solution is urged by the L_5 Society at Princeton University. Gerald O'Neil of the Society suggests that we build factories in 'space' along the moon's orbit. These new 'objects' (factories) would circle the earth with the moon. Materials for building the factories can come from the moon -- the moon can be seen as a very large mine. Bova reported O'Neil as saying that getting materials from the moon would be cheaper than 'trucking' it 'up' from earth. "What costs you money in space is overcoming gravity."

The L_5 Society envisages landscaped space stations to keep the earthlings relatively sane. (Mr. Bova presented an exciting series of slides during this part of his lecture. Even if none of these schemes becomes actual, the art work alone justifies the speculation.) Locally generated clouds would provide 'weather' for these colonies of the industrial revolution. According to Bova a mere $20,000,000,000 over the next ten years would "do it."

Meanwhile, back down to earth: water may be usable as a fuel source. (Note: not as an indirect energy source as in hydroelectric power, nor as a converted source as in steam power; as a fuel.) Lockheed presently has a 1/4 billion dollar contract from NASA to develop a hydrogen-using jet superior to the Concorde. Bova pointed out that in thermonuclear fusion which occurs in H bombs, the sun and all stars, hydrogen atoms are 'squeezed together' to produce helium and that means energy. "This is a natural process which we can imitate," he said.

Another energy-releasing technique now being tried involves using laser beams to implode a deuterium (heavy hydrogen) pellet. It is expected that the process may produce as much energy as is put in by the laser beams. The next step will be to try to get more energy out than is put in.

The U.S. government spends $340,000,000 in fusion (sun-imitating) research. Quite a lot of money, but, as Bova stressed, returning to his evaluating and priority-establishing theme, less than Proctor and Gamble spends on advertising one detergent per annum.

"We must encourage industrial and business decision makers to get moving."

The central crisis, he maintained, is not an energy crisis but a decision making crisis: "a 'mental' energy crisis."

Prolonged applause expressed the audience's response to Mr. Bova's wide-ranging, searching lecture.

The question and answer period which followed the formal presentation was well handled, Bova showing himself to be a deft fielder of probing questions, some of which were, as usual, disguised statements. His answers regarding the problem of nuclear seepage seemed not too reassuring but, as a whole the post-lecture part of the evening reinforced Bova's central message that the problems of human beings are solvable if human beings will solve them.

'Priorities', so fondly discussed by managers in industry, the military, government agencies of all sorts and R&D groups, constitute a function of evaluating. The following editorials by Ben Bova from Analog: Science Fiction-Science Fact (Vol. XLV, No. 7, July, 1975 and Vol. XLV, No. 12, December, 1975) discuss classic problems of priority-establishing and the evaluating which underlies it. With uncommon boldness not often found in publications to the right of The Village Voice, Mr. Bova diagnoses and, with surgical aplomb, exposes the patterns of evaluating which he sees as characteristic of leaders in the above mentioned fields, patterns of evaluating which may already have achieved the status of social pathology. As he notes in his first editorial, "The amount of money that this nation spends on bubble gum would produce a practical [energy efficient] hydrogen system." Something to chew on. Ed.

ENERGY MARKETPLACE

Ben Bova

In May 1965, Analog published a science fact article titled "Magnetohydrodynamics." It described how MHD generators were being developed to deliver more kilowatts per unit of input fuel, cleanly and efficiently, even from the dirtiest kinds of fuels, such as high-sulfur coal.

At that time, MHD generators were still in the laboratory stage, even though some of them were quite large chunks of apparatus. One of them had achieved a peak output of more than 30 megawatts for running times of a few minutes. Another, smaller, MHD generator had been run successfully for 200 hours continuously to demonstrate that the materials and high-temperature problems of MHD technology were in hand.

The next step was to build a pilot plant, capable of delivering about 50 megawatts while running continuously for 10,000 hours.

The pilot plant turned out to be a cantankerous beast, and it took several years to get the MHD generator in it to operate reliably. But, thanks to the foresight and daring of the electric utilities and the Federal Government, the scientists and engineers straightened out the bugs in the pilot plan and got it to perform reliably at about 58 percent efficiency -- a 45 percent increase in the efficiency over the best turbine generators in use.

With uncommon boldness, American industry pushed ahead and began to deploy MHD generators, aware of the fact that environmental and safety problems were holding back the deployment of nuclear electric generators, and that the US was becoming overly dependent on foreign sources of oil.

By a stroke of fate, the first commercial MHD generators went "on-line" late in 1972, just as the Middle East exploded with the "Yom Kippur War," in which Israel again squared off against Egypt and Syria. When Saudi Arabia and the other oil-producing nations enacted their famous oil embargo, Europe was nearly paralyzed, as was Japan. Fortunately, the US had abundant domestic oil supplies, and the advent of MHD generators had made it possible to begin using coal for our entire electrical production capacity. America could laugh at the Arab oil embargo, and did.

Today, in mid-1975, the Arab oil embargo has collapsed. The US is selling MHD and other advanced energy technology hardware and know-how to Europe and Japan. The American economy, which had shown signs of weakening because of gold drain and deficit of overseas trade balances, became strong and booming again because of the sudden spurt in exports of energy technology. Unemployment dwindled in the US, the standard of living rose, and even the angriest of minorities found that jobs and affluence did more for them than demonstrations and riots.

Sounds beautiful, doesn't it? It's a science fiction story, of course. An "alternate universe" that might have been.

Up until the time of that article in Analog in 1965, the MHD program was moving toward the kind of 1975 pictured in this alternate universe. But, as noted in the April 1974 Editorial, when the electric utility industry and the Federal Government were faced with the decision to invest in a pilot MHD plant, they backed off. The pilot plant was built, all right. But in Moscow, not in the US. It is still being tinkered with, and nowhere near the stage where MHD

can be said to be a reliable source of electric power.

If the power companies and the Government had shown some "foresight and daring" back in 1965, MHD could have been going on-line right now. As it is, after letting the MHD idea languish for more than five years, the industry and government began to re-investigate the concept and tried to start up the project again. It has been almost as bad as starting from scratch. The state of Montana announced late last year it will sponsor an MHD research institute at the Montana College of Mineral Science and Technology, and an MHD Engineering Test Facility -- a slow-motion version of the original pilot plant idea -- will be constructed in Montana. Too little, and probably too late.

So far, this has been the story of almost every avenue of research on better and more efficient energy systems. We have the basic scientific understanding and a good deal of engineering knowledge to make practical energy systems out of solar cells, hydrogen fuels, MHD, and other ideas. But the decisions that have been made, by private industry and Federal Government alike, have not promoted any renaissance in the energy R&D areas. In this issue's science fact article, Norman Spinrad discusses a plan of action that could make us an energy-rich nation, rather than a nation facing energy starvation. But if the past performance of the nation's decision-makers is any criterion, we'd all better start harvesting firewood.

It will take more than reorganizing Government agencies, changing AEC into ERDA while keeping the same people in the same jobs, to solve the energy problem. It will take more than rebates on new cars by an industry that has fought every step toward better, more efficient engines. (Recognize that, in the long run, the more efficiently an auto's engine runs, the less pollution it will emit. The Detroit barons who blame pollution controls for all the ills of the industry are being much less than honest, and they know it.)

The ideas are available. But they are either being ignored, or worse, "studied" to death by committees whose major function is the prevention of any change in the status quo.

In September 1973, Analog ran an article by William J. D. Escher on the use of hydrogen as a fuel for automobiles. In fact, Escher proposed a system that used hydrogen and oxygen, which would operate at great efficiency and emit nothing more offensive than plain water. In his article, Escher showed how a "hydrogen economy" could be developed, in which hydrogen -- taken from water -- could replace all the fossil fuels we now burn.

What has happened to the hydrogen economy? Escher and all his colleagues are still making their presentations, writing their papers, and making progress that is so slow that it is practically unmeasurable. Not because of technical difficulties. They haven't been able to get to the point where technical difficulties begin to arise! They're stalled close to the starting line because they cannot get funding adequate to the scope of the problem. The amount of money that this nation spends on bubble gum would produce a practical hydrogen system. The amount of funding that goes into spare parts for one type of aircraft turbine engine could probably produce a hydrogen demonstration project that could test out the engineering problems of handling liquid hydrogen over continental pipelines. But that money is not forthcoming.

In Texas, where perhaps you'd least expect it, something valuable is being started. Southern Methodist University's Institute of Technology has proposed setting up a floating platform off the Texas coast to use the temperature differential between surface and deep water levels to generate energy. Moreover, the proposal has attracted the interest of the Free People Foundation in Dallas, which is trying to help raise funds for the project.

The Free People Foundation is the creation of Humberto Rodriquez, a Cuban exile who has unbounded faith in what he calls "people's capitalism" and the energy to try to put his ideas into practice. In essence, Rodriquez wants to start a form of economic cooperative program that will concentrate on solving the problems that are not being solved by existing private industry or Government agencies.

The off-shore energy platform is a case in point. None of the power companies appear to be willing to back it; neither will the oil companies.

The basic idea is to set up the platform some 35 miles off the Texas coast, and use a propane heat cycle that is driven by the differences in temperature between the sun-warmed waters of the surface, and the much colder waters of the bottom layer. Preliminary estimates indicate that for a capital investment of about 445 dollars per kilowatt of plant capacity, the platform could be developed to power an aluminum smelting plant. By 1985, according to Rodriquez' figures, the plant could be turning out 550 megawatts, at a capital cost of 245 million dollars.

This electrical energy could also be used for dissociating water, to provide hydrogen for fuel (as well as oxygen).

None of this technology is beyond current engineering capabilities. Many people have worked out the propane cycle for utilizing water temperature differences to drive a turbo-electric generator. The technology is there. What is lacking is the money; or rather, the decision to go ahead by those who can provide the funding.

The fundamental problem seems to be the lack of a free marketplace where new technological ideas can find financial backers. And this kind of problem goes much deeper than the energy crisis. It has become a basic problem in our democracy. There are precious few free marketplaces left, whether they be for oil, automobiles, groceries, steel, electric power, or ideas on how to solve the political, social, and economic problems we face.

Most of the major industries in the US are controlled by a handful of very large corporations. In each industry, the decision by one major corporation to raise prices is immediately followed by a similar price rise among all the others. There is no previously arranged agreement, as such, which means that the Government cannot prosecute the corporations on conspiracy charges. It's simply a case where the corporations can, within very broad limits, set whatever prices they choose, and the consumer will have to pay. When there are only a dozen or fewer producers in a key economic area, such as food , energy, or basic metals, they can regulate prices very effectively without breaking any laws.

Certainly the corporations bend every effort to convince the public that they are helpless to prevent this price rise. They point to adamant Arabs, or clumsy government bureaucracies, and with some justification. But the simple fact is that if the major oil companies began charging a dollar a gallon for gasoline, the consumption of gasoline in the US would hardly decline at all. We are a mobile society. Take away our automobiles and most of us cannot get to work, or to the supermarket, the doctor, the shopping center, the church, or even to the playground, in many cases.

The top dozen or two corporations are the real decision-makers in the US. They do more to elect Presidents and Congresspersons than any other individuals or groups. If we don't have MHD generators turning our abundant coal supplies into clean electricity, if we don't have a hydrogen economy moving us away from a reliance on fossil fuels entirely, if that platform does not get built in the Gulf of Mexico, it's because the large corporations want things that way and the people of this nation haven't found a way to make their will felt.

The energy crisis shows that we desperately need a free marketplace of ideas, and the strength and foresight to back several contending approaches to new energy technology. The same kind of management and boldness that produced ICBMs in the Fifties and put men on the Moon in the Sixties could turn the energy crisis into an economic bonanza for the United States. But we are more apt to get gasoline at five dollars a gallon before we get that kind of free marketplace. . . .

THE BROKEN PROMISE

Ben Bova

Step back in time thirty years. Read the exciting, optimistic reports about nuclear energy that filled the pages of Astounding Science Fiction and other magazines in the late 1940's. Nuclear power, so long one of those dreams that science fiction people cherished, became a reality. Nuclear weapons won World War Two. Nuclear power plants were going to transform the postwar world into a new era of peace and plenty for all. The average citizen was stunned by this stupendous new scientific breakthrough. Those wild-eyed science fiction fans had been right, all along! One of the "fall-out" results of the newly-born Nuclear Age was that science fiction became respectable -- briefly.

It's interesting to note that, while the popular press of the time was eagerly quoting the Atomic Energy Commission's glowing reports of nuclear research progress and the inevitability of converting our entire electric power industry to nuclear power plants, John Campbell was one of the few voices of moderation. While he gladly pointed out the tremen-

dous new theoretical capabilities of nuclear energy, he continuously cautioned that practical engineering developments always go slower and usually fall short of theoretical limits.

Today, thirty years later, that glowing promise of a clean, power-rich, bright new nuclear world lies in shambles. Energy starvation faces us. Nuclear power plants produce only about two percent of the nation's total energy. And even in the face of continued shortages of fossil fuels, every indication is that nuclear power plants will be producing no more than ten percent of the nation's electrical energy between now and the end of the century.

Why? What happened to that bright promise? The energy of the atomic nucleus is still there; it hasn't disappeared. The scientific knowledge and engineering skills are still with us; we haven't lost our brainpower. Why don't we have vast amounts of nuclear energy at our command?

Digression Question: What are three traits common to the government of the Roman Empire, circa Third Century AD, and the government of Nazi Germany?

Answer: (1) Large governmental bureaucracies that made it increasingly difficult to carry out administrative policies; (2) growing isolation of the governmental leaders from the real world; and (3) collapse and disintegration.

Conclusion: The death of societies is caused not by internal decay, moral turpitude, foreign invasion, or collective brain damage due to heavy metal ingestion. It is caused by strangulation, from the red tape generated by self-perpetuating bureaucracies.

The science fact article in this month's issue details the sad history of the nuclear rocket development program. Despite the desires of many government leaders -- including the President who initiated the Apollo program -- despite the years of toil from thousands of scientists and engineers, despite the obvious benefits that nuclear rockets would yield, there is no nuclear rocket engine today. A series of "safe" decisions led to death. By strangulation.

It is popular today, especially in the power industry, to blame overly-conservative environmentalists and overly-frightened "laymen" for the very slow growth of nuclear power plants. The moguls who run the power industry, and their public relations flaks, are quick to point to environmentalists' "alarmist propaganda" about the dangers of nuclear power plants. They shake their heads, more in sorrow than in anger, at the "scare tactics" used by citizens who don't want nuclear power plants in their communities. They gravely assure us that nuclear power plants are completely safe and reliable, and the only reason we don't have more of them is because a handful of crackpots and fear-mongers have riled up the hoi-poloi.

Nuclear power plants are safe. Far from foolproof, though. It's true that there's more stray radiation coming from the pile of coal outside a fossil-fueled power plant than coming out of a nuclear power station. The environmentalists have overstated the dangers from radiation leaks and potential catastrophic breakdown of the reactor's safety systems. And a psychologist might wonder if the widespread public aversion to nuclear power plants has any link to deep-seated unconscious guilt feelings about Hiroshima.

But if we look at history instead of press releases, two facts become evident. First, although nuclear power plants are quite reasonably safe to operate, they are nowhere near as safe as they could be made. Second, the anti-nuclear activists were forced to raise their voices to a nearly hysterical pitch, mainly because the industry-government bureaucracy refused to admit to the public that there was any possibility of harm coming from nuclear power plants.

For decades, the official reaction from the Atomic Energy Commission and the electric power industry has been, "Everything's fine; trust us." This, while they plow ahead with a game plan that had not been altered since the late 1940's. "Trust us." Despite the fact that the bureaucracy gave every outward appearance of ignoring the real world entirely.

The basic game plan for nuclear development went ahead as originally conceived. Uranium-fueled power reactors were developed and put into use in power generation plants. The gaseous diffusion technique for enriching the natural ratio of Uranium 235 to U238 was chosen as the best way to provide the enriched fuel that the power reactors required. Research was pushed on the breeder reactor, which could not only produce power but would "breed" high-grade fissionables as a byproduct for use in other reactors.

The nuclear power generation plants have been plagued by all sorts of engineering problems, including unexpected cracks and hollows in the uranium fuel rods. The gaseous diffusion plants are enor-

mously expensive and complex. The breeder reactor will produce enough plutonium to potentially poison the entire planet. And the radioactive waste products of the reactors will be a "garbage" problem for millennia.

But no matter. That was the plan, and that's the way the bureaucracy marched on. Doubters within the bureaucracy were hushed up or ignored. Environmentalists and questioning citizens were blandly patronized with a favorite phrase of tyrants: "We know more about it than you." When asked to share this superior knowledge, the bureaucrats declared it to be classified information.

So the doubters raised their voices to an hysterical pitch. And the power companies began to find that nuclear power plants didn't perform at the estimated efficiency, and were hideously expensive to build. And the Arabs forced our so-called "leaders" to scrutinize our entire energy situation.

Two specific examples of the bureaucracy's attitude of "Don't bother us, we know what we're doing":

An important facet in the economics of nuclear power plants is the cost of producing enriched uranium to fuel the reactors. In its natural state, uranium ores don't have a high-enough amount of the easily-fissionable U235 to be useful as a practical reactor fuel. The trick is to extract U235 from the natural ore, and then add it to the natural mix of U235/U238, thereby providing an enriched fuel. Gaseous diffusion is one way to do this. Another technique involves centrifugal separation of the two isotopes.

A third possibility is to use a laser beam to separate the U235 isotope from the U238. Tunable lasers can produce the precise wavelength of laser energy to excite the U235 atoms in a gaseous mixture of U235/U238. The U235 atoms are ionized by the laser energy, while the U238 atoms are not. The ionized atoms can be collected by conventional mass spectrometer techniques, and then used to enrich fuel samples at a fraction of the cost of the gaseous diffusion methods.

This technique was developed, and demonstrated, at Avco Everett Research Laboratory nearly five years ago. Avco and Exxon Corporation formed a jointly-owned organization to push this new technology further. Their aim is to make laser-driven uranium enrichment a profitable venture. Success will mean much cheaper enriched uranium, and the slight but real possibility of obviating the need for the breeder reactor.

When news of their success was announced publicly, it caused hardly a ripple in the technical press, and was roundly ignored in the public press. Perhaps this suited Avco and Exxon; too much premature publicity frightens corporate executives.

But in 1974, two AEC-sponsored laboratories -- at Livermore and Los Alamos -- announced similar achievements in laser isotope separation. And the full power of the government's publicity machine splashed the story through the technical, trade, and public news media. In none of these releases was the previous work at Avco mentioned. None of the newspapers and magazines picked up on the earlier Avco/Exxon announcement. Only the Wall Street Journal, in a followup story in May 1975, connected the government labs' work with the earlier success of the Avco/Exxon team.

"Not invented here" is a dangerous attitude among scientists and their administrators. The next step is to convince yourself that since your group didn't invent it, it hasn't been invented at all. Closed eyes lead to closed minds. Or perhaps vice versa.

An even bigger, snub arose when KMS Fusion, Inc., announced it had succeeded in creating a pulsed thermonuclear fusion reaction, using lasers (again!) to implode microscopic-sized pellets of deuterium.

Since the end of World War Two, the governments and universities of the world's major nations have struggled to make a fusion reaction. For most of this time, they tried to produce a continuous fusion reaction in a star-hot plasma of deuterium that was suspended in one form of "magnetic bottle" or another. None of these attempts has worked. The ionized plasma always leaks through the containment of the magnetic field and ruins the experiment.

About five years ago, when lasers began to achieve the power levels necessary to trigger fusion reactions, several AEC laboratories started efforts in laser-induced pulsed fusion. So did KMS Industries, Inc. Their subsidiary, KMS Fusion, accomplished what Livermore and Los Alamos and all the world's best fusion scientists failed to accomplish: KMS produced fusion reactions.

The bureaucracy hinted mightily, once the news was out, that KMS was wrong. That the experiments were inconclusive. That the data was too scanty to

be believable.

Over the past year, the weight of scientific evidence has proved that KMS is indeed making fusion reactions. The scientists examined KMS' data and agreed that it was valid. The bureaucrats finally capitulated by giving KMS a modest government contract to produce data on laser-pellet interactions.

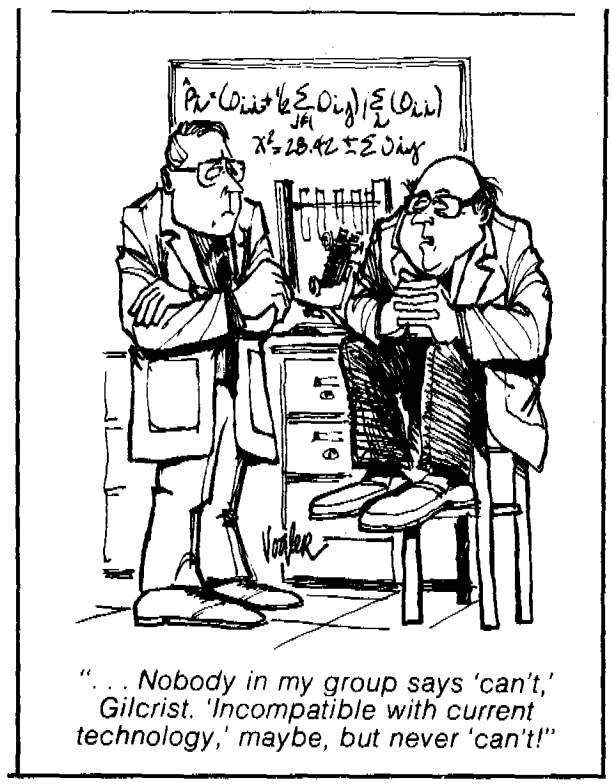
Thankfully, in science it's the data that counts. Not opinions. Not official attitudes. Not press releases.

By early 1975 it had become painfully evident that the old AEC "game plan" was not scoring for anyone. The entire lemminglike march from gaseous diffusion plants to breeder reactors slowly ground to a halt. The Atomic Energy Commission officially reorganized into the Energy Research and Development Agency. ERDA's chief is Dr. Robert Seamans -- a scientist and administrator who comes, significantly, not from the nuclear research community (as AEC's leaders did) but from the rather successful world of missiles and space exploration. One of Seaman's first actions has been to recommend a slowdown on breeder development, because of its enormous potential environmental threat, and more emphasis on solar energy research.

It would be curious if the laser fulfilled the original promise of the atom. Laser-driven isotope separation plants might make it possible to provide enriched uranium for power plants without the necessity of deploying breeder reactors and playing Russian roulette with extremely dangerous plutonium. Laser fusion might end energy shortages forever, and could begin to make an impact well before the end of this century.

But none of this will happen if the nuclear bureaucracy is allowed to continue its old ways. That attitude has resulted in mammoth public resistance to nuclear power plants, and poor technical decisions based on obsolete ideas.

The broken promise of nuclear energy can be mended and made bright and shining again. But only if we insist on it.



". . . Nobody in my group says 'can't,' Gilcrist. 'Incompatible with current technology,' maybe, but never 'can't!"

Cartoon courtesy of
Industrial Research/Development