manities, no less than the old, would have the virtues of tolerance for ambiguity, of patience with complexity, and of multiplicity of perspective (if not of explanation). Historians, for example, have much to teach to futurists; we have yet to see that "global village" promised for a new "technetronic era," and the reason why lies in national and cultural histories. Similar hindrances most probably lie in the way of realizing the "computerized future" we are promised. Humanists are accustomed to grappling with human experience in its emotional as well as in its analytical modes.

What would the new humanities look like? First, they would recognize the increasing coalescence of science and technology which is erasing the distinctions between theory and practice, knowledge and action, possibility and reality. Those distinctions underlie much traditional thinking about science and ethical values. They do not go far in helping, say, the Cambridge City Council. Second, they would acknowledge the corporate nature of science and technology, characterized by mission-oriented research carried out by large numbers of workers organized by the precepts of modern management. In contrast to the traditional image of the lone genius—whether a Newton, Darwin, Einstein, or Edison—many scientists today work in teams on parts of problems and rely on an intricate support system. Such organization alters the nature of scientific inquiry and the relation of the thinkers to the product of his or her thought. It also redefines the question of individual responsibility for results and their vital effect on society as a whole, and it raises the specter of the loss of moral agency by those whose decisions determine the pattern of our lives.

Third, the new humanities would take account of the successful adaptation of management techniques originally conceived for manual labor and for machine production into the area of mental labor. They would take account of how innovation itself has become a corporate enterprise—to the point where a company can boast that progress is its most important product—and would explore with that enterprise the nature and limits of such organization. Management is currently not a burning issue for humanists, but it will have to become one if the humanities mean to speak to the late twentieth-century experience.

Finally, they would confront directly the question of the social structure and the social construction of scientific thought and technological development: what should be the means by which society exercises control over science and technology? Analysis of the question, and especially of its extreme form, requires the joint expertise of scientist and humanist because, as Clifford Geertz has recently argued, the sociological modes of analysis used here take their lead from areas of humanistic, rather than scientific, inquiry.

The scientific workplace may be a good point of departure for the collaborative effort needed.[2] As discussed, the nature of modern science and technology has led them to incorporate such previously non-traditional elements as division of labor, organization into teams, and coordination through management. The corporate constraints of a defined mission with a deadline and the steady rate of innovation in fulfilling the mission have also become a part of these institutions. But matters of traditional concern to the humanist, such as a sense of purpose, the excitement of competition, the nature of leadership in scientific research, and the hazy line between challenge and exploitation, should also be of concern to scientists and engineers, especially as they progress to managerial responsibility. At the foundation of such matters lie questions about values: both new and old, personal and public, and technical and social ones.

Before such issues can become part of continuing education in general (or, for that matter, part of traditional education), they must become part of the continuing education of professional scientists, engineers, and humanists. Humanists must have means of staying abreast of today's technical reality. Scientists and engineers must have means of exploring the non-technical realities of their enterprises. Such education requires cooperation in addition to common study. Creating forums for mutual continuing education is both a need and an opportunity.

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NOTES

1. Introduction to the fall 1977 issue of *Daedalus*.

2. This notion is supported by Tracy Kidder, *The Soul of a New Machine* (Boston, Mass.: Little Brown, 1981).

CONSUMER AFFAIRS

Irradiated Foods

Ellen Berman

If recent recommendations made by the Bureau of Foods' Irradiated Food Committee are approved, the next strawberry or potato you eat may have been treated with gamma radiation. The committee submitted its findings in August 1980 to the Food and Drug Administration (FDA), which has accepted its safety evaluations and is recommending that all foods treated with up to 100 kilorads (or 100,000 rads) of radiation be approved for human consumption, without prior tests for toxicity. FDA is also outlining testing procedures and regulation criteria on irradiated foods exceeding 100 kilorads, approval for which may have to be secured through petitions.

Although never used commercially in this country, irradiation processing was approved in 1960 for wheat, wheat flour, and potato exports. Three sources of radiation—X-rays, high energy electrons from electron beam accelerators, and gamma radiation from cobalt-60—produce a variety of powerful preservation effects, such as sprout inhibition, insect control, pasteurization, and food sterilization. More specifically, they prevent food spoilage by destroying pathogenic micro-organisms such as salmonella: disinfest cereals, peas, beans, lentils, and dried food of insects: extend the shelf life of fresh fruit, fish, vegetables, and meats; and destroy pests in tropical fruits. Potentially, irradiation could replace harmful substances, such as nitrite, which are presently used as bacon and cured meat preservatives.

FDA's Advance Notice of Proposed Procedures for the Regulation of Irradiation of Foods for Human Consumption[1] accepts the Bureau of Foods Committee's claim that when appropriately applied, irradiation "does not induce any detectable radioactivity in foods when measured by methods that can easily detect the presence of radioisotopes that occur naturally in foods." FDA is also considering the report of the Joint Expert Com-

mittee on the Wholesomeness of Irradiated Food (JEFCI), sponsored by the Food and Agriculture Organization, World Health Organization, and the International Atomic Energy Agency. In 1976, JEFCI recommended that strawberries, papaya, chicken, and, provisionally, rice, onions, and cod-redfish be accepted for treatment at levels below 100 kilorads.

At their most recent meeting in Geneva in the fall of 1980, the three organizations concluded that, "at present, for approximately 95 percent of food items to be treated by irradiation, the dose needed is much lower than 10 kilogray (1 megarad, or one million rads)." Twenty-two countries, among them Bulgaria, Canada, France, Hungary, the Netherlands, and the USSR, have already given clearance for unconditional or provisional irridation conservation for such foods as deep-frozen meals in hospitals, cod and haddock fillets, chicken, spices, strawberries, mushrooms, onions, and potatoes.

The Irradiated Food Committee's five-week study, however, did not include complete evaluations of toxicological data; neither did it focus on any studies which have demonstrated the safety of irradiated foods. Rather, it concentrated on *how* that safety might be scientifically determined, and based its recommendations on *projected* levels of human exposure. It should be noted, however, that tests being conducted by the U.S. Department of Agriculture (USDA) have thus far confirmed no manifestations of mutagenic activity.

The chief concern has been the possibility of chemical changes in the nutritional quality of food substances. Particular nutrients are sensitive to ionizing radiation, but this can be controlled, upon observation, by dose, temperature of the product being irradiated, and the quantity of oxygen in the products during processing. Published studies, though, reveal demonstrated losses upon irradiation of the following vitamins found naturally in foods: carotene, thiamin vitamins E, C, B-6, and B-12. The suggested criteria for determining nutritional adequacy and safety of irradiated foods are generally the same as policies established in 1967, although the problem has not been erased.

Another question is the extent of consumption of irradiated foods, as it relates to relative proportions found in the "average" human diet. But, because of changing U.S. dietary habits, the range of items that could be approved for irradiation, and the percentages of those that would actually be irradiated, as the report states, "it is difficult to predict with any degree of accuracy the exact amount to which the population will be exposed in the foreseeable future. A worst-case estimate would predict that 40 percent of the human diet would consist of irradiated foods."

Several factors, however, could mitigate such high rates of dietary exposure: It will take many years before mass commercial processing can be developed; even foods approved for irradiation will, more than likely, continue to be processed by more economically competitive techniques, such as canning and refrigeration; consumer acceptance may initially be low, due to the connotations of the term "irradiation."

The Bureau of Foods admits that a public education program on irradiation safety instituted by either the government or private industry "may encounter considerable resistance on the part of the consumer." Thus, while irradiation may not receive immediate widespread acceptance as an alternative food processing method for many years, thereby sweeping the "worst-case estimate" out of view, it is nevertheless not outside the realm of possibility.

FDA has expressed its own concerns over the influence the following issues might have on the agency's final decision: the need for labeling of irradiated foods; the environmental impact of irradiated foods or of the process itself; and the economic impact of sound manufacturing-process regulations and labeling. The dominant perception on the part of FDA, however, is that "any regulations based on this advance notice would have beneficial economic impact on manufacturers due to reduced testing requirements."

On the other hand, Richard Hall, vice president of science and technology for McCormick and Co., Inc., the spice and canned goods packer, says that while FDA's guidelines are a step in the right direction, the proposals "don't permit any useful application," because they do not conform to JEFCI's recommendation that up to one megarad of irradiation should require no further testing. Hall notes that the company will argue strongly that there is "no more need to label these foods than for any other fumigant."

The proposals have been further complicated by proposals of the Environmental Protection Agency concerned with ethylene dibromide (EDB), a hazardous chemical that irradiation could replace. In low doses, EDB has been shown to cause gene mutations and reproductive changes. EDB is used primarily to disinfest southern and southwestern fruits that are exported to Japan. It is also used on imported Latin American, Mexican, and Puerto Rican fruits, and on silo-stored grains. The chief danger from EDB is in occupational exposure, in the fumigation treatment chambers and warehouses. When used in farm wheat-storage elevators, the problem is compounded by EDB residues getting permanently stuck in milling machinery, where it penetrates wheat that will be consumed. It is even more acute in older storage bins on smaller farms.

Farmers are understandably concerned about the initial installation and start-up cost of switching from chemical treatment to irradiation, despite experts' claims that it would be cheaper than spraying. "But," says Joe Panetta, EDB project manager with EPA's Special Pesticide Review Division, "in light of the health risks to the general public of EDB, the cost would have to be much higher for irradiation if we were to seriously consider their complaints." Still, EPA has delayed a proposed ban on quarantined EDB-treated citrus until 1983 "to allow time to build the irradiators." Some researchers feel there will be competition among large irradiating firms once it is legalized, as identical processing facilities are capable of multiple applications. Many medical instruments are now sterilized via radiation, and kidney transplant patients and others often depend on sterilized foods for their survival.

The history of irradiation research has been erratic at best. The U.S. Army began investigations on food irradiation 25 years ago; since that time, over $55 million has been spent on research. The idea was to develop a safe process for high doses of irradiation necessary for sterilization and preservation of meats that could be used for troop subsistance and K-rations. Once the Army had established that the technology was feasible, testing being conducted on bacon and ham was discontinued when the Delaney Amendment to the Federal Food, Drug, and Cosmetic Act was passed in 1958, which prohibits the use of any new food additive until the sponsor establishes its safety and FDA issues regulations specifying conditions of safe use. (Radiation was at that time officially categorized as a food additive.)

During the last ten years, the Army had focused on perfecting the process and proving that irradiated foods remained wholesome, safe, and non-carcinogenic. In 1978, the Army came to the conclusion that it was not their place to conduct studies with such a potentially broad consumer orientation. All irradiation studies were then turned over to USDA, which now monitors the research of Roltech Service, Inc., a contractor-testing company

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studying the effects of irradiation processing.

Once these data have been collected, USDA is expected to present a clearance petition to FDA, specifying testing procedures and the effects of given amounts of irradiation on particular foods. The petitioning process could be endless, if a different petition is required for each possible foodstuff. However, according to Colonel Dungan, the coordinator of the Food and Nutrition Research Department of the Department of Defense, there is a distinct possibility the tests will be sufficiently comprehensive to encompass a wide range of foods for public consumption, and FDA could give "blanket approval for a whole class of products" after the Roltech data are presented in the USDA petition.

Dr. Eugene Wierbicki, group leader for Food Irradiation Research at the Eastern Region Research Center of USDA, also hopes that individual food testing will not be a requirement in FDA's final guidelines, and, as there are no foreseeable difficulties in the remainder of the tests, he believes the high dose treatment for sterilization purposes, will be cleared. "I suspect," Wierbicki comments,

that the minimum FDA approved dose will be raised once they see the comments on the Advance Notice. The identical temperature and quantity of radiation will apply to foods of similar composition. Nobody can afford four to six million dollars for one animal study. It's not fair to ask taxpayers to pay for all these studies.

In response, the consumer might ask if is fair to subject the population to a process where there remains even the remotest possibility of side effects that millions of dollars could not possibly remedy?

FDA's research has been completed and is now being analyzed. It is currently drawing up proposed regulations for low dose (less than 100 kilorads) and spice applications of radiation. These may not be finalized until 1983,and may not go into effect until a year later. In the interim, consumers should be made aware of the facts collected to date about irradiation, an issue that is, ultimately, a matter for serious consumer concern.

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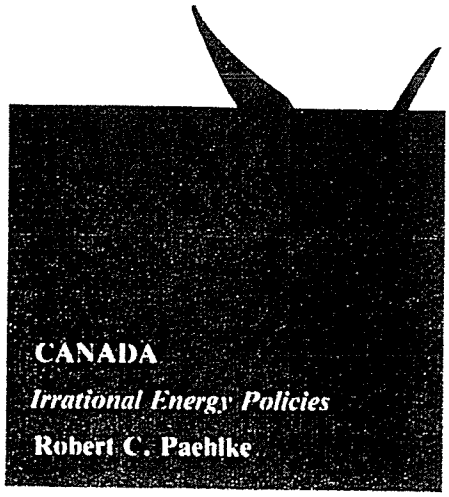
NOTE

1. 46 **Federal Register** 18992-18993, March 27, 1981. Further information about FDA's Advance Notice can be obtained from Clyde Takeguchi, Bureau of Foods, FDA, 200 C Street, S.W., Washington, D.C., 20204.



CANADA
Irrational Energy Policies
Robert C. Paehlke

The 1980's thus far would leave rational, non-Canadian observers of the country's energy scene perplexed at best. Luckily, Canadians were conditioned for irrationality by the 1970s, which saw their nation move from a situation of an enormous energy surplus into a "looming, desperate energy shortage" virtually overnight. This sort of training, in retrospect, seems the only background appropriate for Canada's current energy policies and dilemmas—realities of the 1980s.

Despite the "looming desperate shortage," recent weeks have seen the collapse or at least postponement of three major energy projects here: the Cold Lake (Alberta) heavy oil plant, the Alsands oil sands plant, and the Alaska Highway natural gas pipeline. All have fallen victim to the combination of high interest rates and increasing doubts that oil prices will continue to rise at an annual rate of 5 percent in real terms. However, upon looking a bit deeper at these situations, a large number of questions present themselves.

Canada's conventional oil reserves are presumably now beginning a steep decline. Courageously, if not madly, in the face of this possibility the federal government is committed to eliminating oil imports by 1990. At present, the country imports a large fraction of its total oil consumption to eastern Canada, and exports a similar but declining fraction from western Canada to the United States. Thus far, the Canadian government has in large measure pinned its plans for reducing exports on oil sands and heavy oil development; this hope now seems lost—certainly for 1990.

The next best prospect for energy independence appears to be the expanded domestic use of Canadian natural gas; to that end Ottawa has offered subsidies to companies and individuals who convert "off oil" and onto gas. (For more information on Canada's "Off Oil" program, see "Overview: Canada," *Environment*, June 1981, p. 4.) Even with the collapse of the Alsands plant, which had been so desperately promoted by the federal government, the National Energy Board seems to be in the process of sharply increasing the natural gas *exports*. The government itself seems determined to weaken the next best prospect for achieving and maintaining its stated policy goals.

Even more baffling perhaps is the fact that the Canadian government very much wants America to bring its natural gas from Alaska to the lower 48 via an overland Canadian pipeline. Since the Berger Commission sank the Mackenzie Valley route for that pipeline and the Alaska Highway route was approved, Canadian environmentalists and native peoples have had few strong objections to such an effort. In fact, if Alaskan gas could help slow the expansion of coal use in the eastern United States, the Canadian environment might, on balance, be *enhanced* by the project. Such a pipeline would supply some employment opportunities to Canadians and presumably allow the United States to further reduce oil imports from abroad. However, selling Canadian natural gas in place of the available but undelivered American product would not encourage pipeline construction.

In light of Canada's weak balance-of-payments situation, the only explanation for the expansion of gas exports must be with political pressure from Canadian and multinational gas companies. Publicly, the Canadian government still claims to be seeking energy independence by 1990. Rising demand has been all but eliminated by the recession/conservation combination; the next most likely source of supply after natural gas—offshore and frontier oil and gas—seems unlikely as a short term (pre-1990) prospect.

On another front, in Ontario—where electrical energy demand is actually declining—nuclear capacity continues to expand even in the face of staggering interest rates. The timetable for expansion dates back to a time when electrical energy demand was rising, and was forecast to continue to rise at 7 percent per annum. And, the Ontario government has never revised its assertion that the massive new