TECHNOLOGY and SOCIETY

CONTRIBUTED PAPERS, REPORTS, REVIEWS, AND CORRESPONDENCE OF THE COMMITTEE ON SOCIAL IMPLICATIONS OF TECHNOLOGY

EDITOR: NORMAN BALABANIAN **VOL. 7, NO. 25 MARCH 1979(USPS 321-090)**

OLD SOL COMES OF AGE—NUKES SUSPECT

With every passing day, it is becoming increasingly clear to all thoughtful people that more and more of U.S. energy needs must be satisfied by the sun—and sooner rather than later. (See "Solar Energy and Conservation" by D. Redfield in the September 1978 issue of TECHNOLOGY and SOCIETY.) A short decade ago the amount of attention—and funds—devoted to solar energy research and development was minuscule. Since the great awakening of 1973, the situation has gradually changed, although not without foot dragging on the part of some and active opposition from many detractors of solar energy.

Those with the closest association with existing energy sources and the strongest commitments to "high energy" have been among the greatest detractors. Among these is Rep. McCormack of Washington, Chairman of the House Science and Technology Subcommittee on Advanced Energy. A few months ago he was quoted as saying that "Solar cultists are talking about 20 percent of the nation's energy needs by the year 2000, but we'll be lucky to get 4 percent. These solar cultists want the U.S. to commit [energy] suicide." Of course, it is possible for a person in his position to try to make his percentage prophecies become self-fulfilling.

Among those that displayed a less than sanguine attitude toward solar energy in the past was the IEEE Energy Committee. But after a great deal of study and analysis the Energy Committee has revised its position and has come out "in support of vigorous development and deployment of solar energy systems;" it recommends that "the development and utilization of solar energy be given the same high priority as conservation in national energy policy." At its last meeting (before this went to press), the Committee adopted a position statement on solar energ and urged it up upon the Board of Directors for adoptio as an IEEE position. (The position statement with appendices is reproduced in this issue). This is a thoughtful and farsighted position. Readers are urged to contact the IEEE Board of Directors to express their views on the issue.

As this goes to press, there has been no reaction from the White House to the report of the interagency Solar Energy Policy Committee—whose members hardly qualify as "solar cultists." (See News, Notes and Comments.) The Committee's conclusion that, within 20 years, solar energy could be providing 20 percent of the nation's energy needs, assumes continuing increases in the price of oil, equivalent to a doubling in oil prices. With Iranian oil now selling at almost 50 percent above the price in effect when the Committee wrote its report, and with the prospective deregulation of domestic oil, the doubling assumptions may be more than justified.

The scenario is also changing for nuclear power. At the time of the great awakening of 1973, the Atmoic Energy Commission predicted 240 GW (gigawatts) of installed electricity-generating capacity by 1985. (That is the equivalent of 14.3 quads—quadrillion BTU—out of a total expected energy supply of 86.7 quads; that is, 16.5 percent of total U.S. energy needs in 1985 from nuclear stations.) By last year the Department of Energy prediction for 1985

IN THIS ISSUE

dropped from 240 to 110 GW. Since, in mid 1978, nuclear plants were furnishing only 48 GW of power, even this prediction is unlikely to be achieved. It has been estimated by Earl T. Hayes, former Chief Scientist at the U.S. Bureau of Mines, that installed nuclear capacity will not exceed 185 GW (11 quads) by the year 2000. Since the total energy supply expected to be available to the U.S. in that year is 95 quads, this means nuclear energy would be supplying less than 12 percent of total energy in the year 2000. This is far less than the 20 percent estimated for solar energy.

And if one were to look beyond the year 2000, it is abundantly clear that the percent of solar to total U.S. energy will be increasing rapidly while the percent of fission to total energy cannot help but go down. It is, therefore, difficult to understand why there still exist disinterested individuals who would strongly promote further deployment of nuclear energy. I would like to invite someone who can illuminate this question to submit an article of appropriate length for publication in a future issue.

NORMAN BALABANIAN
Editor

TO OUR READERS

With this issue, the editorship of TECHNOLOGY AND SOCIETY is changing hands. Frank Kotasek, who served admirably as editor for the last two years will stay on as Associate Editor, and provide the publication the benefit of his long experience.

As Editor, I would like to invite you to contribute articles, items of news, reviews of books, correspondence—and even poetry—on issues relating to the interactions of technology and society. Some areas of special focus are:

- Bioelectronics and medical technology
- Effects of automation on life and work
- Issues related to energy
- Issues related to usage of materials
- Issues related to the environment
- Responsibility of engineers for defective products
- Engineering ethics and professional responsibility
- Engineering education for responsible and ethical conduct
- Information technology and privacy
- Weapons development and the arms race
- Application of systems engineering to societal problems.

IEEE TECHNOLOGY AND SOCIETY is published quarterly by the Committee on Social Implications of Technology of the Institute of Electrical and Electronics Engineer, Inc. Headquarters: 345 East 47th Street, New York, NY 10017. Subscription price: $2.00 per year, IEEE members only.

John Fielder

One consequence of the engineering profession's increased interest in ethics and the social effects of technology is the involvement of philosophers in these areas. Philosophers and engineers are now beginning to work together on ethical and value problems that arise in engineering, just as philosophers and the medical profession have worked together on similar problems. Although this collaboration is somewhat belated, it will unquestionably be beneficial, for the ethical problems faced by engineers are generally mixtures of both philosophical and technical issues. They can only be effectively understood and resolved by applying the different kinds of skills and knowledge possessed by engineers and philosophers.

My participation in engineering ethics is in the area of teaching. Two years ago the Dean of the College of Engineering, Dr. Robert Lynch, asked the Philosophy Department to work with him in developing a course on engineering ethics to be taught by a philosopher. A group composed by myself, Dean Lynch, and Dr. Edward Wallo (Civil Engineering) worked out the basic framework for the course which I taught in the Fall term of 1977. The result of our efforts may be helpful to engineers because it provides a somewhat different perspective on engineering ethics, one that includes philosophical analysis as well as more traditional material. I hope it will also stimulate and encourage the developing dialogue between engineers and philosophers.

FORMAT OF THE COURSE

In designing the course in engineering ethics, we began with the various codes of ethics. There are two main reasons for this. First, the codes provide a convenient focus for a number of important issues which would be taken up in the course. Hence the codes served as an organizing principle, generating questions that introduced important areas of inquiry. Second, the codes are the official expression of the profession's view of proper ethical behavior for engineers. Since the codes, in effect, *define* ethical conduct for engineers, they are a logical place to begin a course dealing with ethics for engineers.

Given the existence of codes of ethics, a number of questions arise. They formed the basic elements of the course.

1. Why do engineers have codes of ethics?

The short answer to this is: because they are professionals. The existence of a code of ethics points to their professional status and introduces a discussion of professionalism in general and of engineering in particular. I include a brief outline of the history of professional engineering organizations in the United States and an analysis of the concept of professionalism and its criteria. Perhaps the most important feature of this discussion is the conflict between professional goals and the demands of the organization in which the engineer is employed.

The author is Professor of Philosophy, Villanova University.

This is the first question students ask. Unfortunately it also has a short answer: nothing. Since most engineers need not be licensed to practice their profession, they cannot lose their ability to do engineering work by unprofessional conduct. Expulsion from an engineering society is possible, but this rarely affects the engineer's practice. Other problems that stand in the way of enforcement are the difficulty and expense of conducting a fair investigation of alleged unethical practices, and the possible adverse effect on the tax-exempt status of professional societies that could result from actively disciplining members. Consequently serious ethical problems are adjudicated by the courts rather than professional societies.

3. What happens if you obey the code?

This is a much more interesting question, partly because what happens is less predictable, and partly because obeying the code may bring worse consequences than violating it. No doubt the built-in conflict between the demands of one's employer and one's professional obligations is well known to practicing engineers, but students tend to be unaware of it. They may be aware of some of the celebrated "whistle-blowing" cases involving BART or the Goodrich brake, and although these cases are useful for bringing out the problem of ethical conflict between engineer and employer, they have the disadvantage of portraying that conflict as one involving dramatic confrontations where one's job is at stake. However, most ethical conflicts are not so dramatic, and they provide a better model for handling this kind of situation. A number of cases in which engineers were able to finesse ethical conflicts, keeping their jobs *and* their self-respect, are more useful for preparing students for the inevitable ethical conflicts they will encounter.

I have obtained case studies of such incidents by sending students out to interview practicing engineers. In our discussion of these incidents we look for the kinds of procedures that allowed engineers to resolve their problems successfully. Generally we found that engineers who were *not* successful in resolving their ethical conflicts were unprepared, having given little thought to how they would handle such a situation; they did not discuss their problem with their friends and co-workers but kept it to themselves; they did not seek to discover a responsible person among supervisory staff who would be sympathetic to their problem; and they tended to see the problem in terms of relatively stark alternatives—informing the press and losing their job vs. doing whatever the supervisor asks. I treat the issue as a problem in design, for one must design a strategy to slip between those bleak alternatives. It is not as difficult as one might think, once you've worked through a number of cases. (I would appreciate any descriptions of problems of this sort that engineers would be willing to send me for use in my course. You need not use the names of persons or firms: I am only interested in the ethical conflict and how it was resolved).

An engineer who tries to live by his professional code of ethics faces a number of difficulties apart from ethical conflict with his employer. The language of the code is broad and requires a good deal of interpretation to bring it to bear on concrete cases. The NSPE *Opinions of the Board of Ethical Review* is useful for many cases. However there are ethical problems which don't seem to fit into the code at all. For example, one of the student interviews turned up the problem of an engineer who, while driving by a competitor's plant, noticed that he had a good view of some new structures being built. Since there is a good deal of information that can be gained just from observing a competitor's operations, the question arose as to whether it was ethical to do so under these conditions. The case is interesting because observing from your car is just the tip of the iceberg. What about stopping and taking notes? Why not take pictures? Is it all right to use an instamatic but not a 600 mm telephoto lens? What about renting a helicopter and flying over? Thus the casual observation as one drives to work raises a number of difficult questions concerning confidentiality of information. Granted, it is unethical to steal "private" company information, but how far does that privacy extend? Should one regard the physical structures of the company as private also? Nothing in the code provisions on confidentiality are much help on this kind of problem.

In cases like these engineers must create their own rules for ethical behavior because the code does not provide sufficient guidance. How is this to be done? Here is where a philosophical analysis is useful.

5. Philosophical analysis of the code.

The question of how to make an ethical decision when there is no code provision to guide you requires some understanding of the philosophical features of ethical decision-making. Although I cannot provide much detail here, an outline of the analysis follows:

a. Distinction between facts and rules. One's ethical decision will be in the form of a rule which states what one ought to do or not do in certain kinds of circumstances.

b. There are a number of possible rules that one might propose for a given factual situation, not all of which will be ethically correct. How do we choose among these different responses? One must have an ethical theory that tells you which rules are ethically correct. Just as a scientific theory will tell you which procedure will be effective for a certain type of problem, so an ethical theory will provide a test for proposed rules of behavior.

c. Alas, there are a number of competing theories as well, and their resolution involves a number of difficult philosophical problems. The time and effort such an inquiry would entail can be better spent on learning to use a single, philosophically respectable theory. The theory I use is that of Utilitarianism, which holds that the ethically preferable course is the one that promotes the greatest balance of good over evil consequences in the long run. (Students refer to this as the g/e index, so that the test for rating.)

Thus in the case of the engineer who raised the question about observing a competitor's plant, a utilitarian would consider the various alternatives in terms of the long run consequences for the profession and its clients, the public, and generally anyone who would be affected. This is not easy, and it is certainly possible to have different judgements about what those long term consequences are likely to be. But the theory does tell you what kinds of things are ethically relevant, and the difficulty of determining the consequences of our actions is partly the factual problem of predicting what will happen. However it is fairly easy to predict that the public esteem of the profession is not likely to rise if engineers participate in minor-league industrial espionage. Nor are the bonds between engineers likely to be strengthened by a very narrow view of what is private, confidential information. Thus we can see some bad consequences of a course of action, and unless they are counterbalanced by a greater weight of good consequences, the ethical engineer would refrain from spying on his competitor, even while driving to work.

6. Engineering and the impact of technology.

Just as an individual must consider the consequences of his actions, so also must the profession consider the impact of the technology it creates. Physicians have a responsibility for the health care system as well as the welfare of their individual patients. As professionals, engineers have a role to play in seeing that the technological innovations they produce are used in the public interest. Just what that role should be is a current topic of discussion, and it is essential that engineering students have an informed acquaintance with this area of professional responsibility.

CONCLUSION

I have attempted to balance theoretical and practical aspects of engineering ethics in my course. The emphasis is on preparation for the inevitable ethical problems that students will have to deal with when they become practicing engineers. Theoretical and historical material is introduced as something necessary to understand and proceed in solving the problem. This is not the only way to approach this topic, but it has the advantage of similarity to the approach used in many engineering courses.

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IEEE ENERGY COMMITTEE POSITION STATEMENT ON SOLAR ENERGY

The IEEE hereby revises and strengthens its position in support of vigorous development and deployment of solar energy systems. This revision is in recognition of advances that recent analyses have made in the various solar technologies and their prospective economics. There is increasing promise that renewable energy sources derived from the sun will be able to significantly alleviate our dependence on the limited resources of fossil and uranium fuels with consequent benefits to our economy, environment and national security. Therefore the IEEE recommends that the development and utilization of solar energy be given the same high priority as conservation in national energy policy.

Solar energy broadly refers to both the direct use of sunlight for heat or electricity generation and to the indirect energy that the sun provides by way of wind, falling water, ocean heat, and biological matter. Sunlight alone reaches the U.S. at 600 times the total rate of energy use, the winds carry somewhat less, and tropical oceans receive much more—all on a continuously renewable basis. These sources are not being exploited at nearly the levels that are possible. The technical feasibility of energy from all of these sources has been established, often in several technological versions. The developmental status of the various technologies is quite varied and separate comments on a number of them are presented in the accompanying appendixes. The following recommendations, however, are made to promote the timely realization of the promises of solar energy generally:

(1) Aggressive programs in research, development and demonstration should be pursued in all promising areas to advance the technologies, improve their net energy production, and reduce their costs.

(2) The institutional, economic and environmental consequences of eventual large-scale utilization of solar energy should be analyzed thoroughly.

(3) Public information programs should be increased to stimulate the understanding of solar energy consumers, manufacturers, and utilities.

(4) Costs of solar energy have been the main deterrent to its use. With the goal of making it more cost-competitive with conventional fuels whose prices are often artificially low, the IEEE recommends:

(a) establishment of vigorous economic incentive programs by federal, state and local governments to foster the use of solar energy during the early years of its growth;
(b) identification and reduction of institutional barriers that may inhibit the use of solar energy or increase its cost;
(c) the use of marginal cost criteria in comparisons used in establishing energy policies;
(d) encourage general use of life-cycle cost criteria by governmental adoption of this practice for its energy uses.

APPENDIX A TO IEEE SOLAR ENERGY POSITION SOLAR HEATING AND COOLING OF BUILDINGS; AGRICULTURAL AND INDUSTRIAL PROCESSES

Solar heat is now being applied for space heating of buildings, domestic hot water (the most cost-effective current use), and agricultural and industrial processing. Since these uses now consume well over one-fourth of U.S. energy, the potential for solar heat is very large, even if used for only a portion of these needs. In new buildings the benefits from inexpensive "passive" solar heating are particularly promising, and "active" solar space-heating systems are now becoming cost competitive with electrical heating systems in many parts of the U.S. Recent analyses show that present economic incentives will also make such active systems competitive with oil and gas heat in the near future. This area is also in a good position to benefit in the near term from demonstration projects and public information programs on both the technologies and life-cycle cost evaluations.

Solar cooling of buildings is technically less advanced and still in need of further development. There are several promising techniques that currently need vigorous development and testing; existing demonstration projects should be expanded and new ones initiated.

Solar heat for agricultural processing is growing in applications such as crop drying, food dehydration and greenhouse heating. In several cases, expensive propane gas and scarce natural gas are being replaced this way. Demonstration projects, information programs, and some economic incentives should promote substantial growth in this area.

Industrial process heat consumes large quantities of energy in a wide variety of applications. A significant number of these applications appear amenable to solar heat but this area appears not to be growing. Institutional barriers, particularly tax disincentives, are inhibiting the growth; technological factors are not currently dominant.

APPENDIX B TO IEEE SOLAR ENERGY POSITION
SOLAR ELECTRIC GENERATION

There are at least six distinct technologies capable of converting solar energy to electricity: hydropower, biomass combustion to drive turbogenerators, wind energy conversion, solar thermal energy conversion using turbogenerators, photovoltaics, and ocean thermal energy conversion (also driving turbogenerators). The developmental status, cost and suitability for base-load power generation are quite varied for these six options, but each has a potential for significant contribution to the nation's needs. The geographical regions for which different systems may be most appropriate are often complementary so a diverse mix of these technologies is likely to be desirable. Further analysis is needed on land-use constraints, energy storage requirements, and optimum use of these renewable resources in the context of full utility systems. Limitations on availability of particular resources must be accommodated by appropriate modifications in overall utility system design and operation, including consideration of storage requirements, generation mix and load management.

1. Hydropower

Although most large hydroelectric sites in the U.S. have now been developed, the many available small dam sites have the capability of generating appreciable additional base-load power at low cost. In addition, these "low-head hydro" systems have relatively short construction times and low environmental impacts. The greatest attraction for these systems will be probably be in the Northeast where much expensive oil is now used in electrical generation and electricity prices are among the highest in the nation. The only apparent technical need in this area is for domestic producers of suitable turbines.

2. Biomass Combustion

Wood is already being mixed with coal in a few power plants having large, conveniently located wood supplies. Fully wood-burning plants are being constructed in New England. In such cases the costs and air pollution due to the wood are low. The forest products industry already generates some of its electricity at low cost by burning its own wastes. The conversion of biomass to clean fuels (discussed in Appendix C) offers additional options for power plant fuel but those fuels may be more valuable for transportation.

3. Wind Energy Conversion Systems (WECS)

Opportunities for WECS extend over a broad spectrum of system sizes, from a few kilowatts to a few megawatts. Current capital costs are not much above costs of conventional systems and the smaller WECS appear to have promise of finding a commercial market in the relatively near term. The larger WECS are now a key area of emphasis in the national solar energy program wherein WECS of 200 kW are being demonstrated and 2 MW units are under construction. It is likely that numerous units of this type can be deployed into selected utility grids on a cost-competitive basis. Innovative combinations of WECS with pumped-hydro storage have considerable potential for base-load power in 17 Western states. This program appears to need only vigorous continuation.

4. Solar Thermal Energy Conversion (STE)

These systems concentrate sunlight to heat a working fluid that drives a turbogenerator. The heat may also be used for process applications and for the manufacture of fuels or chemicals. Thus "total energy," or cogeneration, systems form an important set of options with potentially better overall economics. Present STE systems use either a central receiver or distributed receivers. Although the distributed type now appears more costly, further development work seems warranted for possible use in small systems.

Central receiver STE systems are approaching the pilot plant phase with a 10 MWe unit to operate in a utility grid in Barstow, CA in 1981. Costs for such systems—chiefly the heliostat mirrors—need significant further reduction. Also, since such concentrating systems use only the direct component of sunlight (not the scattered skylight), they appear most suited to clear-air regions like the Southwest and West.

5. Photovoltaics (PV)

Currently, photovoltaic systems have very high costs, although there is substantial promise for cost reductions that could make them competitive in a number of applications within a decade. The modular structure of PV systems leads to such versatility in their use that many applications are in prospect. To realize the major cost reductions that are needed and that are projected, aggressive R&D programs are warranted. Promising candidates that should be pursued are flat-plate crystalline silicon modules, light-concentrating devices with silicon or gallium arsenide cells, and several thin-film flat-plate modules that might provide the lowest ultimate power cost.

The development of other components needed for PV systems should proceed in parallel. To gain practical field experience with PV systems, many small and medium size systems are being installed currently. In view of the advanced state of some PV technologies, continued expansion of demonstration projects should be fostered. Detailed study is required of how best to handle the transition period during which PV costs decline but are still high enough that applications are feasible mainly in regions lacking power grids.

6. Ocean Thermal Energy Conversion (OTEC)

OTEC power plants use temperature differences between warm surface water and cold water pumped from considerable depths to generate base-load power. Suitable temperature differences are widely available at tropical and sub-tropical latitudes, thus offering a very large shore by submarine cable or be used at sea for manufacture of energy-intensive products. Markets with early promise include U.S. islands such as Puerto Rico and Hawaii which now use expensive oil; with further cost reductions, OTEC may become competitive in the U.S. Gulf Coast market.

Because of the low net energy efficiency of OTEC systems (a few percent), very large volumes of warm and cold water must be circulated and extensive areas of heat exchangers are required. The cost of the heat exchanger is about half the cost of a complete system and it must resist corrosion and biofouling which impair its performance. The development of such heat exchangers—and cleaning procedures for them—is the key to success of OTEC and needs significant further R&D as well as ocean testing. Concurrent development should continue on other system components including the cold-water pipe (about 1000 meters long and 20 meters in diameter), mooring systems, and submarine electric cables.

APPENDIX C TO IEEE SOLAR ENERGY POSITION ENERGY FROM BIOMASS

Biomass energy conversion comprises a group of technologies that use a number of different source materials and varied methods for their conversion. The source materials are generally separated into two broad classes: (1) agricultural and forest residues, and (2) energy crops grown specifically for this purpose. Direct combustion of biomass for heat, steam, and electricity is economic today in certain regions and now contributes 1.3 quads annually, mainly in the forest products industry. Other principal future markets are likely to be the supply of liquid or gaseous fuels. All of these uses are likely to have low environmental impacts because biomass materials have essentially no sulfur, their ash content is low, and they add no net carbon dioxide to the atmosphere since plants extract CO_2 during growth.

Existing sources of farm and forest residues have the potential for providing several quads annually, about half from wood and the rest from sugar cane, corn, wheat, soybeans, and animal wastes. The use of wood for energy is far from optimization. Existing cull wood, pelletized or densified wood residues, and improved forest management offer further options having favorable economics and environmental impact. Silviculture (tree) energy farming has promise of substantially larger energy yield, particularly in Southeastern states. More data are needed, however, on transportation costs, sustainable growth rates and competitive land uses. Further studies of the consequences of large-scale energy farming should proceed in parallel with moderate-size demonstration projects.

Several conversion technologies are available for biomass materials. Biochemical or thermochemical processes can readily produce alcohols, fuel gases, oils, or petrochemical substitutes. Because some of these processes are closely related to those by which municipal solid waste can be converted to energy, the two programs should be fuels are of major importance for transportation needs. Blends of alcohol with gasoline show promise, especially if the octane enhancement due to alcohol can offset its currently higher price. Development of such fuels deserves accelerated efforts.

Poetry Corner

LEISURE

What is this life if, full of care,
We have no time to stand and stare.

No time to stand beneath the boughs
And stare as long as sheep or cows.

No time to see, when woods we pass
Where squirrels hide their nuts in grass.

No time to see, in broad daylight,
Streams full of stars like skies at night.

No time to turn at Beauty's glance,
And watch her feet, how they can dance.

No time to wait till her mouth can
Enrich that smile her eyes began.

A poor life this if, full of care,
We have no time to stand and stare.

W. H. Davies

NRC Withdraws Rassmussen Summary Endorsement

In 1975 the Nuclear Regulatory Commission (NRC) accepted the report of a committee headed by Norman Rasmussen, Chairman of Nuclear Engineering at MIT, which conducted a study of U.S. nuclear reactor safety—the Rasmussen Report. An "Executive Summary" of the report presented the main findings in layman's language. The summary was extensively quoted to the effect that nuclear reactors were extremely safe. [Eg. by Norman Rasmussen in "Electric Power—the Nuclear Option," National Forum (the Phi Kappa Phi Journal), Fall 1978, pp. 13–17.] Objections were raised, among others, by the Union of Concerned Scientists (UCS) and Rep. Morris Udall, whose concern led the NRC to set up in 1977 a panel under the chairmanship of physicist Harold Lewis of the University of California to review the Rasmussen Report.

The Lewis panel's report was submitted in September 1978. Its principal conclusions were that the executive summary of the Rasmussen Report represented "a poor description of the contents of the report, should not be portrayed as such, and has lent itself to misuse in the discussion of reactor risks." That the absolute values of risk are far less accurate than claimed and "should not be used uncritically either in the regulatory process or for public policy purposes." That people reading the summary "may be left with a misplaced confidence in the validity of risk estimates and a more favorable impression of reactor risks in comparison with other risks than warranted." Also that the Rasmussen committee staff failed to pay adequate attention to criticism in a par review conducted during preparation of the report; cogent comments were either evaded or not acknowledged. On the other side of the ledger, the panel did find that the reactor safety study had developed useful methodologies and frameworks for discussion and that greater use could be made of these methodologies.

Last January the NRC reacted to the report of the review panel. It accepted the findings of the review panel and said: "The commission (NRC) withdraws any explicit or implicit past endorsement of the executive summary" of the Rasmussen report. In agreeing with the inadequacy of the peer review conducted during the reactor safety study, the NRC said it would take "whatever corrective action is necessary" to make sure similar failings are not repeated.

Since 1975 a number of licensing decisions were based on the Rasmussen report. According to the NRC executive director for operations, there were only three or four of these and they must now be reconsidered. But a week after the NRC action, the UCS demanded that sixteen operating reactors, in which the NRC has identified safety hazards, be shut down, claiming that continuing operation had been justified by NRC on the basis of the low-risk estimates contained in the Rasmussen report.

The U.S. Civil Service Reform Act of 1978 (which toc effect early this year) contains a number of far-reachir provisions that affords civil service employees—includir engineers—the right to act ethically in the performance (their duties, without fear of retribution. Specifically, Tit II protects the disclosure of information abo mismanagement, gross waste of funds, abuse of authorit or a substantial and specific danger to public health ar safety, as well as information about a violation of la rule, or regulation. It gives substantial power to a Speci Counsel in an Ombudsman role. The Special Counsel ca receive and review information, complaining of improp action by officials, transmit the information—keeping tl identity of the whistleblower confidential—to the agen head and require an investigation and written report. Th report would go to Congress, the President and to tl Special Counsel for transmittal to the complainant. (Th is tantamount to public disclosure.)

Title I of the Act prohibits officials from taking or fa ing to take a personnel action (e.g. dismissal, promotio commendation, censure, pay raise) as a reprisal again whistleblowers. If such reprisals are alleged, the Speci Counsel has the authority to investigate, without revealir the identity of the complainant, and to ask the Civil Boa to stay the personnel action.

More Protection For Whistleblowers

A number of acts of Congress enacted into public law the last few years (listed below) contain sections which pr vide protection to employees who assist in carrying out tl regulatory purpose of the legislation; for instance, by no fying responsible officials of violations by their employ of provisions of the law, or identifying public health ar safety hazards. The protections generally apply to ar employee working in an organization whose activities a affected by any of the listed laws. They offer a means (appeal for employees who have been fired or otherwi retaliated against for taking steps to insure that the organization complies with the regulation.

To qualify for the protection, in some cases t employee must file a complaint with the Secretary (Labor within 30 days of the alleged discriminatory act, suc as a dismissal or punitive transfer. It is importan therefore, that a complainant not wait until the completic of other appeals, such as union or civil service grievan procedures, because the statutory time limit is current strictly enforced by the Department of Labor. Complain may be filed by writing directly to the Secretary, citing tl appropriate legislation which offers the protection ar describing the prohibited action. Any affected employ should obtain a copy of the legislation.

The Secretary of Labor is required to investigate t complaint. Parties unable to amicably settle their dispu in accordance with the Administrative Procedures Act. If discrimination is found, the employee may be entitled to reinstatement, back wages, and possibly an award of attorney's fees.

The sections of specific legislation offer the beginning of legal protections for the professional rights and responsibilities of scientists, particularly when conflicts arise between the professional judgments of scientific and technical employees and the judgments of their supervisors. In many cases, scientists have been uncertain about whether to disclose an employer's action which violated the law or created a potential public health or safety hazard because such disclosure might be the basis for dismissal on grounds of insubordination. The protections listed above offer a means of providing legal support for employees faced with such a situation.

The preceding information was collected by the Committee on Scientific Freedom and Responsibility (SCFR) of AAAS. The Committee also urges scientists and engineers to bring these legal protections directly to the attention of their colleagues, particularly non-professional technical workers who might also come into conflict with employers over health and safety issues. Several complaints have been dismissed by the Secretary of Labor solely because they were filed later than the 30-day limit, *even though the claims provided evidence of prohibited actions.* Therefore, it is important that employees be aware of these protections before crises arise.

For further information on the employee protection legislation, contact Walter S. Marks in the Wage and Hour Division of the Employment Standards Administration, U.S. Department of Labor, or the staff of the AAAS Committee on Scientific Freedom and Responsibility. The Committee is monitoring the enforcement of the protections and asks scientists or engineers who appeal to the Secretary of Labor to send copies of their complaint material to the AAAS Committee Staff Officer, Rosemary A. Chalk.

The following statutes include employee protection sections:

- Occupational Safety and Health Act of 1979 (P.L. 91-596, Sec. 11c)
- Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500, Sec. 507)
- Safe Drinking Water Act of 1974 (P.L. 93-523, Sec. 1450)
- Toxic Substances Control Act of 1976 (P.L. 94-469, Sec. 23)
- Resource Conservation and Recovery Act of 1976 (P.L. 94-580, Sec. 7001)
- Clean Air Act Amendments of 1977 (P.L. 95-95, Sec. 312)
- Federal Mine Safety and Health Act of 1977 (P.L. 95-164, Sec. 105 (c))

of 1978 (P.L. 95-601, Sec. 10)

Federal Solar Policy Review

Until recently, attitudes toward solar energy had ranged from indifference to hostility on the part of those in the energy "establishment." Those who championed solar energy were looked upon as "cultists." In the federal government, only the Council on Environmental Quality looked with favor on solar energy. A transformation in these attitudes seems to be taking place.

A year ago President Carter commissioned a domestic policy review of solar energy, entrusting it to a Solar Energy Policy Committee chaired by Secretary Schlesigner of the Department of Energy (DOE) and including representatives of the Council on Environmental Quality (CEQ) and over 30 other federal agencies. The Committee made its report to the White House in January. The report lays out three policy options. The fraction of total U.S. energy needs in the year 2000 which could be supplied by solar energy is projected to be up to 10, 20 and 25 percent under the three options.

The first option requires doing nothing more than continuing present policies and programs, but it assumes an increase in energy prices equivalent to a doubling of oil prices, in constant dollars. Both of the other two options would require tax credits and subsidized loans for the purchase of solar systems. In option 3 these would be larger and more widely applied. Furthermore, if, after the passage of some time, these financial incentives do not bring about widescale adoption of solar technologies, then use of these technologies would be made mandatory.

Option 2 seems to be the preferred one. It goes beyond the National Energy Act of 1978 (NEA) in permitting tax credits to builders (in addition to home owners) of energy-efficient houses and apartment buildings which include passive solar design features. Such features did not qualify under NEA. Another policy change would be to require all new federal facilities to use passive and active solar systems when such systems are cost-effective; and to require federal buildings heavily used by the public—like post offices—to be retrofitted with solar systems. But perhaps what is more important is a redirection of federal solar R&D effort. The report says: "Near term technologies for the direct production of heat and fuels, community-scale applications, low-cost technologies and basic technologies would be developed at a more moderate pace."

Option 2 requires $2.5 billion in additional funds during the first five years.

Argentine Engineer Kidnapped

The following release is taken from the Friday, January 26, 1979 issue of the *Buenos Aires Herald.*

Engineer kidnapped

TWO men, who showed what appeared to be police credentials to gain admittance to a Buenos Aires apartment building, are believed to have kidnapped Hector Antonio Abrales, a leading electronics engineer and a company director.

His wife, Maria Susana Pagana de Abrales, filed an habeas corpus writ yesterday in a bid to trace him. He was last seen on Monday at 1:15 pm, when he left the offices of Sisagro S.A., an agro-industrial development firm at Paraguay 1307, to return to his house for lunch—it was his son's birthday.

He never arrived home and the janitor of the apartment building at Santa Fe 2698 said that she had let in two men, who claimed to be police and showed credentials, at about noon. When they allowed her to leave they were still waiting near the lift.

His wife received a telephone call at 6pm. Her husband told her that he was being held but could not say where and that she was not to worry. Another man came on the line and told her that her husband was being held in connection with "economic and legal matters". He promised that he would telephone with more news the next day but she has heard no more of her husband although another person tried to reach her by telephone to arrange an appointment.

Mrs. Abrales reported her husband's disappearance the following day after she discovered that on the evening of the day he was abducted three men went to the garage where he had left his car to be serviced and took it away, after showing the respective ticket. The car is a Lutteral Torino station wagon.

Mrs. Abrales appealed to the Interior Minister yesterday to help trace her 42-year old husband, the father of her three children, after having checked at all hospitals and having been assured by the police that he is not under arrest.

Mr. Abrales is a leading figure in the electronics industry, having worked as an advisor to the government and to the OAS in 1971 and 1972. He formed part of a Peronist study group before March 1973, but did not accept any post in the Justicialist government and has not been active in politics since his student days.

He studied in France and taught at the University of Buenos Aires and the University of Chile in the 1960's.

For more information on this case contact the Committee on Scientific Freedom and Responsibility (CSFR) of the American Association for the Advancement of Science (AAAS). Anyone wishing to express concern for the human rights of Ing. Abrales, write to the Embassy of Argentina, Washington, D.C.

Scientific Freedom Report Proposed

At a symposium held during the annual meeting of the American Association for the Advancement of Science (AAAS) in January, Jeremy Stone, director of the Federation of American Scientists (FAS) proposed that AAAS issue on annual report on the state of scientific freedom in all countries of the world. Such a report would provide information for people attending conferences in countries where freedoms are under attack so that they would be in a better position to protest. It would also be seen as a more even-handed and universal approach to dealing with these issues.

EDGERTON GETS CSIT AWARD

The IEEE Committee on Social Implications of Technology presented its second Award for Outstanding Service in the Public Interest at Electro '79 on April 24. The Award, consisting of a certificate and $750, was presented to IEEE member Virginia Edgerton. The award was established to recognize engineers who, in the course of their professional duties, have acted to protect the public interest, particularly where such action was taken despite personal risk.

The Edgerton case was the first one under IEEE's new bylaw designed to provide support for IEEE members placed in jeopardy by their adherence to the IEEE code of ethics. Both the report of the IEEE Member Conduct Committee and that of the CSIT Committee that investigated the case were published in issue No. 22 of Technology and Society. A summary appeared in the December, 1978, issue of The Institute.

MODERN SCIENCE AND TECHNOLOGY One Person's Position

Frank T. Turner

For most of my working life, I was an electronics engineer, enjoyed my work, and was proud to be contributing to the progress of technology. I had a great interest in and reverence for pure science and those who practiced it, and I kept abreast with the results in many fields. As long as I was a part of it, I was unable to see the basic errors of the system. Since my retirement, I have had the time to look back over a considerable span of years, and appreciate some of the real differences between the world as it was fifty years ago, and as it is now.

SCIENCE

As I look at the world today, I am increasingly disillusioned with Science and Technology. Science is a relative good, not an absolute; it is possible to have too much as well as too little, and I think we passed the optimum level some years ago (1). Whatever improvement to human life science has brought in the past, the ratio of real human benefit to cost is decreasing rapidly. If Science exists for the service of mankind then it behooves us to direct its efforts to the areas where the greatest needs are found. If it is principally an end in itself, as is the view of many of its practitioners, then it is simply an art form. If so, it is certainly deserving of the support of interested private parties, just as are symphony orchestras or opera companies or the ballet; but it certainly does not merit the imperial level of tax support now given to it.

The extent of all possible knowledge is infinite; the entire scientific community could spend lifetimes seeking the knowledge locked up in one cubic foot of soil; and then go on to determine the differences between that and the next adjacent cubic foot. Science is infinite in extent, we are never going to be able to know it all, and we are already experiencing considerable difficulty in developing methods for retrieving the information we already possess. Young engineers occasionally come up with an idea they think is new, only to be told by an older person that they have just "reinvented the wheel." For lack of time, it is already impossible for the colleges to give engineering students a complete background of their field.

One can liken Science to the exploration of a new continent; parties should of course be sent out in various directions, and reports sent back of what they find along the way. But this continent is infinite in extent, and they are never going to come to the end of it. It makes no sense therefore to make extremely detailed surveys of the most remote areas; the maximum effort should be concentrated on nearby terrain. When the number of sub-atomic particles became so great that even nuclear physicists had difficulties remembering their presumed properties, when in when they ascribed to quarks attributes they called "color" and "charm," I got off the bandwagon.

One of Parkinson's "laws" states that a government department, once it exceeds a certain critical size, is capable of keeping its staff completely occupied with internally-generated work, with little time left for the agency's original mission. Something of the sort seems to be happening in Science. The world has problems, for sure; but most of them are social or economic rather than scientific or technical, and it is time that more brainpower was directed toward real human needs.

TECHNOLOGY

I have reached the same position with respect to Technology; a large and everincreasing proportion of it is applied to solving problems that are peculiar to technology itself, or are by-products of technology or were not bothering anybody in the first place. The pocket calculator is a case in point. It is a great gadget, but did we really *need* it? Especially since it appears that we will raise a generation of people who will be helpless without it! The microcomputer is an incredibly ingenious development. With it we can play ping-pong on our TV set, thus avoiding the exercise we should be getting. We can organize our home around the microcomputer, balancing our checkbook on it instead of on paper. We can store our recipes in it, instead of on 3×5 file cards. We can built it into our autos—the industry is in fact moving in that direction, thus taking the diagnosis of troubles out of the realm of difficult-for-the-average-mechanic and into the realm of the impossible.

Technology in the service of mankind? RCA has developed a computer-controlled device to insure that the correct taped commercial goes out on the correct TV channel at the correct time. Should I rejoice?

I spent a good part of my life, as have many others, developing labor-saving machinery. To what end? To increase the unemployment rolls? It is one thing to develop means of saving labor when that labor was burdensome or debilitating, or when the individual whose labor so saved could without difficulty find other more useful things to do, but we seem long since to have passed the point where that outcome prevailed.

Another thing that distresses me is the frenzied pace of development in recent years. In bygone years, a technological innovation served society for at least decades before it became obsolete. The ratio of return to society per unit of engineering time, or order of complexity of background technology, was very high. Witness the steel plowshare, which is still serving mankind in a very real way. At Henry Ford's Greenfield Village there is a steam engine which had been in pumping service in English coal mines for over a century.

The Monroe desk calculator served business and industry—and science and technology—for fifty years or so. But the Monroe Electric Calculator that my lab purchased in 1969 was rendered obsolete in three years or less by the Hewlett-Packard HP-35. And the HP-35 looked

The author is a retired engineer formerly with Western Union.

pathetic compared to another scientific calculator I bought three years later still. Progress is desirable, no doubt, but need it take place at a rate so great that we do not have time to completely master a given facility, before it is replaced by another? Particularly in view of the fact that while all these goodies are dropped in our laps, we continue to make a mountain out of the molehill of producing a simple, efficient, economical and non-polluting automobile engine.

Before my retirement, I made the observation that American engineers seemed to have lost the ability to do anything in a simple fashion. One cardinal principle which I applied in my work was this: if your device has a defect, don't try to cure it by adding more complexity; rather, go back into the original design and find the cause. Look under the hood of any modern car and you will see the death of *that* concept.

Adaptability is a paramount attribute of the human animal. Human beings can live—and without advanced technology—at the Artic Circle or in the Sahara, in the Amazon Basin or in the Himalayas. However, this adaptability is lost if it is not challenged. The subjective nature of that challenge is discomfort; that is if we do not allow ourselves to experience discomfort we will lose our ability to adapt. What does technology give us? Air conditioning, which we use, not in moderation, but to such an extent that the electrical power required becomes a very real part of our energy problem. Some offices are kept so cool that the occupants must wear jackets and sweaters!

We once had a non-polluting technology for the use of coal. For some reason it now seems that we cannot return to it but must spend billions trying to develop new methods of gasification. I refer to the method of by-product coke ovens, which yielded materials for the early chemical industry (these materials are now largely supplied from petroleum) followed either by the burning of the coke for fuel or its use for the production of illuminating gas. That gas had a lower BTU content than today's natural gas, but years ago most of the world's major cities were lighted with it, and most housewives in those cities cooked with it. Sulfur, today a principle source of problems in the burning of coal for the production of electricity, was then a marketable product in the array of compounds produced by the coke ovens.

An example of technoloy run amok is the computer. In its scientific applications it can do many things heretofore impossible; but far too often, just because it is there, it is programmed to analyze data that could as well be done by a reasonably intelligent person. Instead of training people to think, we are training them to program. Those working closely with them know that computers cannot "discover" anything which is not implicit in the data fed to them, but still many workers devise "computer experiments" and then present the results as if they had the validity of real-life experiments.

In business use, the computer is king, at least in the view of many executives, to whom it is also a great prestige item, in the same class as the executive jet. Seen from the other end, i.e. by the man in the street, it is another story. There is by now a tremendous accumulation of stories of agonizing difficulties experienced at this level. Also, as seen by employees at lower levels its value is questionable. As a middle-management executive in a large corporation, each Friday for years I prepared a report on my activities or those of the group I supervised. This was collected and collated, and a summary presented to the higher-level executives about the middle of the following week. When the computer took over, the report was on their desks on Monday. Wonderful? So it seemed to the executives, but this was accomplished by having us people down where the actual work was done, prepare our reports on the previous Wednesday so that it could be collected, collated, and keypunched for input to the computer. So top-level management received on Monday a report on actual activities up to the previous Wednesday, with guesses as to what would happen on Thursday and Friday. Is this progress?

When my automobile insurance company processed its papers manually, it took about two weeks from the date of one's payment to receive the certificate confirming the fact of insurance. Now the operation is completely computerized, and it takes four weeks.

There is another point: In many applications, the computer saves a considerable amount of human time. But to the extent the computer reduces the work force, it further compounds our social problems, for which neither Science nor Technology is so far offering any solutions.

A more disturbing trend is in recent efforts to develop computers that can think, ("artificial intelligence," so called) i.e. perform the function heretofore assumed to be the exclusive province of Man. To what end? If it is impossible, then the effort is a complete waste of time; but if it is possible and is achieved, then we are doomed to become merely the servants of the Machine, and to eventual extinction when we are no longer needed. Efforts of this sort seem to me to be the ultimate in idiocy.

The automobile is another example. It is true that it makes for far greater mobility than ever before. But where at one time ownership of an automobile was an option, and therefore an undoubted benefit for a large part of our population, it is now an absolute necessity. For reliance on the private automobile mode of transportation has led to the shrivelling of our public transportation network.

DIMINISHING RETURNS: GROWTH VERSUS SATURATION

An example of declining benefit/cost ratio or declining benefit/complexity ratio may be seen in the field of photography. Excellent photos were made as far back as the Civil War, at a time when the technique was largely empirical, and little was known about what was actually going on, chemically speaking. The art was, though, an extremely inconvenient one to practice, and we can certainly welcome the technological improvements that brought us higher-speed emulsions of controlled characteristics, finer grain, etc., as well as improved lenses to bring us the added dimension of color required a tremendous increase in

Given the development of photography and suitable film materials it required only the application of existing mechanical techniques and skills to bring us the silent movie, and a whole art form developed in this medium. Yet it required the development and application of the vacuum tube, the microphone, the photocell and the dynamic loudspeaker merely to add sound, to a medium that could produce films of great dramatic value without it.

Television was a tremendous technological achievement, almost unbelievable to those working in parallel electronics fields who could appreciate the order of the difficulties to be overcome. But the addition of color required nearly a three-fold increase in the complexity of the receiver, and about a five-fold increase in cost. Yet today the medium is used chiefly for the presentation of an extremely low grade of entertainment, and as an advertising medium for a large range of products, most of which are of little or even negative value. What is the real value to Society, of all that effort?

Agricultural technology has greatly increased the productivity of today's farmer, and his efficiency has increased tremendously. That is, if you define efficiency as amount of crop produced per man-hour. The productivity per acre has increased to some degree, but the productivity per dollar of invested capital, or per dollar of input, i.e. fertilizer, fuel, insecticide, fungicide, herbicide, etc., has decreased immeasurable and is today in the U.S. and Canada probably the lowest in the world. The old "inefficient" farmer had practically no expenses other than his own and his family's labor, since he tilled the soil with his own draft animals, which he fed from his own land, which he fertilized with the manure from the animals. Today's farmer operates on so narrow a spread between his expenses and the cash value of his crop, that he can be wiped out by a very small percentage drop in market prices, and many are going to the wall for just that reason. The more so because many of them, to make more "efficient" use of their time, and to live the "modern" way, have given up raising any of their own food, and get it all from the supermarket. Unfortunately, for perfectly sound reasons, supermarket prices don't go down in the same ratio as the farmer's net income.

When an agricultural experiment station undertakes the development of a new strain (of corn for example), seeds of various genetic crosses are planted in test plots. In order to insure uniform conditions for the test, all plots are given the same application of fertilizers. Granting the scientists the best of intentions, the result is inevitably that the strain is selected that gives the best production under the given fertilizer program. The so-called "green revolution," which was to save the "third world" has largely failed to do so simply because the new strains of rice and other grains require such quantities of fertilizers, herbicides, and fungicides that no Third World country has the necessary foreign exchange to purchase them. Somewhere in the tilizer, but if so his efforts are unpublicized.

Commercial seed producers, to guarantee their crop, follow insecticide/fungicide programs suited to each species. The result is that, over the years, we have developed strains of food plants that are extremely vulnerable to insects and disease, a fact that is only too plain to anyone who had a vegetable garden forty or fifty years ago, and has one today. It is simply one of the facts of life, genetically speaking, that if you raise generation after generation of any form of life under the protection of a disease-fighting agent, you ultimately produce a population that no longer has natural resistance to the target disease.

It is true that crop scientists can and do develop resistant strains, but this is done on a spot basis, one target at a time, rather than on a general across-the-board basis as was the case from the beginning of agriculture up to our era. The old approach was a simple one. If the plant was not resistant to any and all insects and diseases that might attack it, it was abandoned.

Recent and very thorough studies have shown that agricultural yields, (of corn for example) per unit of fertilizer applied, are considerably lower than they were a few years ago. In 1945 the average application of artificial fertilizer in terms of active ingredients, was 19 lbs. per acre, and the production was 34 bushels. By 1970 the rate of fertilizer application had risen to 203 lbs. per acre, but the crop had risen to only 81 bushels per acre; less than a three-fold increase in crop for over a tenfold increase in fertilizer used (2).

There are other more subtle effects. With the increase in the use of artificial fertilizer, aided by the use of herbicides for weed control, there has come about a decrease in the organic matter content of the soil. This makes the soil less able to hold fertilizer, especially nitrogen which leaches out readily, requiring the application of more fertilizer just to maintain the same yield. The ability of the soil to retain moisture is also reduced, resulting in a more rapid runoff which leads to flooding, and also to increased erosion. It also leads to a lowering of the water table and to wider fluctuations in stream levels, adversely affecting the generation of hydroelectric power.

Similar negative aspects appear in the field of modern mass production and marketing. There is just beginning to be some realization that the economies of scale do not continue indefinitely regardless of the absolute magnitude of the operation; but the idea is barely hatched, and has no weight whatever with people who are calling the shots today.

A whole new field of technology has developed in recent years, that of food technology. Its practitioners are not cooks, however, but engineers and they regard agricultural products simply as raw materials to be beaten into submissive uniformity more suited to mass production. In the process they remove many of the nutritive qualities, a few of which they then replace with substitutes from synthetic sources with the claim that they have "enriched" the food. In the U.S. we have perhaps the world's most advanced medical technology—and the most expensive—and we are anywhere from fourth to fourteenth among the world's advanced nations, in the various measures of the state of our public health.

The crystal-controlled wristwatch is a great technological advance. It is capable of an accuracy equal to or better than a good nautical chronometer. I have yet to encounter anyone who has need for that order of accuracy in his timepiece, other than a ship's navigator. A fine development, if heretofore there had been no such thing as a wristwatch. But we have had mechanical wristwatches for years, and they served us adequately. Was there nothing else, more needed, that could have been created?

One of our country's leading manufacturers of electronic equipment has just created a combination wristwatch-stopwatch-alarmclock-calculator-calendar, plus a few other functions. It is capable of timing events to the nearest hundredth of a second. Since human reaction times are of the order of a tenth of a second, there is a degree of deceit here, if unintended. You may have a readout to a hundredth of a second, but that is an illusion: you simply cannot press the button to that order of accuracy. It also saves you the great effort of getting a calendar card out of your pocket, to find out next Thursday's data. This device sells for about $700. Who will buy it, and why? It is certainly a great put-down for your neighbour, who has only a wristwatch-calculator, or a wristwatch-calendar, or a wristwatch-alarmclock. The one application where it might be of unquestionable value: it makes an ideal gift for an executive whose company's business you wish to obtain! But is there an application where its capabilities are really needed?

CONCLUDING REMARKS

Defenders of the present technological system have developed a number of standard responses to anyone expressing displeasure with the present level of technology or criticizing some aspect of techological life. One of these ploys is to accuse the critic of wanting to roll back the society to the 1920's or even the 1830's. Since it is easy to point to some great disadvantages of living in those times—threats of disease, lack of comforts, etc.—the critic's arguments seem to be easy to dispose of. A second ploy is the assertion that modern technology is a package deal; we cannot have the good and useful, without having the destructive and ridiculous. Neither of these responses is valid. No sensible critic of contemporary technology rejects all scientific knowledge. It is not a rejection of scientific knowledge to reject the methods of agribusiness, as done in this essay, and to promote a more sensible application of genetics and ecology. It is patently false that acceptance of the telephone systems means that we have to accept nuclear weapons systems also.

Take the area of business management and entrepreneurship. At one time, factory owners based a substantial part of their self-esteem on the quality and utility of their product, granted they took care of themselves financially also. The business executive began as a young man in, say, the shipping department and worked on the factory floor for a time; when he assumed an executive post, he knew a great deal about the product, the way it was made, the working conditions in the plant, and the needs and aspirations of the workers. Today's executive, on the other hand, is likely to have an MBA and has been taught that, in order to run a business, it is not necessary to know anything about the product. In fact, learning about it is a waste of his time since, in the course of his career, he is likely to go on to several different industries. He has been taught that, rather than go out on the factory floor to see for himself, he should have subordinates who do that and then "brief" him in his office. He firmly believes that a knowledge of "business" is all that is needed and that the sole purpose of business is to make a profit. If it does that, nothing else matters; if anything threatens that—such as the need to reduce pollution or the discovery that the product is harmful—it is to be fought tooth and nail.

Criticizing the practices of modern corporate management practices does not imply a rejection of the production of goods of quality and utility in a humane setting.

Technological change is now occurring at a much greater rate than one which society can assimiliate and put to real societal use. An ever-increasing fraction of scientific research is solely in the service of science. An ever-increasing fraction of technological development is in the service of: (a) business or industry interests—what is good for General Motors is not necessarily good for the country; (b) technology itself or dealing with the problems created by technology; and (c) most importantly, the military.

I am not calling for a moratorium on science and technology but for a reassessment of goals, guided by the new consciousness that continual growth in a finite world is impossible; that we should so design our technical systems that they operate mainly on current "income" rather than deposits of the earth's stock; that improvements in the conditions of human life should be placed before the profits of special interests.

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BOOK REVIEWS

Light Water—How the Nuclear Dream Dissolved, by Irvin C. Bupp and Jean-Claude Derian, Basic Books, NY, 1978, 241 pp. $10.00. *Reviewed by David Redfield, RCA Labs, Princeton, New Jersey.*

This well-written history of peaceful uses of nuclear energy brings a fresh perspective to the now-familiar, but still-sensitive subject. The authors' goal is to explain—in terms chiefly of economic and social factors—why the growth of nuclear power has "come to a virtual halt." Surprisingly, this attempt is almost free of the usual pro-or-con postures that have so polarized this field. The dispassionate, almost reportorial, style is very successful in presenting an "impartial" history, albeit with a distinctive economic flavor. Its technical level is general so that few demands are made on the reader. The discussion benefits from the economics background of both authors as well as the technical background of Derian who also has degrees in engineering and physics. For the devotee there are 22 pages of notes, but they are collected at the end to ease the flow of the text. A reasonably good index is also included.

The thesis of this book is that the economics of nuclear power have been the factor of central importance in its rise and fall. The ways in which several important influences affected the economics form the core of the history. A useful new feature of this treatment is the international scope that is presumably Derian's contribution. (He has been active in French nuclear policy while Bupp has been a prolific contributor to the analysis of U.S. nuclear economics.)

The growth of the Light Water Reactor (the U.S. system) is traced briefly from early weapons—material reactors through ship-propulsion systems to the Atoms for Peace program begun in 1953. An interesting account is given of how the competing British and French gas-cooled reactors were squeezed out of the market in favor of the LWR by a curious set of circumstances including an apparent distortion of the Euratom Treaty of 1957.

The real take-off for the LWR—as is now well known—dates from the Oyster Creek, NJ plant contracted in 1963 as the first "completely unsubsidized" power plant that promised cheap electric power. The optimistic assumptions and the losses absorbed by the manufacturer, all of which formed the basis for that promise, are shown to be the nucleus for a widespread misreading of nuclear economics. This misconception became self-reinforcing and almost universal on both sides of the Atlantic, leading to the "Great Bandwagon Market," a flood of orders for large nuclear power plants that numbered 75 by the end of 1967. All this with miniscule operating experience with power reactors and none at all with the large sizes that soon dominated the order books. Evidently "many people mistook...economic promise for accomplished fact." The authors' analysis concludes that the *real* cost (excluding inflation) averaged twice the predicted cost at every part of this sequence.

A shadow was cast on nuclear power growth in Europe during the boom in cheap oil use in the 1960's but the quadrupling of oil prices in 1973 gave new luster to the tarnishing image of nuclear economics. Particularly in Europe and Japan, energy futures looked nuclear to apprehensive leaders facing greatly increased costs and uncertain supplies of oil.

At this juncture, however, the opponents of nuclear power also began to gather strength and public acceptance weakened. One of the strengths of this book is the unification of the stories of the nuclear debate in France, Sweden and the U.S. Out of this debate grew new environmental protection policies, quality assurance requirements, and nuclear safety regulations. Together with manufacturing problems the developing nuclear industry was having, these contributed further to the escalation of costs of nuclear power. In the face of this "economic swamp" the complexities of comparative cost-analysis of coal *vs* nuclear power are illustrated graphically; evidently neither is a winner, as of early 1978.

The upshot of all this is the current "political stalemate" in which orders for LWR's plummeted to nearly zero in most Western countries. With the present perspective, chapter 11 asks, "How did it all happen?" Four distinct groups contributed: nuclear engineers and scientists with an intellectual stake, industry with a financial stake, public officials with a political stake, and a heterogeneous group of nuclear opponents. The role of each group is assessed without finger-pointing. The stalemate is thus much more than a technical matter: it is a debate "about the nature of contemporary society."

The final chapter with lessons for the future is a bit disappointing, perhaps because the best that can be done to end the stalemate seems to be, "Compromise." To this reader it appears that a possibly significant facet of the situation is slighted. That is, how much of the drop in nuclear power plant orders may be due to just the leveling-off in demand? If the present "stalemate" is largely a huge transient effect, the lessons to be drawn may be rather different. Nevertheless, this lucid history is a worthwhile addition to this important field.

BIOELECTRONICS
Michael Pessah
2825 Ridgeview Avenue
Los Angeles, CA 90041
(213) 222-3341

CRIME
COUNTERMEASURES
John S. Jackson
Electrical Eng. Dept.
University of Kentucky
Lexington, KY 40506
(606) 257-3926

EDUCATION
Leon W. Zelby
School of Electrical Eng.
The Univ. of Oklahoma
202 West Boyd Street
Room 219
Norman, OK 73069

EFFECTS OF AUTO—
MATION ON WORK
M. Kutcher
IBM Systems Prod. Div.
Neighborhood Road
Kingston, NY 12401

ENERGY/ENVIRONMENT
David Redfield
RCA Labs.
Princeton, NJ 08540
(609) 452-2700 Ext. 2442

ETHICS
Stephen Unger
229 Cambridge Avenue
Englewood, NJ 07631
(201) 567-5923 (home)
(212) 280-3107 (office)

INFORMATION
TECHNOLOGY
Larry L. Stine
MITRE Corp.
1820 Dolley Madison Blvd.
McLean, VA 22101
(703) 790-6311

NATIONAL SECURITY
Otto Friedrich, Jr.
Eng. Science Dept. 114B
Univ. of Texas at Austin
Austin, TX 78712
(512) 471-1800

SYSTEMS ENGINEERING &
PUBLIC TECHNOLOGY
Gerald Rabow
21 Berkeley Terrace
Livingston, NJ 07039

Send Form 3579 to IEEE, 445 Hoes Lane, Piscataway, N.J. 08854