TECHNOLOGY and SOCIETY

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

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The Committee on Social Implications of Technology of the IEEE TAB: 1972–1981 a Eulogy

R. J. BOGUMIL, Chairman, CSIT

This is the final issue of *Technology and Society* as the Newsletter of the Committee on Social Implications of Technology. Over the past decade, the 36 issues published provided a forum for presentation of views on a wide range of topics in the Committee's field of interest. (See "Social Implications of Technology: The Past and the Future," R. J. Bogumil, *Technology and Society,* September 1981.)

On this occasion it is a great pleasure to acknowledge the efforts of at least a few of the large number of people who have contributed to committee projects. While according special mention to those who have been active on the central committee, gratitude must also be expressed to the hundreds who have signed Committee petitions, the thousands who subscribe to *Technology and Society* and yet others who have contributed in different ways.

The initiative to petition for establishment of such an IEEE entity developed from the concerns of individual IEEE members with the support of several preexisting organizations. In particular, the Committee for Social Responsibility in Engineering (CSRE) was of great assistance in this effort. T. Werntz, A. Ashkinazy, M. Benjamin, F. Collins, F. Kotasek, W. Higinbotham, V. Paschkis, A. Robbi, P. Stoller and S. Unger contributed greatly to the petition process "...to authorize the formation of a Professional Group on Social Implications of Technology...to promote among IEEE members a sensitivity to the impact of their technology on society and to conceive means to predict and evaluate that impact." With creation of the new TAB Committee, P. Edmonds, R. Emberson, A. Killin and L. Nagel among others began what was to become a multi-year association. CSIT, born of events that polarized many elements of contemporary society, strove to achieve balance and rationality in the analysis of controversial social/technical matters.

V. Klig, M. Benjamin, G. Rabow, A. Bronwell, J. Kaufman, A. Robbi, S. Unger, C. Barus, and W. Higinbotham participated in the first CSIT *Open Forum,* addressing a variety of topics dealing with technology and society. Also at *INTERCON '73, The Engineer and Military Technology* was the title of a CSIT-sponsored workshop, moderated by B. Barrow with E. Ramberg, W. Davidon and W. Cory. The study, refinement and implementation of codes of engineering ethics became a major Committee interest, with Ethics Working Group Chairman S. Unger aided in certain projects by F. Kotasek, J. Kaufman, M. Apter, D. Cook and others. Additional CSIT Working Groups became active on topics including Education (B. Myers), Energy and the Environment (F. Kotasek, P. Russo, and A. Robbi) and Systems Engineering (G. Rabow).

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In This Issue

News, Notes, and Comments

Photovoltaics: Observations at Specialists' Conference

John Shewchun

A major body blow was delivered to the federal Solar Photovoltaics program when an FY 1982 budget of $63 million instead of $160 million was announced by the Administration in Washington. The photovoltaic community seemed to be in shock when this news reached them at the 15th IEEE Photovoltaic Specialists Conference held in May, 1981 in Orlando, Florida. This was especially so in light of the commonly held view in that community that excellent progress was being made in reaching the DOE price goals for energy delivered by photovoltaic electric systems. Was the technical progress overrated? Or was this a case of the DOE technical chiefs simply not paying attending to the shifting political sands?

The goals of the DOE photovoltaics program have always been stated quite unequivocally in dollars/peak watt of power delivered by a solar cell module. With such a strong emphasis on price goals, little room was left for maneuvering when problems arose. It is fairly apparent, especially to the industry, that the projected price goals cannot be met, unless there is some dramatic breakthrough in the research arena. No such breakthroughs were apparent at the May conference.

The mainstay of the photovoltaics industry is a 3″ or 4″ round or square single crystal silicon p–n junction solar cell. The limitations with single crystal silicon have been known for some time. A 1982 DOE goal of $2.80/peak watt is unrealistic with single crystal silicon when the cost of the single crystal material contributes a cost/watt component much in excess of this amount and there are no known ways of reducing this component. Polycrystalline silicon was to have reduced the cost of the material component substantially, but there is no evidence that this has occurred or will occur. Thus, the only hope at the moment is for a thin film semiconductor material capable of delivering 10% conversion efficiency. A number of interesting candidates are being examined.

Amorphous silicon is currently in vogue. As with all such trendy stampedes, wishful thinking seems far ahead of reality. While some cells in the 6–7% conversion efficiency range have been achieved, there has yet to be a convincing demonstration that there exists any amorphous material, either theoretical or experimental, that is capable of yielding more than 9–10%. A minimum of 10% is required before any system can be considered commercially viable. We should all be reminded of the sage of the Cu_2S/CdS thin film system where the 10% level was reached only after years of painstaking tweaking.

Of the thin-film systems with the most potential for a breakthrough, the $CuInSe_2/CdS$ one, as reported by the research group at Boeing Aerospace, is the most promising. Efficiencies of 10% have been achieved within a relatively short time. GaAs is capable of higher efficiencies but it is a difficult material to tame. At the moment, different thin-film systems are still candidates. A fundamental scientific problem is that compound semiconductors, especially in film form, are very chameleon-like. They do not easily replicate the potential they exhibit in single-crystal form.

In light of the radical surgery performed on the DOE photovoltaics budget by the federal administration, it is difficult to be sanguine about the prospects of rapid progress. Although there have been over 4000 scientists and engineers engaged in this area, the number is being drastically curtailed. Clearly, talent will go where the funding support goes; the best people will find other things to do. Unless there is a change in budget priorities or some spectacular technical advance, the earlier promise of direct conversion will remain unfulfilled—and that would be tragic.

The author is Professor of Electrical and Computer Engineering, Syracuse University, Syracuse, NY 13210. His research is in the photovoltaic area.

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Agriculture, U.S. Technology, and Waste

JOHN G. SINCLAIR, JR.

Agriculture is the backbone of American society. If our crops decline, we also decline. Within the past few decades, agriculture has become increasingly dependent on technology, with mixed effects.

RECENT TRENDS IN AGRICULTURE

Technology has provided "cheap" fertilizers which, together with machines, permit a vastly increased total production. But this production is based on heavy consumption of limited resources such as oil, natural gas, mineral deposits, and even water. It has also encouraged "extractive" farming in which trace mineral and organic components of ancient soils are depleted, causing a gradual downward trend in productivity per acre, pollution of ground waters, increased erosion, and reduced water retention. Machines make possible rapid conversion of bare land to urban development, accelerating the loss of prime agricultural land beyond the suburbs of urban centers. The greater distance to market caused by this loss of land means a built-in, permanent increase in transportation cost as well as loss of greenbelts to improve urban existence. The remaining lands, with gradually diminishing fertility, are called upon to produce more per acre.

Technology has made possible uniformly graded, blemish-free fruits and vegetables through agricultural chemicals which control growth and ripening and protect from disease, pests, and weeds. Grading standards, however, result in huge losses, sometimes as much as one-third of crops actually grown because in the U.S. we have been trained to expect perfect appearance in the grocery store, and what are called substandard fruits and vegetables never get to market. In addition, we have a national problem of chemical residues in our food which many medical and nutrition experts suspect are responsible for a subtle decline in public health. Our overuse of pesticides has led to increased resistance by pests, requiring even larger doses of poison, and the rapid commercialization of many new pesticides each year, whose long-term effects on humans we simply do not know but which, in some cases, are highly suspect.

URBAN WASTE, A RESOURCE

An apparently tangential problem which is actually related to agriculture is that many urban governments are beginning to consider a new high-technology "solution" to the problem of urban refuse disposal: its use as fuel to generate power and/or steam. The political decision-makers have Environmental Impact Statements to assist them with environmental problems but, since most politicians are not trained in science or engineering, when it comes to questions of feasibility and advisability, they depend on advisory boards made up of academic or industrial experts whose independence of judgment may be questionable, or on supposedly independent technical consultants. Proposals to use waste in alternative ways suffer from weak advocacy beause they do not benefit large profit-making groups. Public minded, responsible engineering advisors, who have no conflict of interest, could swing these decisions in the public interest.

Why is there such strong interest in "garbage to energy"? [1] One reason is that these systems will institutionalize waste in this country, and thus ensure (as the promoters see it) the long-term profitability of throwaway packaging. Local political bodies are being told that they need an "assured" supply of waste to justify the huge investments required for such machines. Another reason is that most proposals for these systems are based on the concept of machine separation of waste, permitting the American public to continue dumping garbage, bottles, cans, cardboard, tires, plastic toys, etc., mixed indiscriminately together in bundles at the front curb. Giant machines are designed to "separate" glass, aluminum, steel and combustibles by means of air classifiers, magnets, choppers, screeners, etc. Thus, in theory, one should be able to develop separate "streams" of each type of non-combustible plus a stream of combustible material.

The problem with these large machines is that they don't work very well and each "stream" of material is contaminated with some of the other "streams". The result is that market prices paid for the somewhat mixed materials is not very high and some materials are so mixed as to be almost useless for the intended industry.

A number of philosophic questions arise: Is it socially beneficial if we crush or chop up a used nonfunctioning washing machine and eventually melt it down for its metals, or should it be repaired and utilized again for its original intended purpose, or should its parts be made available for repair of similar models? An inspection of many such machines as they enter the "waste stream" shows that the nonfunctioning parts are minor indeed and sometimes consist of such absurdly simple things as a break in the line cord! Ninety-nine percent of such machines consist of relatively rugged parts which could last far beyond the few years' warrantee. Obviously the makers of such machines will not favor recycling of the uncrunched machine. But what decision can this society afford?

The concept of source separation has been researched, practiced on a modest scale, and promoted by recycling groups [2, 3, 4, 5] and environmentally conscious groups for some time, but the idea is not popular with industry or

The author is a Senior Member of IEEE. He is the owner of Sinclair Research Corp. (invention development) and Sinclair Farm (producer of goat cheese) in Little River, California.

government. Source separation consists of separating out recyclable items at the source, the business or household. Glass, sorted by color, aluminum cans, steel cans, newspapers, and cardboard are a few examples. These materials can be sold as clean raw materials to industry for top prices because they need very little reworking before reuse. A few bottle and aluminum can makers have begun national campaigns for separate collection of their own containers based on resulting energy savings. State bottle bills have been furiously and expensively opposed in the very states where they could really help.

How do questions about noncombustible, nonbiodegradable urban waste impinge upon agriculture? The waste of *any* materials can be translated into decreased availability of resources for agriculture. For example: if the fuel, materials, energy and labor that go into making a washing machine or a car must be replaced in a few years because the product was not repaired or because it was *designed to fail,* these resources are denied to other needs, such as agriculture. These may seem elementary considerations but I believe they are, nevertheless, vital.

FERTILIZER VALUE IN REFUSE

A portion of the combustibles referred to above can be considered biodegradable, that is, they can serve as nutrients for soil microbes, which in turn can feed plant life. Such materials, together with sewage plant sludge and septic tank seepage constitute an enormous resource of potential direct use in agriculture. Almost 100% is wasted by burial in landfills.

Annual U.S. production of all organic wastes is about 800 million tons, dry weight. [6,7] The three major sources are:

400×10^6 tons crop residue, 86% applied to land
175×10^6 tons animal manure, 90% applied to land
145×10^6 tons municipal refuse, less than 1% applied to land.

The nutrients in municipal refuse compared with those provided in commercial fertilizer are given in the table below for the U.S.

Nutrients (10^6 tons)	Nitrogen	Phosphorous	Potassium
In municipal refuse	0.938	0.224	0.406
In commercial fertilizer	10.6	2.4	4.8

Thus the nutrients wasted in municipal refuse could provide about 10% of the purchased inputs, or could fertilize about 2 million acres. The utilization of these nutrients is dependent on the location of the waste with respect to surrounding farm land. Also, losses can occur due to improper storage or composting, particularly in the case of nitrogen.

Crops fed with generous organic amendments gain many other advantages than would be indicated by basic nutrients alone. Soil tilth is improved reducing plowing energy, increasing root penetration, increasing water penetration and water retention. Soil microbiological growth is multiplied, releasing growth nutrients slowly and steadily and bringing up trace nutrients from greater depth. Erosion from the action of wind and rain is reduced, and crops so treated are better able to withstand extremes of weather. There is also evidence of improved ability of such crops to resist disease and pests. A truly impressive list of advantages!

WORLD USES OF ORGANIC WASTES

Composting of agricultural and industrial organic wastes together with night soil (human bodily wastes) is an ancient art in the orient, particularly India and China. Rice straw, which we in the U.S. burn off, is regularly used for compost, home heating, cooking, and the manufacture of many marketable items. In contrast, a recent article in AG Alert, an agribusiness newspaper of the U.S. Farm Bureau Federation, celebrates the development of a new kind of rice with shorter stems because there will be less to burn, and less bother to the neighbors!

The Chinese learned long ago to control the ratio of carbon to nitrogen in composting, both to insure high enough temperature to kill pathogens and to hold captive as much nitrogen as possible. In Europe composting machines have reached a high state of development and are able to produce pathogen-free, relatively odorless compost from municipal waste in 10 days. [8] Europeans feel that there is such a great social and economic good from compost-making that *they do not demand that their compost plants make a direct profit,* although some of them actually do. If the wastes were not utilized, they would be buried in landfill, and these costs become considerable as the distance to landfills steadily increases. Germany and Switzerland have been leaders in this development in Europe, although in recent years there has been a slow-down in new composters, probably due to "cheap" fertilizer availability, and perhaps because the original compost machines were unduly complex and expensive. The U.S. Department of Agriculure has developed a low technology system which kills pathogens and is odor free. [9,10] The process, developed at Beltsville, Maryland, requires a capital investment of about 1/5 that of incineration, and it produces a useful output product. A 10 ton/day site requires 3 and ½ acres. Costs are about $51/ton (1973, Maryland, USA). In Moscow, [11] with probably the largest plant in the world, 200 thousand tons of refuse per year are composted. Leningrad processes 140 thousand tons per year and Rome, Italy, 170 thousand tons per year.

In contrast, San Francisco plans a 100 million dollar incineration plant to generate electricity. Thus far there is no interest by the California Solid Waste Management Board in the alternate possibility of source separation-recycling and composting. Both San Francisco and Los Angeles have urgent time-tables in regard to space for landfill. It is to be hoped that neither city will be panicked into such an expensive decision before competent and unbiased evaluation of alternatives has been made. Examples of possible alternatives include:

1. Source separation of nonbiodegradables in any event.
2. Biodegradables used to generate methane; return of resulting enriched sludge (no nitrogen is lost!) to agriculture by drying to reduce shipping weight, or by hydraulic means using existing sewage piping where possible.
3. Biodegradables used to make alcohol, residues used as feed or as fertilizer.
4. Use of existing sewage system to return larger portion of biodegradables to central plants for methane or alcohol. Increased use of garbage disposers.
5. Sewage treatment effluent used to pass through water hyacinths beds for purification. Plants harvested for food or fuel.

Here is a situation in which politically independent technologists could make a major contribution. The technology of incineration is relatively straightforward, albeit expensive. However, this solution tends to institutionalize waste, particularly monumental packaging waste. In order to make a proper decision in the *public interest*, what is needed is a broad systems analysis, employing specialists from the fields of economics, agriculture, government, environmental science, politics, law, and engineering. Such a team of disinterested individuals or research groups, could perform a vital service to municipalities and States faced with solving the problem described. The most difficult question is: How can such an unbiased public interest analysis be made? Supposedly this is the function of government.

UTILIZATION OF HUMAN WASTE

Both raw sewage and sewage plant effluent have been used successfully for crop irrigation, [12, 13] Each can produce fertile lands and safe, pathogen-free crops when appropriate methods are employed. A serious problem with the sewage from a large urban center is heavy metal content, primarily from industrial sources. [14, 15] Studies have been made to optimize the use of these contaminated waters for agriculture but uncontrolled usage can cause serious problems for the plants and for humans and animals who consume them. [16, 17, 18] Very little has been done as yet to tackle the problem of cleaning up urban sewage at the source, to identify major polluters and to require other methods of disposal of their wastes. [19] Technology could help. The economic benefits to society of safe sewage nutrient would be great. How can this problem be solved?

There have been proposals to utilize existing sewage piping systems to conduct all biodegradable garbage as well as normal sewage to much enlarged treatment plants. The advent of home garbage disposers has moved in this direction. There are U.S. studies of conversion of organic wastes to yeast and numerous studies of both composting and methane production from sewage and garbage. [20, 21]

The agriculture of China is testament to the concept of organic, self-sufficient farming. This large population has supported itself until very recent times, without any of the manufactured commercial fertilizers upon which our own agriculture depends. Nothing organic is wasted and the art of composting is highly developed. The primary inputs have been the inorganic silts of their very long winding rivers, solar energy, and human effort. With these elements China has managed to be a large exporter of silk, tea, and rice, for many centuries. [22] There has been a great deal of recent development in composting and extensive use of bio-gas (methane) units in homes. [23] Some idea of how Oriental cultures view the wastes we in the West have learned to abhor is reported by Takahashi who says there is not only no prejudice against collection of night soil from the small portable latrines of Japan, but farmers have at times paid for the privilege of collecting these nutrients. [7] The night soil of big cities such as Tokyo and Osaka were almost completely collected.

A recent vistor gave the following account of farming in China today: "In Chekiang province, night soil collection is almost a passion. We saw literally thousands of roadside privies, placed to lure passers-by into depositing valuable fertilizer within reach of farmers. On one heavily travelled country road there were as many as ten in a one-block stretch." [24]

An interesting comparison can be made between input and output for human bodies. A 180-pound man generates enough urine in one year to provide about 12 pounds of nitrogen, enough to fertilize a 50 by 100 foot garden. This garden in turn can grow more than enough fruits and vegetables for his needs.

What are we to conclude about the preceding discussion? It is not a plea to revert to a pretechnological culture but a recognition that prudence should cause us to consider *all* possible answers and modifications thereof. Dr. Hidetoshi Matsuo, a technical officer of the Food and Agriculture Organization of the U.N., writes of the visit of an American Plant Studies Delegation to China which stated, "When one compares the basic level of soil fertility of crop land in China with that of crop land in India, Pakistan, or many other developing nations in Asia, Africa, or Latin America where organic matter is generally used as fuel, the beneficial effects of the Chinese practice is very apparent. The value of organic fertilizers is universally appreciated in China. Virtually no chemical fertilizers were used in China before 1960, and soil fertility was maintained to the extent possible by use of organic manures, green manures, and silt and mud from the rivers, canals, and lakes." [25]

HIGH-ENERGY VS. LOW-ENERGY AGRICULTURE

Modern agriculture in the USA is an energy-intensive industry that relies heavily on electrical and fossil fuel inputs. Since the energy crisis, many recognize that this problem is *one of the most important facing us* for urgent and clear answers. The problem is that we have to learn how to use energy more sparingly and more efficiently in our agricultural operations. We have to create a "low-energy" agriculture, which means a special system of agriculture that will increase the quantity of food obtained from a

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The IEEE Society on Social Implications of Technology (SSIT) is now an approved reality. A full range of activities—conferences, symposia, publications—is now possible. Membership in SSIT gives you the opportunity to participate in these activities, to meet and exchange ideas with others who have technical and professional interests in the social implications of technology.

Your Society membership dues entitle you to receive the new *IEEE Technology & Society Magazine.* Being an archival publication of permanent reference value will make *Technology & Society* even more appealing to authors and will serve to enhance its quality. Society dues for current subscribers are included in the dues statement for 1982. IEEE members not now subscribing to *Technology and Society* are urged to join the new Society by February 1, 1982 in order to receive the first issue of *Technology and Society Magazine.*

Libraries and people who do not wish to join IEEE may subscribe to *Technology & Society Magazine* at an annual rate of $11.

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Bogumil, continued from page 1

A session on *affluence and waste* was planned by M. Benjamin for *INTERCON '74* and a *Workshop on Engineering in the Service of Society: New Education Programs* held at the University of Kentucky. The workshop, organized by J. Jackson and A. Robbi, was addressed by J. Truxal, J. Jackson, G. Sinclair, B. Myers and L. Zelby among more than twenty presentations.

CSIT participated in the *Conference on Engineering Ethics* (Baltimore, MD, May 1975) chaired by V. Paschkis and sponsored jointly by the ACS, AIChE, AIMMPE, ASCE, ASME, IEEE and NSPE. A *Highlight Session on Social Implications of Nuclear Power* was organized by J. Kaufman for *INTERCON '75* with the collaboration of the IEEE Power Engineering Society. CSIT became enmeshed in a controversy with its conservative stand in support of the IEEE constitutional prohibition of restricted meetings or sessions. Another minifuror was provoked by the Committee's strong recommendation that employment practices guidelines, developed by USAB as a model for enlightened corporate engineering personnel policy, be applied to IEEE technical staff. Other protests followed a letter of inquiry requesting information pertaining to the case of a former Chilean government employee and Rector of the Universidad Technica del Estado who, reportedly, had been imprisoned without charge, in apparent conflict with the spirit of the just mentioned employment guidelines. (Professor Kirberg was subsequently released and expressed his support and concern for others in person at a 1976 CSIT meeting.)

Efforts by S. Unger, the CSIT Working Group on Ethics, R. Anderson, W. Elden and others resulted in an historic *amicus curiae* brief, filed by the IEEE in the BART case, setting forth the principle that every engineer's employment contract contains an implied term that requires the protection of public safety. U.S. national debate over nuclear power was intensified by a 1976 California plebiscite. The proposed California Nuclear Safeguards Act required a measure of safety certification that might have eliminated the use of nuclear fission power plants in the state. The IEEE issued a statement opposing passage of the legislation (which did subsequently fail.) The CSIT position was that the Institute should make every possible effort to provide accurate technical information on all aspects of such matters but that technical expertise must remain subservient to the authority of an informed electorate to establish broad policy and priorities. Because of special features of the situation (including federal limits on industry liability) it was considered that the IEEE statement abused this principle. On a more positive note, D. Redfield joined the CSIT Energy/Environment group and very effectively encouraged IEEE advocacy of solar energy technologies, including a symposium at *ELECTRO'77, Solar Energy: A Status Report.* V. Paschkis and M. Benjamin organized a Conference on Social Consequences of Technology. C. Barus and N. Sinha contributed to newsletter review and publication activities.

J. Jackson organized a symposium dealing with crime countermeasures. J. Kaufman ultimately succeeded in obtaining Institute approval of an *Award for Outstanding Service in the Public Interest.* This proposal was regarded as highly controversial in that the award specification suggested that special recognition be given to such service performed despite personal (financial or career) risk. The award was first presented to three engineers who had been summarily dismissed as a consequence of their expression of concern regarding uncorrected design problems affecting safety of the BART (rail) system. In a subsequent year it was presented to an engineer discharged after filing a memorandum on possible degradation of police emergency dispatch response time by a computer program for which she was responsible. P. Edmonds, D. Cook (Nuclear Plasma Society) and L. Nagel (Environmental Quality Committee) have been instrumented in soliciting Award funds. In the absence of effective IEEE Code of Ethics support procedures, CSIT authorized its Ethics group, under S. Unger, to study actual case histories. Several influential reports resulted from this work. An Institute Member Conduct Committee was subsequently assigned responsibility for ethics code support and enforcement procedures. Not withstanding principles espoused in both the Code and the IEEE Policy and Procedures Manual, CSIT encountered strong opposition to its efforts to ensure that, in instances when "expert" testimony is given to legislative bodies in the name of the IEEE, relevant Institute Position Papers and responsible dissenting views (if any) are provided. CSIT has also participated in the review of proposed position statements, in particular those originated by the Energy Committee and the Committee on Man and Radiation.

A European CSIT Working Group has functioned for several years, created by the decision of members of the Swiss IEEE Section to affiliate with the Committee. H. Rudin, S. Sarkar, R. Peter, J. Tödtli, H. Koller, E. Biefer and D. Kramer have been active in their projects. A Washington D.C. area CSIT group was formed by M. Abramovich, W. Anderson, M. Apter, T. Hewitt, R. Labonski, S. Thomas and others.

J. Demetry, T. Sheridan, M. Schwartz, O. Friedrich, B. Friedland, I. Feerst, H. Cherney, H. Chestnut, J. Andresen, L. Stine, R. Harris, J. Lindsay, V. Edgerton, R. Grow, D. Wilson, M. Weiss, C. Landis, H. Brown, R. Bibbero, R. Brook, and A. Gruenwald have participated in Committee activities. F. Furfari, J. Jatlow, W. Underwood and S. Unger have served CSIT both by direct participation and by their efforts, on an *ad hoc* TAB committee, in drafting the new SSIT Constitution. E. Wolff, B. Barrow, H. Goldberg, and R. Hansen served, *ex officio,* as CSIT Chairman at a time, during their respective tenures as TAB Vice Chairman, when this was required by charter and more recently, G. Rodrigue and H. Brown have provided TAB liaison support. A. Robbi, M. Benjamin, S. Unger, F. Kotasek, P. Edmonds, J. Kaufman and G. Rabow, for many years in various capacities and, more recently, R. Koch, L. Zimmerman and P. Lubell have been elected officers of the Committee. Perhaps the most

Newsletter Editor. As if in atavistic sacrifice of the messenger with disagreeable news, none have been more reviled by CSIT critics. In succession, M. Pessah, V. Klig, N. Balabanian, F. Kotasek and N. Balabanian (again) have served capably and courageously at this task.

This service to the Committee, the Institute and the profession has been performed, in large measure, at personal sacrifice of time, effort and expense. In contrast to many other technical and professional activities, neither corporate employers nor the Institute has provided general expense reimbursement. However, it is also the case that IEEE Headquarters staff have provided indispensible assistance. R. Emberson and I. Engelson have given freely of their time and advice. P. Edmonds, E. Bidstrup, J. Breslin, R. Jerrill, J. Baker, M. Reisman, and B. Ettinger provided further support services. S. Coles/Wolfson, F. Newburg, D. Rhodes, J. Morsicato, T. Greco and J. Grondin have handled Newsletter production responsibilities. They have tolerated late manuscripts and revisions in a cooperative spirit.

Throughout its existence there have been allegations that CSIT has demonstrated an anti-technological bias, a serious charge to direct at any IEEE entity. It may even be that the brief account of its activities given here could further such beliefs. This would, however, represent a tragic misperception of the motivation, work and vital role of the Committee. Modern science and technology can be most beneficial when its application is tempered by a detailed appreciation of its limitations. While this may not suit the special desires of all groups, it is certainly in the general long-term interest of society and engineers. Through USAB and other programs the Institute has committed major resources to promotional activities. In our enthusiasm for the great benefits of contemporary technology, it is important that engineers not fail to also acknowledge actual or potential detrimental effects, for this is essential to engineering their solution.

Engineering Faculty and Students

Readers who are members of engineering faculties are urged to acquaint their students with SSIT and its quarterly magazine. A photocopy of the membership application form on page 6 to each student would help our cause. Copies of the September T&S and other promotional literature may be obtained through J. Jatlow, SSIT Membership Chairman, c/o IEEE Headquarters.

Editorial Staff Positions

Although a number of the staff positions described in the September issue have been filled, others remain open:

- Managing Editor
- Advertising Manager
- Promotions Manager
- Associate Editor in some technical areas.

Readers are urged to volunteer; contact the Editor.

given quantity of fossil fuel: in other words, a maximum yield from a minimum energy consumption.

"Low Energy" Agriculture can be characterized as follows:

1. Greater use of labor-intensive, soil-conserving methods. Prime technique is to maintain crop yields by using organic wastes and legumes in rotation to reduce application of nitrogen and other commercial fertilizers.
2. More direct marketing of food between farmer and consumer to reduce transportation energy costs.
3. The application of agricultural and urban wastes to the land.
4. Extraction of fuels from crop residues and utilization of the remainder as fertilizer.

Pimentel estimates that if we use all petroleum reserves solely to feed the world population, the 66 trillion litre reserves would last a mere 13 years if the population of 4 billion persons is fed an average American diet. [25] He suggests that low energy agriculture may be one of the answers to the world Agricultural problem but, at present, it is contrary to American agricultural policy. However, the U.S. Department of Agriculture (USDA) has recently given a hopeful sign in recognizing organic farming as a viable process. [26] Tanaka reports on his concept of energy efficiency in the production of rice in Japan. [25] One Kg of nitrogen can produce 15 Kg of brown rice and 15 Kg of straw. If all the rice is used for food, the rice straw could produce more than 2 Kg of fixed nitrogen, even if processed at a much lower efficiency than fossil fuel systems. Thus, the cycle could accelerate.

Pimentel calculates that U.S. agriculture produces about 5 tons of corn on one hectare (about 2.5 acres) with a total energy of 17.8 million Kcal while using up 7.1 million Kcal of fossil fuel inputs (fertilizer and machinery). So U.S. energy conversion gain for corn production is about 2.5. For primitive agriculture, the conversion gain is estimated at more than 16. [25]

There is some current interest in the U.S. in the development of alcohol as an alternative to oil for running agricultural machines, crop processing, and transportation. Some alcohol production programs utilize so called agricultural "wastes", some of which have traditionally been burned off. Where some special circumstance prevents the incorporation of such wastes into the land there *may* be justification for conversion to alcohol. Calculations of overall efficiency of this process should include the energy equivalence of the spent mashes which are valuable, high protein animal foods. The possibility of using these "wastes" as soil amendments should also be quantified and compared. Other alcohol plans envision the growing of specific "energy crops" such as trees, beets, cactus, or certain shrubs. Any such plans must include methods of attaining near-independence from high-energy fertilizer inputs or they will surely be destined to fail. This argument means that some sizable portion of the crop must be set aside to maintain soil fertility. Naturally such studies must also involve requirements for water,

harvesting, processing, and transportation, all measured in terms of energy cost.

CONCLUSION

We electrotechnologists are, like other human beings, prone to put on blinders, to focus almost exclusively on our own specialty. It is clear to me that many of us could contribute importantly to obliterating the wasteful practices of our culture. We could use our expertise to formulate and put into practice manufacturing and agricultural methods which would have a far better prospect of long-term survival than those currently in use. In order to do this we in the US must face some unpleasant facts of our present situation. As I see them:

1. If we attempt to continue consumption and waste at present levels, our civilization will collapse. This process can occur in a very few years.

2. Therefore, we must learn to consume less: food, clothing, shelter, amenities. In fact, we must begin to make our wants approach our needs.

3. The "Miracle of American Agriculture" is based upon a false premise, that "cheap" energy can continue to produce "cheap" fertilizers.

The cost of energy will continue to rise into the indefinite future even considering such large resources as domestic coal. We should learn from the "primitive" agricultures of the world and develop a "low-energy agriculture" of our own. This is the opposite direction from present corporate farming which is based on centralized control, highly mechanized methods, large energy inputs, and short-term high percentage return on investment. Unfortunately these methods are spreading rapidly to agriculture for export in third world areas. That these policies lead directly to waste is well known and has been documented by many. [27, 28, 29] That the productivity of small farms is superior to that of the giants is also known, even by our own USDA. [30, 31, 32]

We should not kid ourselves that most of the problems discussed can be solved by the application of "high" technology. They cannot. What is needed is a different technology, more appropriate to new conditions, and a willingness of technologists to devote their creativity and energy toward the public good in the face of demands for their technical services and their "loyalty" by employers or others having short term economic goals which conflict with the public good. It won't be easy.

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Letters

An advance copy of the editorial titled "Public Positions on Controversial Technical Issues" that appeared in the September issue of T&S was made available to the Committee on Man and Radiation (COMAR) and the Committee's response invited. A letter dated September 14, 1981 from Dr. Om P. Gandhi, Chairman of COMAR, was addressed to R. J. Bogumil, Chairman of CSIT. This letter was subsequently (October 13) submitted by Dr. Gandhi as the COMAR response.

Mr. R. J. Bogumil, Chairman
Committee on Social Implications of Technology

Dear Mr. Bogumil:

At its meeting on August 12, 1981, the Committee on Man and Radiation (COMAR) discussed the editorial by Dr. Balabanian which is scheduled to appear in the forthcoming issue of your newsletter *Technology and Society*. We are deeply disappointed that, without bothering to understand the background and facts, an individual of a sister committee has chosen to editorially criticize our entity position statement on "Human Exposure to Microwaves and Other Radiofrequency Electromagnetic Fields." (His right to do so as a private individual is not questioned). The facts are as follows:

1. At the time I acceded to Dr. Balabanian's request to publish our position statement verbatim in the newsletter *Technology and Society,* I was not told and did not realize that he was going to write an editorial longer than the original statement itself. We are wondering whether the contents of the editorial received the sanction of your committee.
2. This position statement has been examined and reexamined by COMAR in its various drafts over a period of seven years. The draft chosen for the committee's vote was devoid of references because of our misunderstanding of the format of IEEE position papers.
3. The position statement in its last version (April 1981) was approved by regular members of COMAR by a vote of 25 to 1, with the lone negative vote cast by an individual who wanted to see the paragraph comparing the EM fields to X-rays and other ionizing radiation eliminated from the text.

   Of the thirteen intersociety liaison members, only seven voted—all were for approval of the position statement. I did not, unfortunately, recognize the importance of their vote and did not therefore urge the remaining six to vote.
4. Contrary to the assertion of Dr. Balabanian, the committee is not composed predominantly of engineers. The current composition of COMAR by disciplines is seven engineers, seven physicists, eight life scientists, and four physicians. The roster of the committee is attached. The committee consists of some of the most prominent individuals in the field, with the present President and Vice tromagnetics Society, as well as the editor of the Society's journal having been working members of COMAR for the last several years.
5. The committee stands by the basic contents of the paper, but is prepared to alter the wording somewhat to satisfy the format of the IEEE position papers. At the recent meeting of COMAR, for example, a few changes were made. A revised draft (August 1981) is attached herewith for your perusal.
6. The document has been approved, in principle, by TAB at its meeting on June 5, 1981, with a proviso that the exact wording may be modified somewhat as a result of responses of the members of TAB after they have had a chance to read it carefully. The six responses received so far have generally been in the affirmative, with an input "no problems with the write-up."

From the foregoing it is apparent that a great deal of misunderstanding exists and, by this editorial, is being perpetuated by Dr. Balabanian. Like the other societies of IEEE, if you anticipate a continuing interest in the deliberations of COMAR, you should appoint a liaison member of our Committee. We value the inputs of our thirteen liaison members who get to comment on the draft position statements and vote on them in their final versions. In fact, six of these members attended the August 12, 1981 COMAR meeting in Washington, D.C.

We would welcome and appreciate a response to this letter from your committee.

Om P. Gandhi
Chairman, COMAR

To the Editor:

Your editorial, "Public Positions on Controversial Technical Issues" (T&S September 1981), makes a number of valid points in criticism of the proposed IEEE position paper on human exposure to microwaves and other RF EM fields. The tone of the paper, drafted by the Committee on Man and Radiation (COMAR), seems to be defensive and impatient with public concerns that have been expressed. Peter Lubell's comments introducing the COMAR paper reinforce the perception that the position statement is a response to recurring exaggerations in the public media.

An IEEE position paper on this subject would indeed serve the public interest at this time, given adherence to the high standards, as outlined in your editorial, that should be expected of a professional society in issuing such a statement. However, resentment of journalistic exaggeration is not a sound basis for such a paper, nor is the understandable but self-serving desire of the industry to allay public fears.

The Atomic Energy Commission and its successor agencies, together with the nuclear industry, have long since become masters of the pontifical public-soothing statement, such as: "There is no possibility of hazard to the general public at this time," even following bomb-test mishaps or events like Three Mile Island. We can surely expect higher standards than that in a professional position paper by IEEE.

Although I am inclined to agree with COMAR's unsupported claim, "In summary, the position of the IEEE is that there is no cause for public concern...," at least for the present, it is not the kind of assertion that belongs in a professional assessment. And maybe there *is* cause. I worked on microwave equipment extensively for the Navy in World War II. At age 52 I had to have cataract surgery. Cause and effect? There is no evidence either way. But I have seen many a private power boat equipped with radar that sweeps just inches above the helmsman's head. And what about microwave ovens? New ones are undoubtedly built to strict specifications, but there must be many in use with poorly fitting doors and deteriorating gaskets.

In any case, there *is* cause for concern in the future as the electromagnetic environment becomes increasingly intense. Well-founded standards introduced today could prevent both public hazard and public anger in the future. COMAR's call for further research might appropriately lead to an IEEE position that present standards are inadequately based and should be promptly and completely reassessed.

The history of standards of "permissible concentrations" of hazardous chemicals or radiation has invariably been one of progression from no limits to ever tighter limits as the true extent of the hazards emerged with experience and research. The case of ionizing radiation is a prime example. It is hard to believe that further research could lead to standards *less* exacting than present for non-ionizing EM radiation.

Finally, there is the principle of burden of proof. Surely the burden is on the promoters of a technology to prove it safe—not on the general public to prove it unsafe. To the extent that IEEE is (as it seems to claim) a neutral, disinterested professional society, it should support this principle. To the extent that IEEE is a promoter of technologies, its position papers will lack credibility.

Carl Barus
Professor of Engineering
Swarthmore College
Swarthmore, PA 19081

To the Editor:

I have reviewed the position paper adopted by the Committee on Man and Radiation (September 1981) and found it to be very well done. I believe the fundamental analysis and conclusions are correct. Needless to say, in all such matters there are unknowns; however, the evidence to date concerning these matters and the potential to man are so scant as to eliminate any present concern.

After working in this field for nearly forty years in direct contact with microwave radiation along with my colleagues, I do not know of a single case where biological damage has occurred, or could even be construed to have occurred. Your editorial takes the position that such committees must be "more proper than Ceasar's wife". I have the deep seated feeling that we are once again dealing with an environmentalist attitude that is more interested in a no-build philosophy than in scientific and constructive analysis of available data.

While I certainly agree that all reasonable evidence should be continuously evaluated, it appears to me that your editorial takes the position that to use any such technology one must first prove it does cause trouble. Obviously, this is a contradiction that allows little latitude for progress.

Thomas L. Leming, Senior Vice President
MCI Telecommunications Corp.
1133 19th St., N.W.
Washington, DC 20036

To the Editor:

I was especially pleased by the juxtaposition of the IEEE statement regarding low-level radiation dangers from microwave ovens, TV sets, etc., and the editorial assessment that followed it in the last issue. It was an excellent example of ways in which seemingly thorough "expert opinion" in fact is seen to leave a surprising number of unanswered questions. Yet, and here I can only speak for myself, I was at first quite reassured by the IEEE pronouncement...until I read editor Balabanian's critique. Then I could only wonder at my ignorance of the complex issues involved.

David L. Dungan, Director
Colloquy on Technology, Society & Common Good
University of Tennessee
Knoxville, TN 37916.

To the Editor:

I find the two articles in the June, 1981 issue of Technology and Society to be filled with false and misleading statements, half-truths, and truths out of context, to the point that they add up to a totally biased presentation supporting nuclear power. Let me point out the worst of these.

The second paragraph of Del Sesto claims that improved regulation will make nuclear power plant operation safer. But this is true only to the extent that the regulations are sound from the point of safety—engineering safety, to be exact. Further, there is a claim that improved regulations take a "myopic view of the underlying social and political issues." This statement, and the ensuing discussion, are themselves myopic, in ignoring the fundamental aspect of safety, and in claiming that nuclear power, because it is power, requires and deserves its own set of rules.

When the author claims (page 3) that "These people...shared a larger vision of reality..." what he means is what they *conceived* to be reality. The full story of the difference between the conception and the reality is not yet in, but it seems clear that the people were excessively optimistic, negligent of critical factors, and uneducated, outside their own field. A dangerous combination.

When the author claims that differences in regulation are indicative of significant social conflict (first full paragraph, page 4), he fails to comprehend the root of the issue—safety. When people's concern over safety has been reinforced by carelessness, and cover-up on the part of

their promotive propaganda, open conflict can, and has, become widespread. But is it "social conflict" when a victim of a crime calls for an improved police system? I think not.

Rooney at least does acknowledge (page 6) that: "Safety is the essential issue." But from this point on, the author is willing either to display ignorance or to bend facts to suit prejudices.

The statement that the "safety history...suggests that TMI and Brown's Ferry are exceptions" flies in the face of facts. The long history of breakdown, accident, and failure simply suggests that these are just part of a distribution of size of accident—and by no means the largest which can occur. [See Editor's Note below.]

I would have assumed that no one would any longer make the statement about the relative risk of driving to work and nuclear power. It neglects the difference between voluntarily undertaken risk and risk imposed by others—others who are so sure of the risk that they have demanded, and gotten, a limit on the financial risk they can be held liable for.

The statement that "The major concern with a normally operating nuclear plant is the...emission of certain radio nucleides" is untrue. The handling, reprocessing and "storage" of spent fuel and used components is of far greater concern. The comparisons with sunbathing, living in Denver and coal burning are specious; in particular, the author neglects the fact that radio nucleides released by fuel is a long-term process. He further neglects the so-far-plant. And regarding storage in salt mines, the author seems to be unaware of the events in the mine in Louisiana—an extreme case, to be sure, but enough to reinforce doubts.

The arguments regarding terrorist groups grossly underestimates the capability of such a group, if backed by a trouble-seeking national power. And it neglects completely the problem of a rogue or power-hungry government, and of takeover of a government.

A final comment. There is nothing wrong with pro and con papers per se. But they must be accurate. And in a technical society this means technically accurate.

R. P. Haviland, (Fellow, IEEE)
2100 S. Nova Rd., Box 45
Daytona Beach, FL 32019

Editor's Note. Utilities licensed to operate nuclear power reactors submit monthly Licensee Event Reports (LER) to the NRC. An "event" is any occurrence in which "technical design specifications" are exceeded; they range from minor to very serious. In 1980, the number of such events reported was 3800. Of these, 57% were attributed to equipment failure, 20% to human error and 16% to design/fabrication error. Fully 104 events were classified as "especially significant." But is it really possible to classify *any* event as minor? The stuck valve at Three Mile Island in 1979 was originally classified as "minor."

A FINAL REMINDER: JOIN SSIT FOR 1982

form on page 6

Calling All Authors

With the March 1982 issue, *Technology & Society* will be transformed into the new *IEEE Technology & Society Magazine.* Members of the new Society on the Social Implications of Technology (SSIT) will receive this quarterly publication. Other IEEE members who do not wish to join SSIT, libraries, or nonmembers of IEEE can subscribe to the magazine.

Potential authors are invited to submit articles of high quality on any topic lying within the scope of SSIT, including the following areas:

—health and safety implications of technology
—engineering ethics and professional responsibility
—education in social implications of technology
—history of electrotechnology
—technical expertise and public policy
—social issues related to energy
—soical issues related to information technology
—social consequences of technological process wastes
—social issues related to telecommunications
—systems analysis in public policy decisions.

Three copies of each article should be submitted to the Editor. Length is flexible but a typical article will consist of 8–15 double-spaced typed pages. All notes and references should be consecutively numbered and should appear at the end of the article.

Brief notes and comments should be submitted as letters to the editor—two copies, doubled-spaced.