TECHNOLOGY and SOCIETY

IEEE

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

EDITOR: NORMAN BALABANIAN

VOL. 9, NO. 3, SEPTEMBER 1981 (USPS 321-090)

Social Implications of Technology: the Past and the Future

R. J. BOGUMIL

On June 6, 1981 the Executive Committee of the IEEE gave final approval to formation of the IEEE Society on Social Implications of Technology (SSIT). This action, in response to a membership petition circulated by CSIT in 1980 was the culmination of efforts extending over many years. In fact, a similar membership petition nine years earlier led to formation of CSIT. This is not to imply that the past nine years have been spent unproductively and this occasion provides an opportunity to mention at least very briefly a few of the many worthwhile activities of the Committee.

From its inception CSIT was remarkably unsuccessful in avoiding controversy. The reasons for this have been and remain somewhat puzzling. By its charter, there probably has never been (nor may ever again be) an IEEE entity as open to direct participation by the general membership. The CSIT Newsletter has had a long tradition of publishing correspondence from both critics and supporters, and has actively solicited articles to illuminate all informed viewpoints on any and every topic covered. One is forced to conclude that it is the expression of divergent views which has itself become controversial.

The author is Chairman of the Committee on Social Implications of Technology.

SOCIAL DEBATE

It may be that education and technical specialization predispose engineers to the notion of a single correct answer to all problems with a technological component. Debate must then be for the purpose of convergence to this truth. By superimposition of some democratic concepts, it is a small step to assert that the single correct answer to any such problem is the one subscribed to by the greatest number of trained engineers within the appropriate specialty. Ironically, the fact of the matter is that engineers, through intimate acquaintance with the process of design trade-offs, should be more aware of the subjective nature of technical decisions than the general public. An offsetting consideration is the tendency, once a decision has been made, to steadfastly resist its reexamination—in the interest of accomplishing the task at hand.

It is a quirk of technological history that major advances have attracted little notice amidst great debate over various peripheral issues which are then quickly forgotten in the

(Bogumil, cont. on p. 19)

In this Issue

Social Implications of Technology: The Past and the Future, *R. J. Bogumil* 1
Letters to the Editor 2
Non Ionizing Radiation: Fact and Fiction, *Peter Lubell* 3
Human Exposure to EM Fields, COMAR 4
Editorial: Public Positions on Controversial Technical Issues, *Norman Balabanian* 5
Book Reviews 7
Annotated Bibliography of Periodicals, *Nancy Perlman* 10
News, Notes, and Comments 12
Membership Application 13
Engineers and the Work that People Do, *H. H. Rosenbrock* 14

To the Editor:

Upon reading both Chalk's and Winton's articles in *Technology & Society,* I was appalled at their lack of understanding regarding the ethical dilemma faced by engineers. Unless the problem is understood, all solutions are of negligible value. Engineers through both the nature of their training and work tend to be highly rational. Ethics by its nature, tends to be emotional and thereby irrational. An emotional view becomes irrational when it conflicts with reality. Till such a conflict occurs, one can maintain emotional views of any kind. Reverend (father) Jones of the People's Temple represents this clearly. His appeals,etc. had a considerable dose of emotionalism and he received support from many religious, social and political leaders as has been indicated by the books, articles, etc. written on the subject since the tragic Guyana affair. Only when reality impinged on what he said and did, were comments made regarding his rationality.

To show the dilemma faced by engineers more clearly, two current examples in an abbreviated format will be cited. First, the need for the ever increasing oil requirements in the world caused the large multinational oil companies to locate and drill for oil in the most promising and least expensive areas. A rational decision. These areas were in the middle-east. They are now blamed for these decisions and have been accused of all kinds of crimes in trying to do their job to the best of their ability. A second example relates to the use of nuclear energy. Here the need for energy is escalating and one means for obtaining it that is part of the state-of-the-art is nuclear. The vilification of engineers for this is well known, but are other options, knowing what we know now, viable? If no power, the engineers will again be vilified. A no-win situation.

Engineers, apparently, adopt two extremely divergent paths to cope with the ethical dilemmas. Engineers either bury their heads and noses in their work and close out the outside world or move into management and become spokesmen for more liberal arts, broadening the engineer, and less technology while in their hiring doing just the opposite.

Sincerely
Martin Levine
2269 Maiden Lane, SW
Roanoke VA, 24015

Winton responds

As I understand Martin Levine's letter, he wishes to perpetuate the division between the two roles of every engineer—the technical role connected with professional work as an engineer, and the social, ethical, moral, role connected with the results of professional work which concern him as a citizen.

In my view the division of these two roles is a major reason why the engineer does not achieve greater status; if we look at professions which have achieved status, for instance doctors, we see that they have been able to merge the two roles. Eventually engineers must merge them too if they are to achieve real credibility with the public as a profession. Engineers may see themselves as having two roles which must be kept apart, but the public certainly does not see them in this way; the public expect engineers to take responsibility, or at least to show that they are concerned with the social, ethical, and moral results of their work.

Of course it is immensely difficult to merge the two roles, and it will lead to all kinds of difficulties and dilemmas, but now the IEEE will soon be celebrating its Centenary, is it not time we started trying to do it?

Robert C. Winton

Technology and Society

Editor

Norman Balabanian
Elec. & Computer Engineering Dept.
Syracuse University
Syracuse, NY 13210
(315) 423-4401

TECHNOLOGY AND SOCIETY is published quarterly by the Committee on Social Implications of Technology of the Institute of Electrical and Electronics Engineers, Inc. Headquarters: 345 East 47th Street, New York, NY 10017. Subscription price: $3.00 per year, IEEE members only. Second-class postage paid at New York, NY and at additional mailing offices.

has provided me with a wealth of thought-provoking articles.

Many of these articles have struck a chord, as engineers in Australia suffer similar ethical and moral dilemmas, even though the social environment here is significantly different from the United States. Many times I have been on the point of writing to you—but each time I allowed the impulse to pass me by. However, this time I have just prepared an article for the Australian IEEE Section's Newsletter, so I have taken the liberty of forwarding it, as I hope it will be of interest to you.

This article is deliberately brief and is written for a less sophisticated audience than would read *Technology & Society*. Many of the points I make deserve to be expanded but I will only elaborate on one of them.

Although the social aspect of technology is one matter relating to an Engineering Institution, it is not one of its prime objectives. In fact, it can cause a conflict of interests within an Institution—as is evident by the lack of success in forming an IEEE Society of Social Implications and Technology. Also an Institution only has a limited number of resources, so it will channel most of its resources into its primary objectives. In my opinion, the most satisfactory manner of dealing with this issue—Technology and Society—would be to form an Association with this being its prime objective. This Association could co-exist with IEEE, much the same as in Australia many engineers are members of both the Institution of Engineers, Australia and the Association of Professional Engineers, Australia, as both these organizations serve their specific but different needs.

Additionally, such an Association would be open to engineers from *all* disciplines; it would act as spokesman for the engineering profession as a whole. It could help resolve conflicts of interest in technical matters. It could help enlighten the community on technological matters. It could help resolve the ethical dilemmas of individual engineers.

Mr. W. R. Lachs, PE
7 Garnet Avenue
Lilyfield, N.S.W.
Australia 2040

Non-ionizing Radiation: Fact and Fiction

Public awareness of the "potential health hazards" of RF and microwave radiation dates from the disclosure, in 1972, of Russian irradiation of the U.S. Embassy in Moscow. Previously, so-called "death rays" had been relegated to the pages of science fiction. This concern was heightened a few years later by a series of expose-type articles by Paul Brodeur, which appeared in the *New Yorker* magazine. While it is certainly not a scientific journal, the *New Yorker* reaches a highly intelligent and decisive element of the general population. These articles were soon followed by the publication (in 1977) of Brodeur's sensational book, "The Zapping of America," wherein he contended that the entire U.S. population was immersed in a toxic sea of unhealthy radiation. Most recently, in June 1980, a New York State Compensation Board, ruling that a New York Telephone Company technician had died of a disease labeled as "Microwave Sickness," caused a rash of articles in the public press with such headlines as: "Panel Says Mcirowaves Were Fatal "(*Newsday,* March 3, 1981) and "Microwaves: Are They a Peril?" *(The New York Times,* April 21, 1981).

Throughout the period following World War II, this question has been of significant concern to the scientific and engineering community. Notable IEEE activities include a special issue of the *IEEE Transactions on Biomedical Engineering* (July 1972) and a recent article by Eric Lerner in the December 1980 issue of *Spectrum.*

Typically, these technical studies have not received the widespread exposure of the public media pronouncements, which is unfortunate, since they provide a balanced review of the question supported by factual evidence and technical references. IEEE established a Committee on Man and Radiation (COMAR) to help ameliorate this situation and to develop an IEEE position on this question which would be based on fact rather than speculation and which would then gain exposure in the public media. What follows on the next page is the draft dated April 1981 of the COMAR position statement, which is presently before the IEEE Technical Activities Board for review, with an ultimate goal of producing an IEEE Position paper. This draft is being published in T&S, in order to make more IEEE members aware of the COMAR effort and to elicit responses from the membership, which will produce a document fully representative of the IEEE position in this matter.

Your comments, to the editor, will be appreciated and will be forwarded to the COMAR chairman, Dr. Om P. Gandhi. Promptness is desirable since the review is to be completed by year's end. We are grateful to Dr. Gandhi for this opportunity to publicize the work of his committee throughout the Institute.

Peter Lubell
SSIT Interim AdCom

Human Exposure to Microwaves and Radiofrequency Electromagnetic Fields

[April 1981 draft of a Position Paper adopted by the Committee on Man and Radiation (COMAR) and proposed as an IEEE Position Paper.]

The IEEE recognizes the public concern regarding the possible health hazards from the pervasive and ever-expanding use of devices that emit microwaves and radiofrequency electromagnetic (EM) fields. Safety guidelines such as those recently proposed by the American National Standards Institute Committee C95 appear quite adequate on the basis of our present understanding of the biological effects of EM fields. Because of the tremendous current and promising beneficial applications of this technology and several identified gaps in our knowledge, the IEEE also recognizes the need for continuing research on EM bioeffects to insure the safe use of such devices.

Modern man has learned to utilize and, indeed, to depend for his personal, social, economic, and political well-being on devices that generate microwaves and other radiofrequency (300 kHz–300 GHz) electromagnetic (EM) fields. Applications of EM fields in radio and television broadcasting, communications (long-distance telephony, commercial and personal use of amateur and citizen bands), navigation (ships, aircraft), and radar (military and civilian uses for detection and guidance, flight surveillance around airports, weather surveillance and prediction) are readily recognized. Applications of these fields in the home (cooking), industry (sealing, drying), and medicine (diagnosis, treatment) are burgeoning rapidly.

The prevalence of these man-made fields and their relatively recent introduction to the human environment has led to public concern over their possible health implications. The answer to this question must lie in rigorous research and dispassionate assessment of laboratory and epidemiological data. Present knowledge is not complete enough to supply final answers, but what is known is reassuring for the general population. The strengths of fields to which 99 percent of the North American population is exposed are hundreds of times below current U.S. guidelines of maximum permissible intensity levels for safe exposure and, indeed, are below the most restrictive limits imposed by any government, worldwide. With the exception of individuals in some occupational situations, the intensities, to which the remaining one percent of the population is exposed, are also well below the current U.S. guidelines. Clearly the known benefits of EM technology outweigh even the most speculative risks to the general population.

Because prolonged whole-body or part-body exposure to EM fields at very high field strengths may result in physical insult, the IEEE has a vested concern for the engineer, technician, or industrial worker who works in proximity to emitters of high intensity EM fields. Sound hygienic-engineering practices in the sork place can prevent excessive exposure. While readily implemented, these practices require surveillance by technically competent specialists to insure safe operation of such emitters.

The IEEE recognizes that the *perception* of risk is an important aspect of safety since the belief that even a benign agent poses danger is a threat to the well-being of the believer, and a source of obstructive and costly litigation when the belief is widely shared.

One of the more pernicious of unfounded beliefs is that EM fields have the same destructive effect on biological tissues as X rays and other ionizing radiations. In fact, their effect is vastly different. Cumulative irreversible damage can occur in tissues that are continuously or repeatedly exposed to ionizing radiations at low levels, but there is no scientific consensus to support the proposition that continuous exposure to low-level EM fields results in damage, irreversible or otherwise, to biological molecules.

A large body of data exists on the biological effects of exposure to EM fields. The data indicate that moderate levels of EM fields (average power densities of 1 to 5 mW/cm^2) are easily tolerated by human beings, at least for short periods, while prolonged whole-body exposure at high intensities (above 100 mW/cm^2) is dangerous at frequencies for which significant energy is coupled to the human body. These data have been judiciously applied by the American National Standards Institute Committee C95 in proposing a revision of the current guidelines of safe exposure to EM fields, which were issued in 1974. However, the data base is not complete. Specifically, continuing interdisciplinary research, involving life scientists, physicists, and engineers, is needed toward the following objectives:

1. An understanding of the mechanisms of interaction of EM fields with biological systems.
2. An understanding of the comparative biological effects of exposure to continuous wave, modulated, and pulsed EM fields at equivalent power densities and exposure durations.
3. Assessment of biological effects of intermittent or continuous exposure to weak EM fields (<1 mW/cm^2) over the long term (months to years).
4. Determination from measured values of EM fields, both the total energy and the internal distribution of energy that would be absorbed by mammals exposed to those EM fields, and prediction of the biological effects that would be produced by that absorbed energy.

In summary, the position of the IEEE is that there is no cause for public concern regarding the environmental levels of EM fields to which the general population is being exposed. In addition, prolonged exposure to levels lower than those recommended recently by the American National Standards Institute Committee C95 is unlikely to be

(Microwaves, cont. on p. 12)

Editorial

Public Positions on Controversial Technical Issues

The Proposed Position on Human Exposure to RF Electromagnetic Fields

A number of issues are raised by the release of IEEE position papers. The need for such releases is said to be public education. In a democratic society, the public must acquire accurate perceptions of reality surrounding important public issues which, in today's world, are largely of a technological nature. The information on which public perceptions are based must, therefore, be factual and objective, unbiased by private interests—whether economic or professional.

As a professional society, the IEEE is in a position—through its subsidiary Societies and special committees—to assemble and integrate the available data relating to issues within its scope and, by providing accurate, unbiased information, it can contribute to the understanding of technical questions confronting the public. Indeed, it has a responsibility to do so. However, in the formulation of such statements, IEEE must take pains to ensure that it remains more proper than Caesar's wife. There should not be even the appearance of self-serving. In particular:

(a) References to the scientific data and analyses on which IEEE conclusions are based should be given so that members of the public can go to the sources to verify their appropriateness and applicability.

(b) Starting assumptions and the ways in which the conclusions depend on them should be clearly stated. For it is often the case that changing the assumptions reverses the conclusions.

(c) Declarations should be made in unambiguous, intellectually honest terms.

(d) When there is doubt about the availability and adequacy of data, statements should not be made as if there were no doubt.

(e) More should not be claimed than the evidence honestly and unequivocally warrants.

(f) Statement wording should not imply the validity of positions which are in fact debatable.

(g) Objecivity would require that, if those having extreme and unreasonable views in one direction on an issue are chided, others taking equally extreme and unreasonable positions in the other direction also be chided.

(h) Public understanding is not advanced if pejorative and loaded terminology is used.

The IEEE Committee on Man and Radiation (COMAR) has proposed upgrading their committee position statement on human exposure to microwave radiation to an IEEE Position Paper. The IEEE Technical Activities Board has requested that members provide their opinions as part of the ongoing review process. As the reader may judge, there are reasons to assert that the COMAR document falls seriously short of the attributes above. Certain of these matters are discussed below.

1. INCONSISTENCY AND LOGICAL FALLACY

The fifth paragraph transgresses in a number of ways. The words "pernicious" and "unfounded" will not provide "public understanding" but will simply raise hackles. Furthermore, if this particular "pernicious" belief is to be pooh-poohed, why not denigrate also the equally "pernicious" and discredited belief held by many engineers that the only potentially adverse health effects produced by microwaves are bulk thermal effects?

But, more importantly, whether intended or not, the formulation of the final sentence in that paragraph is deceptive in that it makes a claim which is not justified. As can be demonstrated by the information contained in the sentence itself. To say "there is no scientific consensus" means that some scientific evidence points one way, some the other way. So, with equal validity, the *opposite* of the proposition can be claimed. But this formulation would demolish the point which the statement seeks to make.

Even if the concluson implied in the original sentence is accepted as correct, it still falls short of disproving what was called a "pernicious" belief. The terms which are set up in opposition in the first sentence of the paragraph are "EM fields" and "X-rays and other ionizing radiation." The final sentence purports to clinch the difference between these two types of radiation. But the two items compared in this sentence are "ionizing radiation *at low levels*" and "*low-level* EM fields." (My italics.) What may be true of radiation at low levels is not necessarily true at all levels. In fact, elsewhere in the statement, explicit distinctions are drawn between "low levels," "moderate levels" and "high intensities." How, then, is it possible to prove something for the general case on the basis of a claim made for a special case?

No special expertise in electrical engineering or radiation biology is needed to detect the internal inconsistency and logical fallacy in this paragraph, resulting in its deceptive appearance. Is it any wonder that the public mistrusts purportedly objective expert statements emanating from engineering organizations?

2. INACCURATE IMPLICATIONS

The formulation of paragraph 4 is confusing and is based on an implied scenario whose validity is questionable. (It should be noted that the language is very general; the "agent" could just as easily be a nuclear reactor, offshore drilling, or an oil pipeline.) In the phrase: "...the belief that even a benign agent causes danger..." who is it that is supposed to judge the agent to be benign, the believer that the agent poses danger? That doesn't make sense but is what the English requires. What I think COMAR means is that there are two actors: (a) the believer that the "agent poses danger" and (b) those of us who, by special knowledge, claim the agent to be benign. When there are enough "believers," they seek legal or adminstrative remedies. This is characterized by COMAR as "obstructive and costly litigation," implying that increased cost has nothing to do with the technology itself but results from the litigation.

This is an inaccurate image and does not correspond to reality. There are many cases when litigation and citizen participation in hearings have pointed up serious deficiencies in the original design and neglect of public safety. The increased costs are largely the result of the need to redo the originally defective design. A notorious case is the nuclear reactor started by Pacific Gas and Electric in Bodega Bay. Construction had to be halted and the project was abandoned only after citizens demonstrated to the AEC in public hearings that the reactor would be sitting right on the San Andreas fault and that the design was inadequate to withstand a modest earthquake. Not "costly litigation" but poor design and inadequate safety standards are the culprit, more often than not.

3. INADEQUATE INFORMATION

Since the issue in question has to do with the health effects of exposure to EM fields, one would imagine that some information would be clearly supplied about: (a) what the current US guidelines are for maximum exposure; (b) what health factors were included in their determination; (c) what other countries' standards are and what factors account for the difference; (d) why, nevertheless, there should be confidence in the US standards; and (e) how the incidence of radiation and the actual exposure of segments of the population can be expected to change with time, in view of the rapid burgeoning of applications noted. But that isn't the case. Instead, sweeping declarations are made which the public is asked to accept on faith with no way of evaluating them. (To the extent that this has been generally true of other IEEE position papers the matter requires general attention and remedy.)

The facts are that the US exposure standard of 10 mW/cm^2 was first adopted in 1966 and reaffirmed by ANSI in 1974. It was based exclusively on thermal effects; that is, on a simple calculation of the amount of heat a human body could dissipate from its surface and, therefore, the permitted amount that could be absorbed without a body temperature rise outside the normal range that could be handled by phsiological regulatory mechanisms. This standard was revised downward in late 1980/early 1981, by a factor of 10, to 1 mW/cm^2, but still exclusively on the basis of thermal effects; only the differential absorption versus frequency was taken into account.

When the 10 mW/cm^2 was first adopted, almost all American researchers in this area operated on the explicit assumption that were no such things as nonthermal effects, that only thermal effects could have any biological consequences. By now, almost all have accepted the existence of nonthermal effects. But does even the new revised standard take cognizance of this? Treating the human body as a mass of so many kg with a surface area of so many cm^2 fails to distinguish the difference between radiation effects on the eyes and on the feet; it fails to take into account the interaction and possible resonance effect between external RF fields and EM fields in the brain; it disregards th susceptibility to EM fields of prosthetic devices such a pacemakers; it neglects long-term effects, including geneti effects; etc.

The position paper does concede that "the data base i not complete" and that research is still needed in at leas four identified areas. All of these are precisely in nonther mal effects. Since the risks from such effects remain to b investigated, on what basis can the following statement i paragraph two be justified? "Clearly the known benefit of EM technology outweigh even the most speculative risk to the general population." Assuming the validity of a risk/benefit analysis, was one actually carried out b COMAR or anybody else? If so, what values were assigne to risks still to be determined by research?

FINAL THOUGHTS

The drafting of factual, objective, unbiased statement on public policy issues involving contemporary technolog is inordinately difficult. Attempts to do so by IEEE shoul be undertaken with great care that all perspectives on th issue are represented on the drafting group. Early draft should be disseminated for comment widely within the in

(Editorial, cont. on p. 18

Calling All Authors

With the March 1982 issue, *Technology & Society* as a Newsletter of CSIT will cease to exist. It will be transformed into the new *IEEE Technology & Society Magazine.* Members of the new Society on the Social Implications of Technology (SSIT) will receive *Technology & Society Magazine* as part of their dues. Other IEEE members who do not wish to join SSIT, 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
—responsibility of engineers for defective products
—education of engineers in social implications of technology
—history of electrotechnology
—technical expertise and public policy
—social issues related to energy
—social issues related to information technology
—social issues related to wastes from technological processes
—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 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, double-spaced.

Reviews

Telecommunications and Productivity, Mitchell L. Moss, ed. Reading, Mass: Addison-Wesley Publishing Co., 1980. 376 pp. $45.00, Index, Biography. *Reviewed by Robert J. Bibbero, Honeywell Inc.*

Many of us who are technically literate in the fields of computers and electronic devices feel competent to express our opinions of such topics as personal computing, cable television, electronic funds transfer, and word-processing. But in reality the future of these fields (lumped generally in this book under the heading of "telecommunications"), depends on many influences other than the technical. The purpose of this book, a report of a conference held last year at New York University's Center for Science and Technology Policy, is to address these "other inflences," the social, political, and economic factors. The participants and contributers, some 30 of them, included many people who would be classified as nontechnical, but who are experienced in such aspects of telecommunications as planning, system operation and programming, and legislative studies. They include a well-known political scientist (de Sola Pool), a vice-president of Western Union Telegraph, the Mayor of Westland, Michigan, and a former president of the Operations Research Society, among others.

The collection of papers by these people form an interesting and unusual slant on the broad aspects of public participation in telecommunications and the problems that will arise. The focus of this book is not the individual technologies, but the effect on people. Furthermore, this work of 28 papers is not a conference proceedings in the usual sense. They are formal papers, prepared after the conference and discussion, and represent an organized entity. The generally pervasive theme is the transformation of our daily lives that might be brought about by advances in communication technology: satellites, advanced video technology, microprocessors, word-processing and the trappings of the "electronic office." Of special interest are the descriptions of experiments in public access to large data bases through home computers or television (Viewdata, videotex, teletext, The Source, and the British, Canadian, and French systems). In a provocative paper, "Selling Teletext to Archie Bunker," questions are raised of the viability of such systems in light of the lowering literacy rate in this country, and the difficulty experienced by many people in operating keypads and other "esoteric" controls. Elsewhere, the question of productivity is raised, perhaps because of the currently perceived official interest in "supply-side economics," but this theme is less prominent.

The book is divided into six parts, covering potential, policymaking, social and economic aspects ("the Office of the Future"), home services, public uses of telecommunications, and emerging policy questions: "who shall control?" Of these, parts I, III, and IV seemed of greatest interest to this reviewer. In part I the failure by many to appreciate the importance of the productive and economic aspects of telecommunications is pointed out by Martin Ernst. This lack may well impede our progress toward an information society by inhibiting good planning.In part III the critical issues in the introduction of the automated office, electronic mail, and similar services are discussed by Marvin Sirbu. And in part IV, questions of design and access of such home services as viewdata are brought forth.

In sum, this book is a welcome improvement over the usual conference proceedings: it is timely, well prepared in terms of the individual papers, and is edited with a degree of continuity—a smooth fitting together of its parts—that is rare in this type of collection. if a nit is to be picked, it is the use of double-spaced typescript (the product of a cost-efficient word-processor, no doubt). If the "publisher of the future" is going to abandon the familiar beauty of letter-press type fonts for this kind of "camera-ready" copy, it is a social cost perhaps too much to pay!

Technology and Man's Future, 3rd edition. Albert H. Teich, ed. St. Martin's Press, 1981. 420 pages. $9.95. Reviewed by *Samuel P. Altman, Communications Research Center, Canadian Department of Communications, Ottowa, Ontario, Canada.*

This stimulating anthology presents diverse views of technology, and its role in modern society and "man's future." In its third edition of 1981, Albert Teich attempts to update it, to include current thinking and developments. However, the accelerating pace of technology itself and the reactions—instinctive or reasoned—by society and concerned groups have driven past this anthology's scope even in the short time since its publication. For example, a new American federal administration has swept into office, with changes in doctrine and objectives which must necessarily have profound impact upon technology's role in society.

The anthology is presented in three sections. "Thinking about Technology" brings together a diverse set of perspectives on the relationship of technology to society. "Forecasting, Assessing and Controlling Technology" is policy oriented, focussing on the need for concerted public action in matters related to technology. The methodology of *technology assessment* is the new and principal approach to this policy orientation and public-action need. "Reshaping Technology" questions the assumptions underlying mainstream, industrial technology and examines alternatives to it. The *alternative technologies* (AT) are divergent from the mainstream technology, and intended to assure a healthy symbiosis between society, its environment and the terrestrial ecologies. Although a few articles are anti- or protechnology, most attempt to examine technology in order to determine what it is, whether it is good for us and what could or should be done about it. Technology is discussed principally in its North American milieu, with only distant and summary observations of its impact on the developing countries, as viewed by international study groups and councils. However, since the American scientific and industrial communities and their technology are—in general—setting the pace for international developments, these observations on the North American scene are probably most pertinent to assessment of current and future technology's impact upon man's future.

Jacque Ellul's "thoughts about technology" are bitter and resigned. He imbues technology or "technique," and "the machine" with a life of its own—dehumanizing and degrading to the human spirit and aspirations. Although depressing to this human's spirit, Ellul has raised vital issues which must be discussed and resolved by individuals as well as society. However, in "Zen and the Art of Motorcycle Maintenance," Robert Pirsig brings human participation and pleasure in the man–machine interaction to life. His charming article captures some of the joy of working with a machine and making its idea work, in a unique literary style. The visions of technology by the other six authors in "Thinking about Technology" are comparably stimulating or provocative.

Technology is a concept which undergoes continuing change in form and character. Consequently, "forecasting, assessing and controlling technology" are formidable tasks indeed, not unlike the challenge of observing, talking to and persuading the jinni of Aladdin's lamp. In this case, it is unlikely to return into its bottle without taking its makers with it. Technology assessment predicts the interactions between a technology development and society, as well as the physical environment. This methodology is presented as a potentially promising step towards effective understanding of a given technology, and consequently its use for the common good. However, the time lapse between the inception of a technology and the observable effects of its ultimate use—noted repeatedly among the eight articles of the second section—has led Peter Drucker (in his 1973 article) to conclusions of monstrous error about automation and the computer. The information revolution, which had already started well before 1973, has resulted in precisely the effects which were predicted by others but which Drucker derided: its use in business, science and government. Moreover, the shock waves of the impact of the information revolution upon the media, entertainment and education of North America are still spreading out.

Alternative or "appropriate technology" (AT) is developed to meet the needs and conditions of a social milieu, rather than to sell or retread an existent mainstream technology, as discussed in the five articles of "Reshaping Technology." Among the several different attributes of alternative technology, the principal ones are decentralization and minimal disturbance of existing ecologies and environment. Although decentralization is personally appealing to an individual threatened by the large and inexorable organizations attendant upon centralized technology, its virtues and realizability have not yet been proven or clearly apparent, in my view, for many vital human needs.

Curiously, few of the articles discuss—except very obliquely—one vital element of technology: its origins and driving forces. Aside from the obvious fact that *Homo Sapiens* enjoys the creation and use of tools, the sciences and the arts provide stimulus as well as demand for technology. As long as science and art are part of humanity's culture and being, so long will technology be present. It does not exist solely to provide our physical needs, but to expand our mental and spiritual vistas as well. Perhaps Goodman, in "Can Technology Be Human?," intends this by his statement that "technology is a branch of moral philosphy, not of science."

This anthology is "must" reading for all, as a baseline for initial entry into the mainstream of thought about technology in society, as a guidepost for the many related works current and impending, and—hopefully—as a desktop reference for the decision-makers and "prime-movers" of the contemporary political, economic and social scene in the United States.

Science and Ethical Responsibility, Sanford A. Lakoff, ed. Reading, Mass: Addison Wesley Co., 1980. 331 pp. *Reviewed by R. Kitai, McMaster University, Hamilton, Ontario, Canada.*

Upon removing the plastic seal of the paperback with the above broad title on the outside cover, it came as a surprise to find, on the title page, that the book also has a subtitle "Proceedings of the U.S. Student Pugwash Conference, University of California, San Diego, June 19–26, 1979". One would think, then, that the main title of the book is hardly appropriate because of its generality. In a sense this is true, but there is much between the covers that renders the book of broader interest than one would at first suspect. It also contains much that is sobering and well-considered; so much, in fact, that this reviewer would be dismayed if his copy were to vanish from his bookshelf. The Pugwash movement and conferences began immediately after World War II from the appeals of Albert Einstein and Bertrand Russell on the threat of a nuclear holocaust. In this they were strongly supported by Szilard, Joliot-Curie, Born, and many other great figures. Why a student Pugwash? Because the average age of the original participants was seen to increase by one year with each passing year. It was likely realized, too, that our educational systems in science and engineering do less than adequately in sensitizing students to the major issues they will face as professionals and as leaders, and that a junior conference could provide useful preparation for future leadership. The conference organizers were of the opinion that while the Pugwash founders were obsessed with urgency, at times resorting to confrontation and seeking "quick fixes," a student Pugwash movement should instead take the cautious route of gaining an understanding of the roles of scientists and of their responsibilities in relation to present-day predicaments, and of formulating possible processes for circumventing predicaments instead of resorting to rapid "action." Whether the student Pugwash will have enough impetus and energy to remain alive after all of the Pugwash founders are gone would seem to depend on the students themselves, as well as on our general level of scientific responsibility.

The book is divided into four sections. The first is entitled "Science, Ethics, and the Aim of the Student Pugwash Conference," and consists of three addresses: one by Leifer on origins and objectives, one by Morin on encouraging scientific responsibility, and the third by Lakoff on ethical responsibility and the scientific vocation. The latter two would interest the general reader particularly. Morin is the director of the N.S.F. Office of Science and Society. His address explains the programs of his office—Public Understanding of Science as the oldest; next, Ethics and Values in Science and Technology (initiated by biologists and now about eight years in existence); and finally, Science for the Citizens. The last of these arises from the recognition that large institutions of all sorts have more access to scientific expertise and information than small groups and individuals. The latter should not be at a disadvantage at times of policy making and policy questioning, by being kept ignorant. Morin continues by stating that all of these programs pose ethical issues at three "levels." One of these is personal conduct—avoiding plagiarism, falsification and the like. The second level is that of personal responsibility for the social impact of scientific discoveries and applications. The third level is what is now quite widely known as "whistle-blowing." This refers to individuals, usually, who are employed to accomplish a particular objective, and who conclude that either their activities or the processes in which they are involved are likely not for the public good. They then "blow the whistle"—usually at considerable risk of being fired from their jobs. Lakoff's address on science as a vocation and on the associated ethical responsibility is an excellent treatise, spread over a wide canvas, and setting a tone rather than dealing with specifics. Lakoff is a Professor of Political Science, but he has great insight, too, into the pure and applied sciences as vocations. His address and Morin's alone make the book worth owning.

The remainder of the book (page 33 on) is devoted to a selection from over one hundred papers that were presented. Section II contains eight papers on Arms Control. Section III has seven papers on Biomedical Research and includes a reprint of Salk's "Toward a New Epoch." Section IV, entitled Sciences and Political Issues has eight papers on a variety of topics, which include lobbying, whistle-blowing, health and environment, mechanization of agriculture, energy and Asian development. Space does not permit a review of these papers here. There are also nine pages of Select Bibliography in small, densely packed print.

Morin makes another point—that being an expert on some highly technical and important subject does not mean that the person's "authority extends well beyond that range. An example is the Nobel Prize winner, who is an expert in his own subject, but who thinks that the award permits him to speak with great authority on every subject." This is as neat an example of innuendo as one could ask for—but let us leave personality aside. This issue that Morin raises seems to be particularly pertinent because it poses the vexing question of our own authority, as electrical engineers, to resolve many of the ehtical issues that arise within our profession—issues that are neither black nor white, but vary in shades of grey.

Economic Growth and Resources, Vol. 3. Natural Resources, Ch. Bliss and M. Boserup, eds. Proc. Fifth World Congress of the Int. Economic Assoc., Tokyo, 1980. New York: St. Martin's Press. Introduction & 12 selected papers, 210 pages. *Reviewed by Rudolf E. Kubli, Dr. sc. techn., Zurich, Switzerland.*

The third volume out of five on *Economic Growth and Resources* is concerned with the impact of natural, especially exhaustible resources on economic growth. The book is divided into three parts as follows: (1) Theories on resource use, mainly energy, (2) Population growth and important resource supplies, and (3) Technology and substitution of crucial resources.

The last chapter covers about half of the total volume and stresses the expected contributions of technology to the process of transition to renewable resources.

Prof. Ch. Bliss provides an introduction to the book which not only reviews the three main chapters, but at the same time gives a conclusive commentary on the topic; it is worth reading as an epilogue.

An in depth assessment of all the individual contributions is not possible in a few lines, owing to the wide variety of complex subjects like energy, food, tecnological innovation, quantitative models for social benefits, etc. However, it is possible to survey the main issues and point out some of the conclusions, particularly those which are common to different papers.

Despite the fact that there is neither enough theory, nor are there practical rules for the optimal rate of depletion of exhaustible resources, the overall conclusion on economic growth and resource supply is a very optimistic one. Great expectations rest on the powerful role of economic forces, such as cost-saving efforts, supply and demand balance, prices, etc. The pervasive impact of these forces on the direction of technological change, the "induced innovation", seems to be a generally accepted mechanism.

However, as this volume points out, there are quite a few requirements to be met in order to realize the substitution by technological innovation. Among them, mostly well known, are the following: long range way of thinking and planning; interdisciplinary approach to complex problems; substantial capital allocation, especially for energy R&D; and better understanding of the factors influencing R&D investments and effectiveness, as well as the future development of technology.

Another optimistic outlook refers to the supply and the availability of industrial minerals: they seem to be adequate in the long run. This statement is also based on the assumption that advancing technology will solve the supply problem, provided that there is not unlimited growth of consumption. The last aspect now leads to another side of the issue, also dealt with within the congress proceedings.

(Reviews, cont. on p. 11)

Periodical Publications Bibliography

NANCY PERLMAN

This list of periodical publications specifically concerned with some aspect of the social implications of technology was compiled from a selection in the Engineering Societies Library, the IEEE Center for the History of Electrical Engineering and the Tamiment Institute Library, New York University. It also includes periodical publications as listed and described in Robert F. Ladenson, et al., *A Selected Annotated Bibliography of Professional Ethics and Social Responsibility in Engineering.* Chicago: Center for the Study of Ethics in the Professions, Illinois Institute of Technology, 1980 and in Howard T. Bausman, compl., *Science for Society: A Bibliography.* Washington, D.C.: AAAS Commission on Science Education, 1972.

The Advancement of Science (quarterly). British Association for the Advancement of Science. London, New York: Adademic Press.
General articles in various science and society areas.

American Scientist (bimonthly). New Haven: Society of the Sigma Xi and the Scientific Research Society of America (since 1913).
General articles, frequently on social implications of technology.

Biology and Human Affairs (three issues per year). London, England: British Social Biology Council.

Bio Science (monthly). Washington, D.C.: American Institute of Biological Sciences.
Includes articles on life sciences and society and science education.

Bulletin of the Atomic Scientists (ten issues per year). Science and Public Affairs. Chicago, Illinois: Foundation for Nuclear Science (since 1945).
General articles emphasizing environmental, nuclear energy and nuclear weapons issues.

Business and Professional Ethics. A Quarterly Newsletter/Report. Troy, NY: Center for the Study of the Human Dimensions of Science and Technology, Rensselaer Polytechnic Institute.

C.I.S.S.T. Newsletter. Evanston, IL: The Northwestern University Center for the Interdisciplinary Study of Science and Technology.

Daedalus (quarterly). Boston, MA: American Academy of Arts and Sciences.
Each issue is generally devoted to a single major topic.

Engineering Issues. Journal of Professional Activities. American Society of Civil Engineers.
Papers on "professional and technical problems of broad interest, especially those dealing with the relationships of civil engineers with other disciplines and professions for the benefit of mankind."

Environment (ten issues per year). St. Louis, MO: Committee for Environmental Information.
Articles drawing attention to misuse of the environment.

Environment and Behavior (two or three issues per year). Beverly Hills, CA: Sage Publications.
An interdisciplinary journal dealing with perception and evaluation of man's physical environment.

Environmental Action. Newsletter, Environmental Action Group. Washington, D.C.: Environmental Action.
Contains short articles on specific legislation and envi ronmental problems and conferences. Geared to ecology activists.

Environmental Control and Safety Management (monthly). Morristown, NJ: A.M. Best.
Contains articles geared to a general audience and written in a popular vein. Also includes news items, reviews of relevant books and films.

Environmental Review (three issues per year: fall, winter, spring). American Society for Environmental History. Pittsburgh, PA: Duquesne University.
Includes articles, book reviews, notes. Written from an historical perspective. Of interest to the general reader as well as the student and historian.

Environmental Science and Technology (monthly). Washington, D.C.: American Chemical Society.
A professional journal with emphasis on the technical aspects of environmental problems. Short articles on current developments as well as feature articles.

Futures (bimonthly). Guildford, Surrey, England: IPC Science and Technology Press. Published in cooperation with the Institute for the Future, U.S.A.
Contains reports, reviews, list of relevant publications and meetings. For a broad readership.

The Futurist (bimonthly). Washington, D.C.: World Future Society.
A journal of forecasts and trends.

Impact of Science on Society (quarterly). Paris: UNESCO.
An international journal: articles of general interest.

Isis. Johns Hopkins University Press. Official journal of the History of Science Society.
The history of science and its cultural influences.

Journal of Biosocial Science (quarterly). Oxford, England: Blacksell Scientific Publications, Ltd.
Devoted to the "Social implications of human biology and of the biological background of many social problems."

Minerva (quarterly). A review of Science, Learning and Policy. Hampshire, England: Macmillan Journals, Ltd.
General articles in the area of the social and human implications of the medical and life sciences.

Nature Weekly. Hampshire, England: Macmillan Journals, Ltd. News and general articles as well as reports of original research.

New Engineer. MBA Communications.
Frequent articles on social issues and the social implications of engineering.

Perspectives in Biology and Medicine (quarterly). Chicago,

The author is the IEEE Archivist.

IL: University of Chicago Press.

General articles in the area of the social and human implications of the medical and life sciences.

Professional Safety (monthly). Park Ridge, IL: American Society of Safety Engineers (offical publication of ASSE)

Includes articles, book reviews, notices of professional meetings. Directed toward the professional engineer rather than a more general readership. Concerned with the social implications of technology.

Product Libility Trends. A Monthly Analysis of Product Liability Developments World-Wide. Charlottesville, VA: The Research Group, Inc.

The Public Interest (quarterly). New York, NY: National Affairs. Emphasis is on the social sciences.

Physics Today (monthly). New York: American Institute of Physics. General articles pertinent to physical science, its public policy aspects and impact on society.

Science (weekly). Washington, D.C: American Association for the Advancement of Science.

General articles as well as research reports, news reports, and books reviews.

Science For The People (biomonthly). Cambridge, MA: Science Resource Center.

Contains in-depth articles, science related, some with a political orientation. Includes book reviews, listing of relevant publications.

Science, Technology and Human Values. An Interdisciplinary Quarterly Review. Harvard University, Cambridge, MA: Aiken Computation Laboratory. (Founded as the Newsletter of the Program on the Public Conceptions of Science, 1972).

STPP News: An Interdisciplinary Newsletter on Science, Technology, Public Policy and Society. Lafayette, IN: Political Science Department, Purdue University.

Science Technology and Society (six issues per year). Curriculum Newsletter of the Lehigh University Science, Technology and Society Program.

Contains articles, course syllabae, book reviews, lists of relevant workshops and conferences. Readership would include those interested in curricula relating to the social implications of technology.

Scientific American (monthly). New York, NY.

Invited articles in science, applied science, current events.

Technological Forecasting and Social Change (eight issues per year). New York, NY: American Elsevier.

Includes articles on the effects of technology on society, book reviews. Technology orientation, reflected on contents and style.

Technology and Culture (quarterly). The International Quarterly of the Society for the History of Technology. Chicago, IL: University of Chicago Press.

Includes articles, book reviews, conference reports, exhibit reviews and announcements. A scholarly, humanistic approach to the social implications of technology, written from an historical point of view.

Technology in Society. An International Journal. Pergamon Press.

Ethical and value implications of science and technology, science and public policy; technology assessment.

Values Center News. Newark, DE: Center for the Study of Values, University of Delaware.

Zygon (quarterly) Journal of Religion and Science. Chicago, IL: University of Chicago Press.

Among other periodical publications which recognize the importance of the subject area by including it to some degree in their coverage are:

The Institute for Electrical and Electronics Engineers publications:

Proceedings of the IEEE
various IEEE Society Transactions
IEEE Spectrum

The Bulletin of Science, Technology and Society. Pergamon Press

Perspecties on the Profession. Chicago, Illinois: Illinois Institute of Technology.

Renaissance Universal Journal (quartely). Burlington, Ontario, Candada: Renaissance Universal Publications.

Readers are invited to suggest additions to the list. Those who publish in the field are encouraged to comment and perhaps an exchange of publications can be arranged.

(Reviews, cont. from p. 9)

Technologically speaking, many things might be feasible, but it is clear from the papers in this volume that political and social aspects heavily influence the problem-solving process. Well known examples are food supply and population growth perspectives.

Possibly, it is symptomatic that there are a lot of economic models on innovation processes and the social rate of return from industrial research (which tends to be high) but apparently there is no theory on induced institutional innovation. This aspect of the problem is best summarized by Bliss in the introduction: "the issues concern men, women and institutions and how they will adjust and change..."

The book is without any doubt a rich source of contributions to economic modeling, both theoretical and empirical approaches, including policy suggestions. Most of the papers review a well-defined aspect. However, the reader has to have a certain basic understanding of economic questions to assess the details of the arguments.

For an engineer the book gives valuable insight into the economic forces and factors influencing his work today and tomorrow. It does not leave any doubt about the amount of technological problems to be solved in the future.

Washington Area CSIT Meeting

Dinner meeting, Monday 14 September 1981.
Dinner 7–9 p.m.; cocktails 6:30
Sheraton Inn, 8727 Colesville Rd., Silver Springs, MD.

Guest speaker is Norman Christeller, Chairman of the Maryland-National Capital Parks and Planning Commissions. Will discuss political and planning processes used in regional development of one of nation's fastest growing areas. These processes are important in dealing with energy, transportation, environmental, and zoning issues.

Reservations required by September 1. Call:

Richard Labonski: (202) 637-1934
Susan Thomas: (703) 836-2356

Next CSIT Meeting

The next CSIT/SSIT Interim Adcom meeting is scheduled for:
Saturday, September 19, 1981. 10:15 to 3:15
Microband Corp., N.Y., N.Y.
Call Jeff Bogumil to confirm if you want to attend.

EQC Contributes to CSIT Award

The IEEE Environmental Quality Committee has set aside the sum of $1,250 from which it will contribute $250 to each of the next five *IEEE-CSIT Awards for Outstanding Service in the Public Interest.* The action was taken at the November 5, 1980 EQC meeting.

The award, which consists of a certificate and $750, is intended to recognize the engineer or technical person who acted to protect the public health, safety, and/or welfare despite risk to their career. Thus far, the award has been given to BART engineers Max Blankenzee, Robert Bruder, and Holger Hjortsvang (see T&S, December 1978), and to V. Edgerton, who had been employed as Senior Information Scientist by the Criminal Justice Coordinating Council of New York City (see T&S, June 1979). All four recipients had been fired in retaliation for informing top-level managements of faulty engineering practices, which produced potential hazards to the public.

The IEEE Nuclear and Plasma Sciences Society donated $300 to the CSIT Award Fund in 1979. The rest of the money has been donated by individuals. Anyone who would like more information about the award fund or the award itself is asked to contact Stephen Unger, (212) 280-3107.

Ethics Report Published

A report on the *Professional Ethics Activities in th Scientific and Engineering Societies* based on a surve study has been published by the American Association fo the Advancement of Science (AAAS). An appendix con tains excerpts from the IEEE Bylaws and the IEE] Member Conduct Committee report on the Virginia Edger ton case in 1978. The report also gives a summary of a twc day workshop which reviewed the role of professionɛ societies in developing ethical rules for their members. Ac cording to the report, there are few visible programs in th AAAS-affiliated societies directed toward ecouraging at tention to ethical concerns in science and engineering. Th suggestion is made that professional societies review on regular basis the values felt to be important in thei members' work.

(Microwaves article, cont. from p. 4)

hazardous to human health. Continuing research on th biological effects of EM fields is, however, needed to en sure that these guidelines or any revisions thereof ar soundly based. On the other hand, prolonged exposure t high-intensity EM fields can be harmful, except under pro per supervision in medical usage. There is consequently aı unquestioned need for continued surveillance to ensur that, with the ever-increasing uses of EM fields for thei obvious benefits, neither environmental nor occupationa levels of exposure exceed prevalent safety standards.

JOIN THE NEWEST IEEE SOCIETY

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. Any IEEE member not now receiving Technology & Society who joins the Society on Social Implications of Technology by September 31, 1981 will receive the December 1981 issue free; so act now. In addition, anyone not now an IEEE member who applies for IEEE and SSIT membership at any time in 1981 will remain a member for all of 1982 without additional dues. For current subscribers, the Society dues will be reflected in their forthcoming IEEE dues statement.

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

MEMBERSHIP/SUBSCRIPTION

IEEE

SOCIETY FOR THE SOCIAL IMPLICATIONS OF TECHNOLOGY

____
Print name (First, middle, last)

____
Street address

____

____
City State Country Postal code

☐ IEEE nonmember subscription to Technology & Society Magazine

☐ IEEE Member, No.☐☐☐☐☐☐☐ Please enroll me in the Society on SIT

☐ IEEE membership plus SSIT membership
☐ IEEE membership only
☐ I will volunteer for committee work (IEEE members only)

ONLY APPLICANTS FOR IEEE MEMBERSHIP NEED COMPLETE THIS SECTION

____
Signature

Date of birth______________________ ☐ Male ☐ Female
Month day year

Were you ever a member of IEEE? ☐ Yes If Yes, please furnish
☐ No

____
Grade Membership No.

EDUCATION (Highest level completed)

____
Name of educational institution

____
Course Degree received Date

ENDORSEMENT

____
Signature of an IEEE member who knows you professionally

Please check appropriate box(es) below:

IEEE nonmember T&S Magazine subscription fee, $11 ☐$______

Society membership fee; $6 annually. Includes subsription to Technology and Society Magazine ☐$______

Please check appropriate box(es) below:

IEEE entrance fee, $10 (Required for all applicants for IEEE membership other than renewals.) ☐$______

IEEE membership annual dues payment.
USA (Reg 1-6) $55 ☐$______
Canada (Reg 7) $50 ☐$______
Europe, Middle East Africa (Reg 8) $50 ☐$______
Other countries (Reg 9) $43 ☐$______
PAYMENT ENCLOSED $______
(Remit in US dollars or equivalent local currency.)

Make checks payable to IEEE.

Please mail to:

IEEE Service Center
Member Services
445 Hoes Lane
Piscataway, NJ 08854
USA

H. H. ROSENBROCK

I. INTRODUCTION

The phenomenon which I wish to discuss in this paper can be illustrated by a plant which was making electric light bulbs in 1979. Production was 800 bulbs an hour, of the type having a metallized reflector, and the components of the glass envelope were made elsewhere. They traveled on a chain conveyor around the plant, which occupied an area about 30 feet by 10 feet and was quite new. It was noisy, and the large room which housed it was drab, but conditions otherwise were not unpleasant.

The plant was almost completely automatic. Parts of the glass envelope, for example, were sealed together without any human intervention. Here and there, however, were tasks which the designer had failed to automate, and workers were employed, mostly women and mostly middle-aged. One picked up each glass envelope as it arrived, inspected it for flaws, and replaced it if it was satisfactory: once every four-and-one-half seconds. Another picked out a short length of aluminum wire from a box with tweezers, holding it by one end. Then she inserted it delicately inside a coil which would vaporize it to produce the reflector: repeating this again every four-and-one-half seconds. Because of the noise, and the isolation of the work places, and the concentration demanded by some of them, conversation was hardly possible.

This picture could be matched by countless other examples, taken from any of the industrialized countries. Beyond the comment that the jobs were obviously bad ones, and that something should have been done about them, we are not likely to be surprised or to feel that the situation was unusual. Yet, as I shall hope to show, what has been described is decidedly odd.

II. A DESIGN EXERCISE

To prepare the way, let us take one of the jobs, say the second one, and suppose that in a first year engineering degree course it was proposed, as a design exercise, to automate it. Picking up bits of wire out of a box is obviously not too difficult, but we can easily avoid it. Let the wire be taken off a reel by pinch rollers and fed through a narrow tube. At the end of the tube, let it pass through holes in two hardened steel blocks. Then we can accurately feed out the right length, and by displacing one of the steel blocks we can shear it off. If this is all made small enough, it can enter the coil, so that when the wire is cut off it falls in the right place.

So far, so good, but the coil may perhaps not be positioned quite accurately. Then, if we cannot improve the accuracy, we shall have to sense its position and move the wire feeder to suit. Perhaps we could do this by using a conical, spring-loaded plunger, which could be pushed forward by a cam and enter the end of the coil. Having found its position in this way, we could lock a floating carriage on which the plunger and wire feeding mechanism were mounted, withdraw the plunger, and advance the wire feeder.

There would be scope here for a good deal of mechanical ingenuity, but of a kind which might not appeal to all of the students. "Why not," one of them might ask, "why not use a small robot with optical sensing. The wire feeder could be mounted on the robot arm, and then sensing the position of the coil and moving the arm appropriately would be a simple matter of programming."

An experienced engineer would probably not find much merit in this proposal. It would seem extravagant, using a complicated device to meet a simple need. It would offend what Veblen [1] calls the "instinct of workmanship," the sense of economy and fitness for purpose. Yet the student might not be discouraged. "All that is true," he might say, "but the robot is still economically sound. Only a small number of these plants will be made, and they will have to bear the development costs of any special device we design. Robots are complicated, but because they are made in large numbers they are cheap, while the development costs will be much less."

After a little investigation, and some calculation, it might perhaps turn out that the student was right. A plant might even be built using a robot for this purpose. What I would like to suggest, however, is that this would not be a stable solution. It would still offend our instinct of workmanship. The robot has much greater abilities than this application demands. We should feel, like the robot specialist [2], that "To bring in a universal robot would mean using a machine with many abilities to do a single job that may require only one ability."

As opportunity served we might pursue one of two possibilities. We might in the first place seek to find some simpler and cheaper device which would replace the robot. Alternatively, having a robot in place with capacities which had been paid for but were not being used, we might attempt to create for it a task which more nearly suited its abilities. It might, for example, be able to take over some other task on a neighboring part of the line. Or we might be able to rearrange the line to bring some other suitable task within the reach of the robot. At all events, as engineers we should not rest happy with the design while a gross mismatch existed between the means we were employing and the tasks on which they were employed.

III. THE APPLICATION

The drift of this fable will have become clear. For robot, substitute man or woman, and then compare our attitudes. This I will do shortly, but first let me extend the quotation which was given above [2]: "However, it is less obvious that robots will be needed to take the place of human beings in most everyday jobs in industry...To bring in a

The author is a Fellow of the Royal Society and Professor at the University of Manchester Institute of Science and Technology, Manchester, UK, M60 1QD. *This paper was invited for joint publication in both IEEE Control Systems Magazine and in Technology & Society.*

abilities to do a single job that may require only one ability." There is a curious discrepancy here between the apparent attitudes to robots and to people, and it is this which I wish to explore.'

It will be readily granted that the woman whose working life was spent in picking up a piece of aluminum wire every four-and-one-half seconds had many abilities, and was doing a job which required only one ability. By analogy with the robot one would expect to find two kinds of reaction, one seeking to do the job with a "simpler device," and the other seeking to make better use of human ability. Both kinds of reaction do exist, though as will be seen, with a curious gap.

First, one cannot read the literature in this field without stumbling continually against one suggestion: that many jobs are more fitted for the mentally handicapped, and can be better done by them. The following are some examples.

"Slight mental retardation...often enables a person to do tedious work which would handicap a 'normal' worker because of the monotony.[3]"

"The U.S. Rubber Company has even pushed experimentation so far as to employ young girls deficient in intelligence who, in the framework of 'scientific management' applied to this business, have given excellent results.[4]"

"The tasks assigned the workers were limited and sterile...the worker was made to operate in an adult's body on a job that required the mentality and motivation of a child./Argyris demonstrated this by bringing in mental patients to do an extremely routine job in a factory setting. He was rewarded by the patients' increasing the production by 400 per cent. [5]"

"Mike Bayless, 28 years old with a maximum intelligence level of a 12-year old, has become the company's NC-machining-centre operator because his limitations afford him the level of patience and persistence to carefully watch his machine and the work that it produces. [6]"

Swain [7] remarks that "The methodological difficulties of using this...approach to the dehumanised job problem cannot be glossed over;" the meaning of which, one hopes, is that society would utterly reject it. Nevertheless, the quotations should alert our instinct of workmanship to the gross misalignment between human abilities and the demands of some jobs. A much more respectable response to this misalignment is the one which appeals to many technologists and engineers—that is, to carry the process of automation to the point where human labor is eliminated.

This becomes easier in manual work as the robot becomes cheaper and more highly developed. So, for example, in the manufacture of automobile bodies spot-welding is now regularly done by robots, and spray-painting also will soon cease to be a human occupation. Similar possibilities for eliminating human labor in clerical work are opened up by the microprocessor.

When it is applied to jobs which are already far below any reasonable estimate of human ability, there can be no

ficulties begin when we consider jobs that demand skill and the full use of human ability. To automate these out of existence in one step is never possible. They have to go first through a long process of fragmentation and simplification, during which they become unsuitable for human performance.

The mismatch between jobs and human abilities has also been approached from the opposite side by social scientists. Seeing the underuse of human ability, they have developed their techniques [8] of job enlargement, job enrichment, and of autonomous groups. These take existing jobs, and redesign them in a way which makes more use of the human abilities of judgment and adaptability. For example, in an autonomous group the allocation of tasks among its members is not imposed from outside but is left to the group itself to decide. The jobs that result can be better matched to human abilites, within the usually severe constraints of the technology. As Kelly [9] has noted, the opening which is given for the exercise of judgment and adaptability within the group may account for some of the increased productivity that been observed.

These, then, are the techniques available to us for eliminating the mismatch between jobs and human abilities. There are two which reduce the abilities deployed, one of them inadmissible and the other stemming from engineering. There is a group of techniques which seek to use the abilities of people more fully, and these stem from the social sciences. So far as I know there are no others of significance; and what is remarkable is that engineers and technologists have not produced any methodology for using to the full the abilities and skills of human beings.

The designer of the lamp plant, for example, had made its operation automatic wherever he could do so conveniently. Where he could not, he had used human beings. He might perhaps have used robots, and if so he would have been concerned to use them economically and to make full use of their abilities. He felt, it appears, no similar concern for the full use of human abilities. We may say, paradoxically, that if he had been able to conside people as though they were robots, he would have tried to provide them with less trivial and more human work.

IV. A PARADIGM

The conclusion we have reached discloses the oddity which was mentioned at the beginning of this paper. It is one that becomes more strange the more one considers it, and we are bound to ask how it arises.

The question has two parts: how do individual engineers come to adopt the view we have described, and how did this originate and become established in the engineering profession? As to the individual, engineers in my experience are never taught a set of rules or attitudes which would lead to this kind of view, nor do they base their actions on a set of explicit principles incorporating it. Instead, we have to imagine something like the "paradigm" discussed by Thomas Kuhn. [10] This is the name he gives, in the sciences, to a matrix of shared attitudes and assumptions and beliefs within a profession.

The paradigm is transmitted from one generation to another, not by explicit teaching but by shared problem-solving. Young engineers take part in design exercises, and later in real design projects as members of a team. In doing so, they learn to see the world in a special way: the way in fact which makes it amenable to the professional techniques which they have available. Paradigms differ from one specialization to another within engineering, so that a control engineer and a thermodynamicist, for example, will see a gas turbine in slightly different ways. Effective collaboration between them will then demand a process of mutual reeducation, as many will have discovered from this or other kinds of collaboration.

Seen in this way, as a paradigm which has been absorbed without ever being made fully explicit, the behavior of the lamp-plant designer becomes understandable. We still have to ask how this paradigm arose. This is a question which deserves a more extended historical study than any I have seen. Tentatively, however, I suggest the following explanation, which has been given elsewhere [11] in somewhat greater detail.

Looking back at the early stages of the industrial revolution we tend to see the early machines as part of one single evolution. Examples of the machines themselves can be found in museums, and in looking at them we see the family resemblance which they all bear, deriving from the materials that were used and the means by which they were fashioned. They were made of leather and wood, and of wrought and cast iron, and in all of them these materials were fashioned in similar ways.

What I wish to suggest is that there were in fact two quite different kinds of machine, similar only in their materials and their construction, but with opposed relationships to human abilities. One of them can be typified by Hargreaves's spinning-jenny, which he invented for his own or his family's use. It is a hand-operated machine, deriving from the spinning wheel, but allowing many threads to be spun at the same time. To use it demands a skill, which is a natural development from the skill needed to use the spinning wheel. This skill in the user is rewarded by a great increase in his productivity. Samuel Crompton's spinning-mule was a similar kind of machine, and even when it was driven mechanically it needed the skilled cooperation of the spinner.

The other type of machine can be typified by the self-acting mule which was invented by Richard Roberts in 1830. What Roberts set out to do was not, like Hargreaves or Cromption, to make skill more productive. Rather he set out to eliminate skill so that the spinner was no longer needed except to supervise a set of machines. Fragments of his job remained, such as mending broken threads, or removing thread which had been spun. These jobs were given largely to children, and they began to resemble the jobs around the lamp-making plant.

For reasons which were valid enough in the early nineteenth century, and which are well documented by Ure [12] and Babbage [13], the second course proved more profitable for the inventor and the manfacturer than the first. When the engineering profession arose later in the century it therefore inherited only one attitude to the relation between machines and human skill, which is essentially the one described above.

Whether this attitude is appropriate at the present time is something which I should question. In a broad economic sense, the underuse of human ability is clearly a loss. Some of the reasons which made it nevertheless profitable for an early manufacturer no longer apply with the same force. Unskilled labor is still cheaper than skilled [13], but much less so than it was at an earlier period. Once only skilled workers could strike effectively [12], but the less-skilled now, by their numbers, may have even greater industrial strength.

Under present conditions, the motivation of workers may be a major preoccupation of managers. By "quality circles" or other means they may strive to engage the abilities of the workers outside their jobs. By the social scientists' techniques of job-redesign they may seek to make the jobs themselves less repugnant to human ability. For engineers to spend effort and money at the same time on fragmenting jobs and reducing their content seems neither rational nor efficient, if there is any alternative.

V. AN ALTERNATIVE PARADIGM

If Hargreaves and Crompton could develop machines which collaborated with the skills of workers in the eighteenth century, can we not do the same in the twentieth century, using the incomparable power and flexibility of new technology? A major difficulty is that the problem is not generally posed as a choice between two alternative routes along which technology could develop. The engineering paradigm is not explicit, and it prevails not by a conscious choice, but by suppressing the ability to see an alternative.

It is therefore useful to construct an example to show how a valid choice could indeed be made. This is not easy. At least 150 years of engineering effort have been given to one alternative, while the other has been ignored. One path is therefore broad, smooth and easy, the other narrow, difficult and rough. The example, however, need not be taken from engineering. What has been said applies equally to all technology, and will take on a new force as the advance of the microprocessor affects ever newer and wider areas.

What proves easiest is to choose as example an area where high skill exists, and where the encroachment of technology upon skill has hardly yet begun. In this way, both possible routes which technological development could follow are placed upon an equal basis. Following an earlier account [11], the example of medical diagnosis will be used.

Feigenbaum [14] has recently described a computer system called PUFF for the diagnosis of lung diseases. It uses information about patients obtained from an instrument and from their past history. The information is matched against a set of "rules" which have been developed by computer scientists in collaboration with medical specialists. In the rules is captured the knowledge of the physician, part of which he was explicitly aware of knowing. Another part was knowledge which he used unconsciously and which only became explicit as he compared his own response with that of the computer.

Though still in an early stage of development, the system gave agreement of 90 to 100 per cent with the physician, according to the tests which were used. There is no difficulty in supposing that this and similar systems can be improved until they are at least as good as the unaided physician.

One way in which they might be used is to make the skill in diagnosis of the physician redundant. The computer system could be operated by staff who had not received a full medical training, but only a short and intensive course in the computer system and its area of application. There might then be no difficulty in showing that the quality of diagnoses was as good as before, and possibly even better. The cost would be reduced, and a better service could be offered to the patient.

Alternatively, diagnosis might still be carried out by the physician but he could be given a computer system to assist him in his work. Much that he had carried in his mind before would now be in the computer, and he would not need to concern himself with it. The computer would aid him by relieving him of this burden, and would allow him to carry on his work more effectively.

Under this second system, the physician would usually agree with the computer's diagnosis, but he would be at liberty to reject it. He might do so if, for example, some implicit rule which he used had not yet found its way into the computer system; or if he began to suspect a side effect from some new drug. Using the computer in this way, the physician would gradually develop a new skill, based on his previous skill but differing from it. Most of this new skill would reside in the area where he disagreed with the computer, and from time to time more of it might be captured in new rules. Yet there is no reason why the physician's skill in using the computer as a tool should not continually develop.

This is all speculation, but I believe not unreasonable speculation. Which of these two possible routes would be the better? The first leads, step by step, towards the situation typified by the lamp plant. The operators, having no extensive training, can never disagree with the computer, and become its servants. In time, the computer might be given more and more control over their work, requesting information, demanding replies, timing responses, and reporting productivity. A mismatch would again arise between the abilities of the operators, and the trivialized tasks they were asked to perform. Social scientists might then be invited to study their jobs, and to suggest some scheme of redesign which would alleviate the monotony or the pressure of the work.

The second path allows human skill to survive and evolve into something new. It cooperates with this new skill and makes it more productive, just as Hargreaves's spinning-jenny allowed the spinner's skill to evolve and become more productive. There seems no reason to believe that this second path would be less economically effective than the first.

The example can be readily transposed into engineering terms. It applies with little change to the future development of computer-aided design. It suggests also that if we rethought the problem, the operator's job on numerically controlled machine tool need not be fragmented and trivialized, to the point where "slight mental retardation" becomes an advantage. The task of making a part, from the description produced by a CAD system, could be kept entire, and could become the basis of a developing skill in the operator.

As I have said elsewhere, [15] the task of developing a technology which is well matched to human ability, and which fosters skill and makes it more productive, seems to me the most important and stimulating challenge which faces engineers today. If they are held back from this task, it will not be so much by its difficulty, as by the need for a new vision of the relation between engineering and the use of human skill. That I should pose such a problem to engineers will indicate, I hope, the very high position which I give to the role of engineering.

VI. POSTSCRIPT

My paper could end at that point, but some readers may (and I hope will) feel a sense of unease. The argument which is developed above is in essence a broadly economic one. The skills and abilities of people are a precious resource which we are misusing, and a sense of economy and fitness for purpose, upon which we justly pride ourselves as engineers, should drive us to find a better relation between technology and human ability.

Yet economic waste is not the truest or deepest reason which makes the lamp plant repugnant to us. It offends against strong feelings about the value of human life, and the argument surely should be on this basis.

I wish that it could be, but my belief at present is that it cannot, for the following reasons. To develop such an argument we need a set of shared beliefs upon which to build the intellectual structure. Medieval Christianity, with its superstructure of scholastic philosophy, would once have provided the framework within which a rational argument could have been developed. By the time of the Industrial Revolution, this had long decayed, and nineteenth century Christianity did not unequivocally condemn the developments I have described.

Marxism provides an alternative set of beliefs, and a philosphical superstructure, and it utterly condemns the misuse of human ability: but only when it is carried on under a capitalist system. If it is carried on under socialism then Marxism seems not to condemn it unequivocally, and those are the conditions under which Marxism can have the greatest influence. In support, it is only necessary to say that the lamp plant was in a socialist state, and is in no way anomalous there. [16]

Humanism might serve as another possible basis, with its demand [17] "that man make use of all the potentialities he holds within him, his creative powers and the life of the reason, and labour to make the powers of the physical world the instruments of his freedom." This indeed underlies much of the thought in the social sciences, yet again it seems that no conclusive argument can be based on it.

The difficulties are twofold. First, no system of beliefs is as widely disseminated as industrial society. Therefore if a conclusive argument could be based on one system of beliefs, it would have only a limited regional force. Secondly, and almost axiomatically, if there is a system of beliefs from which some of the prevalent features of industrial society can be decisively condemned, it will not be found as the dominant set of beliefs in an industrialized country.

My own conclusion is that rejection of trivialized and the dehumanized work precedes any possible rationalization. Tom Bell [18] tells the following story of his mate who, day after day, sharpened needles in Singer's Clydebank works. "Every morning there were millions of these needles on the table. As fast as he reduced the mountain of needles, a fresh load was dumped. Day in, day out, it never grew less. One morning he came in and found the table empty. He couldn't understand it. He began telling everyone excitedly that there were no needles on the table. It suddenly flashed on him how absurdly stupid it was to be spending his life like this. Without taking his jacket off, he turned on his heel and went out, to go for a ramble over the hills to Balloch."

No very large part of the population so far has turned on its heel and gone for a ramble over the hills, though a mood akin to that does exist. If industrial society ever comes to be decisively rejected, it seems to me that it will be in this way and for these reasons, rather than as the result of a logically-argued critique. The thought, if valid, takes on a special significance at the present time, when w are engaged in determining the kind of work which me and women will do in the era of the microprocessor.

VII. REFERENCES

[1] Thorstein Veblen, "The instinct of workmanship and tl irksomeness of labour," *Amer. Jour. Sociol.* vol. 4, no. 2, p| 187–201, 1898.

[2] F. H. George and J. D. Humphries, *Eds., The Robots are Comin,* 1974, p. 164.

[3] A. D. Swain *(quoting* M. L. Tinkham, 1971), Design of industri jobs a worker can and will do, *in* S. C. Brown and J. N. T. Mart *(editors)*, 1977, Human Aspects of Man-made Systems, p. 1ξ (Open Univ. Press).

[4] Georges Friedmann, *Industrial Society,* New York: The Fr Press, 1955, p. 216.

[5] Frederick Herzberg, *Work and the Nature of Man,* Cleveland: Tl World Publishing Co., 1966, p. 39.

[6] *American Machinist,* vol. 123, no. 7, p. 58, July 1979.

[7] A.D. Swain, *loc. cit.*

[8] Richard I. Drake and Peter J. Smith, *Behavioural Science in I dustry,* New York: McGraw-Hill, 1973.

[9] John E. Kelly, "A reappraisal of sociotechnical system theory, *Human Relations,* vol. 31, pp. 1069–1099, 1978.

[10] Thomas S. Kuhn, *The Structure of Scientific Revolution* Chicago: University of Chicago Press, 1973 passim, *but especial* pp. 181–187.

[11] *New Technology: Society, Employment and Skill,* Council f Science and Society.

[12] Andrew Ure, *The Philosphy of Manufactures,* London, Charl Knight 1835, *also* The Cotton Manufacture of Great Britain, Lo don, 1836 Charles Knight.

[13] Charles Babbage, *On the Economy of Machinery and Manufa tures,* New York: Kelly, 1832 (reprinted 1963).

[14] Edward A. Feigenbaum, "Themes and case studies of knowled engineering," *in* D. Michie, *Expert Systems in the Microelectron Age,* Edinburgh Univ. Press, 1979, pp. 3–25.

[15] H. H. Rosenbrock, "The future of control," *Automatica,* vol. 1 pp. 389–392, 1977.

[16] Miklos Haraszty, *A Worker in a Worker's State,* Baltimor Penguin Books, 1977.

[17] Jacques Maritain, *True Humanism* Geoffrey Bles. Centena Press, p. 411, 1939.

[18] Standish Meacham, *A Life Apart,* Thames and Hudson p. 13 *quoting* Tom Bell.

(Editorial, cont. from p. 6)

stitute to ensure that the resulting document is accurate and represents the full range of member thought. It can thus inspire trust in the issuing organization. Failing this, IEEE, and engineers in general, will be viewed by the public as nothing but special pleaders whose claims deserve no more attention than any other special interest group's.

To facilitate dissemination and review the COMAR statement is published in this issue. In the next issue COMAR will have the opportunity to respond to this editorial. Members are encouraged to participate in this process. For further background consult: *Proceedings of the IEEE*, January 1980, Special Issue on Biological Effects and Medical Applications of Electromagnetic Energy.

Norman Balabanian

(retrospective) acclaim bestowed upon the discovery. It is natural for each of us to view our own work somewhat in this context and relegate critics to the category of uninformed cranks. The frustration experienced in dealing with naive opposition should perhaps be viewed as one of the mixed blessings of a technical education.

Although the extremely limited public understanding of basic technical issues is a serious and often frustrating problem, it is also the case that many—perhaps poorly expressed—criticisms have an essential validity which may in fact be interpretable in highly sophisticated technical terms. That this phenomenon is especially characteristic of complicated social implications of technology should come as no surprise to those familiar with the nature of engineering approximations. The preface in many engineering texts carries an admonition to the effect that *the true solution to an approximate problem may not represent an approximate solution to the true problem.* Such reservations are profound, have a deep mathematical basis, and cannot be set aside, despite remarkable contemporary advances in technological sophistication. It is quite apparent that the nature and complexity of the problems requiring solution will evolve concomitantly with the available technology. This is an expression of the interactive relationship between society and technology that gives the phrase "the social implications of technology" such extraordinary dimension. It is self-referential. Existing technology affects social systems and, conversely, societies affect their own technological development.

SOCIAL IMPACT

A corollary which frequently passes unnoticed (despite much scholarly writing on the subject) is that engineering exerts a greater influence than philosophy on social evolution, that engineering has a more pervasive impact on public health than medicine, and that engineering affects government more than law, agriculture more than biology, and industry more than economics. This state of affairs is *not* a recent development deriving from the invention of electric power, electronic communications, computers and such. The limits of all human societies have largely been defined by their engineering achievements. From prebiblical times to the present, social equity, public health, food supply, industry, and the very ability to govern have been established by the character of available technology.

To provide at least casual justification for these assertions: the development of water supply and sanitation systems, industrial and agricultural mechanization, as well as food storage and distribution, communication, transportation, and weapons systems have been landmark events in the course of human history. A popular metaphorical interpretation of this sociocultural-technological evolution is that the human species behaves *as if* engaged in a process of externalizing the human mind. This notion can be said to provide a unifying perspective on such diverse concepts as those of (computer) artificial intelligence, (Zen) universal consciousness, and our curious sense of *progress*. Commonly cited biological analogies are the communal behavior characteristic of bees and ants, with respect to which it can be asserted that the social unit has a life and intelligence quite apart from, yet composed of, the unconscious acts of individual members. The obvious distinction is that, through the mechanism of technological evolution, each succeeding human generation is (on average) born into a more advanced social unit.

Such notions have yet to provide a substantive basis for the solution of pressing social problems. Nevertheless, it is understandable that the idea has some appeal to technologists. It serves to interpret—in a limited sense—the grand sweep of history, to provide an overarching purpose and direction to social organization, and to glorify high technology. It is, of course, hardly necessary to pursue such esoterica to justify advanced technology. The more common, pragmatic argument is simply that, on average, living standards have been historically—and causally—linked with technology. The (narrowly) cogent socioeconomic analyses of Malthus and a great many others before and since have been undone by technological advances. Apart from natural career and financial self-interest, it is the certainty of these facts which pervade and motivate the opinions and policies of the IEEE and, more generally, the engineering profession.

SOCIAL RESPONSIBILITY

Despite statements here regarding the extent to which engineering achievements shape society, engineers manifest a general reluctance to fully accept such responsibility. There are various reasons for this, one being the enormous difference in scale between "engineering achievements" and the actions of individual engineers. Moreover, the concept is not written in their employment contract, although frequently expressed in codes of professional ethics, and is a potential source of job threatening conflict. Thus, many management and design engineers prefer to hypothesize a notion of "value free" technology. By this view, scientific research and discovery as well as much of its technological implementation has no intrinsic moral/ethical value. Engineers simply serve society by attempting to develop cost-effective goods and services for which there is some public need. The matter of establishing relative values and priorities is left to the marketplace and government regulation. How a particular invention or discovery is used (i.e., for benefit or harm) is thought to be a quite independent matter.

While it may be judged that, on balance, society has been well served by its engineers, the notion that each engineering advance has only benefitted mankind can only (perhaps) be defended through an historical perspective on a scale which has no relation to individual human experience. Quite apart from a relatively small number of examples of grossly misapplied technology (such as the use of fluoroscopes by shoe salesmen) there are the more important and complex situations in which technological developments have effected changes of a character such that the net of positive and negative effects is not so easily resolved. Development of the gasoline internal combustion powered automobile and its impact on the United States provides a commonplace yet striking example. Clearly, it is an invention with a mass appeal that transcends its utilitarian value. It has been credited by some with the expansion of industry and as an influence furthering the democratization (by independent travel) of American society.

Among the offsetting considerations are the 50,000 persons a year killed by impact, hundreds of thousands more maimed and injured, damage to public health and the environment from toxic effluents, economic dependency on oil-exporting nations and a pattern of land use—fostered by the private automobile—which serves to compound and perpetuate the problems. The nonmotoring public is also forced to suffer the consequences. Interestingly, many of these problems are inherent in the engineering concept and design, in contrast to the design and manufacture of firearms which, at least by the "value free" argument, need not result in loss of life (i.e., the negative effects are latent rather than inherent.)

Automobile users now represent a large powerful special-interest group. Clearly, when such a group constitutes a major fraction of the population, the distinction between special privilege and democratic process becomes blurred. Particularly from the group's perspective it can seem that *special-interest* is truly *public-interest.* The existence of analytic tools to sharpen the very real distinction may appear to be of little practical importance.

SOCIAL CHOICE

For cultural/historical reasons many—if not most—citizens of contemporary industrialized democratic nations believe the economic market can serve effectively to define public interest. The shift from one-person/one-vote to one dollar/one vote is viewed as a tolerable perversion of democratic principles, given the problems endemic to (the alternative) planned-economy systems. It would, of course, be both simplistic and fundamentally wrong to imply that either planned or free market economies actually exist in pure form. Enormous restraints are imposed by direct and indirect government regulation in all real (complete) economic systems, yet experience has also shown it essential that opportunity exist for individual initiative and accomplishment.

The notion that free (competitive) economic markets provide an effective, efficient and democratically value-free capitalistic mechanism for managing production and distribution of goods and services is rooted in the traditional steady-state equilibrium model applied to economic systems. In addition to various commercial factors which undermine true competition, real economic systems exist neither at a steady-state nor do they operate at an equilibrium point. Inertial, time delay and resource-depletion effects are sufficient to guarantee this even without the compounding phenomena of an evolving technology and an uncertain future.

While it is pure speculation to guess at the consequences for world history of OPEC price regulation activities of the 1970's, this does provide an extraordinary example of governmental market manipulation resulting in a commodity price grossly different from the (relatively) free market precedent. It is entirely plausible to argue that this extreme regulatory action may have saved industrial societies from certain collapse or world war early in the coming century.

The social implications of contemporary technology are so forceful and pervasive that to allow unrestrained commercial development could be suicidal. Thus, the question is not whether to regulate but how to regulate well. The use of taxation, subsidy, price control and other monetary measures are not the sole techniques suited for the purpose. Environmental impact, product performance, and worker and public safety standards provide further essential tools for this extremely complicated task. Beyond direct legislative action is the more nebulous sphere of education. This subject can be divided into areas of technical education (the design of engineering curricula, etc.) and efforts to improve public understanding of related issues.

While public demand for goods and services may be defined as the fundamental determinant of all economic activity, a fact well known to the advertising industry is the remarkable extent to which this demand can be altered. The material standard of living for a major segment of contemporary industrial societies has far surpassed the level at which incremental consumption becomes entirely volitional. Moreover, for this segment of the population, conventional measures of consumption (e.g., per capita energy use, caloric intake, dietary protein, disposable personal income, etc.) have, at most, only a vague statistical (rather than causal) relationship to quality of life. Under these circumstances broad-based educational programs have a particularly large potential for influencing public perceptions, attitudes and life style.

Certainly, in a society in which what people wear, eat and do is determined more by fashion than by need, the quality of life depends as much on public attitudes as on advanced technology. The constructive future social role for engineers is to not simply advocate and service escalating demand with new technology but to contribute to a *full* evaluation of its social implications. It may be that the future of mankind lies in the stars; they will wait for us.

TECHNOLOGY AND SOCIETY: THE PAST

There follows an annotated bibliography of articles selected from among those published in *Technology and Society.* As the CSIT Newsletter, it serves to partially chronicle the activities and achievements of the Committee. Even those acquainted with aspects of this history will find new interest in the compilation and the still evolving definition of social implications of technology that it provides.

BIBLIOGRAPHY

Strong ethical standards of professional conduct are vital to the interests of individual engineers, their professional associations, employers and society. The analysis and refinement of existing codes is a matter requiring periodic review. The present IEEE Code of Ethics was developed by a USAB task force and is enforced by the Member Conduct Committee (MCC.) CSIT and others have proposed revisions, in particular, to strengthen the statement of social responsibility and more firmly commit the Institute to substantive support procedures.

Codes of Engineering Ethics; Unger, S. H., No. 5, p. 1, December 1973.
Ethics for Engineers: a Code and its Support; Unger, S. H., No. 13, p. 24, March 1976.
Ethics: Report of the NPSS Ad Hoc Committee on Ethical Standards; NPSS; No. 14, p. 14, June 1976.
Code of Ethics for Engineers in Medicine and Biology; EMBS; No. 14, p. 16, June 1976.
The Defense of Professional Freedom and Social Responsibility; von Hippel, F.; No. 18, p. 3, June 1977.
Proposed Procedures for IEEE Support of Ethical Engineers; USAB Ethical Conduct Activities Task Force; No. 19, p. 8, September 1977.
Proposed Procedures for Handling Alleged Infractions of the IEEE Code of Ethics by Members; USAB Ethical Conduct Activities Task Force; No. 19, p. 10, September 1977.
Implementing the IEEE Code of Ethics; Unger, S. H., No. 20, p. 1, December 1977.
Teaching Engineering Ethics; Fielder, J.; No. 25, p. 3, March 1979.
Ethical Trilemmas; Cebik, L. B.; No. 28, p. 4, December 1979.
Ensuring the Right of Professional Dissent: A Review of a Proposed New NRC Policy; Unger, S. H., vol. 8, No. 1, p. 7, March 1980.
Moral Reasoning and Engineering; Pritchard, M. S.; vol. 8, No. 3, p. 3, September 1980.
The Professional Rights of Engineers; Flores, A.; vol. 8, No. 4, p. 3, December 1980.
Ethical Dilemmas in Modern Engineering; Chalk, R.; vol. 9, No. 1, p. 1, March 1981.

A closely related subject is the case study of difficulties associated with application of such codes. A CSIT report on three engineers, dismissed as a consequence of their expression of concerns regarding safety of the San Fransicso Bay Area Rapid Transit (BART) system, led to the extraordinary initiative of the IEEE in its first *amicus curiae* brief, submitted during subsequent litigation. This brief, in effect, strengthened the legal standing of the ethical concept that engineers have a paramount responsibility to society in their professional conduct.

The BART Case: Ethics and the Employed Engineer; Unger, S.; No. 4, p. 6, September 1973.
Engineering Ethics: The amicus curiae brief of the IEEE in the BART Case; IEEE; No. 12, p. 1, December 1975.
Professional Responsibility and the Dispatching of Police Cars—A Case Study; Unger, S., Bogumil, R. J., Kaufman, J. S.; No. 22, p. 3, June 1978.
To the Editor: In Regard to Ethics and Legal Defense Funds; Barauck, A. H.; vol. 8, No. 3, p. 23, September 1980.

The BART case and other instances involving similar issues motivated a concern that the IEEE establish an award for public service that would give special recognition to engineers who have made personal sacrifices in order to comply with principles espoused in the IEEE Code of Ethics.

An IEEE Award for Outstanding Service in the Public Interest; Kaufman, J. S.; No. 14, p. 13, June 1976.
CSIT Honors Former BART Engineers; Kotasek, F.; No, 24, p. 3, December 1978.
CSIT Honors Virginia Edgerton; Lindsey, J. F.; No. 26, p. 3, June 1979.

It is clear that people who share common opinions can do so for fundamentally different reasons. Conversely, the same basic facts can lead two individuals to fundamentally different conclusions. This exceedingly complex phenomenon has been analyzed at great length and in many contexts. It is frequently explained in terms of hypothetical stages of intellectual/ethical/emotional development. One such categorization in the field of ethics is a six stage progression formulated by Kohlberg. It has been applied to engineering ethics by McCuen and others. By this measure some concepts and attitudes expressed in the current IEEE Code of Ethics, and in the manner of its dissemination and enforcement, only rank in Kohlberg/McCuen stages 2, 3 and 4 (corresponding to rather limited ethical perspectives.) On one hand this illuminates certain self-serving aspects of the matter, while another view is that practical engineering decisions must reflect intricacies not represented in the Kohlberg schema. A central question is the extent to which heroism (i.e., principled behavior despite considerable personal sacrifice) can or should be normative in codes reflecting social realism.

Moral Reasoning and Engineering; Pritchard, M. S.; vol. 8, No. 3, p. 3, September 1980.

Safety codes and performance standards have become an essential element of commercial technology. Although public and governmental concerns with safety and military procurement specifications have been important contributing factors, much of the standards-setting activity has been accomplished by industry on a voluntary basis. Engineering professional societies have had an active part in this work. Standards which have a direct or indirect bearing on safety must, unavoidably, place a value on human life (or lifetime, a not inconsequential distinction.) The mechanism by which this is accomplished and the attitudes and values engendered have broad social implications and can only benefit from an analysis of basic principles.

Drafting Consumer Standards; Costello, R.; No. 14, p. 5, June 1976.
Product Liability: Theory and Practice; Sperber, P.; No. 15, p. 8, September 1976.
The Automobile Fuel Economy Standards: Are They Cost-Effective?; von Hippel, F.; vol. 8, No. 2, p. 1, June 1980.
Safety Engineering and the Value of Life; Lockhart, T. W.; vol. 9, No. 1, p. 3, March 1981.
The Value of Human Lifetime—and its Application to Environmental and Energy Policy; Rabow, G.; vol. 9, No. 1, p. 5, March 1981.

While attention has been focused on social implications of the advanced technology directly affecting a small minority of the world's population, most nations face quite different social/technological problems. This provides both a contemporary demonstration of the limitations of more primitive technology and a challenge to improve the circumstances of these peoples by appropriate adaptation of modern techniques. It is entirely possible for the appropriate technology to range from cattle dung fueled bio-gas generators to synchronous orbiting communications satellites. Successes and failures have clearly demonstrated that each application must be studied carefully on its own terms to incorporate national priorities and cultural values. Further engineering contributions can be made in so-called *technology transfer* and the establishment of suitable local industry. These projects also have a history of mixed success. If we live by the declarations of our fundamental social doctrines and do not cynically exploit third world nations for access to certain resources or as a foil against Soviet expansion, then it is imperative that engineers and international engineering organizations become more responsive to their special needs.

Energy/Environment: India; Murthy, K. K.; No. 11, p. 10, September 1975.
Energy/Environment: Turkey; Ince, F.; No. 11, p. 10, September 1975.
An Interview with Dr. Enrique Kirberg; Balabanian, N.; No. 14, p. 3, June 1976.
Autonomous Energy Systems, Bio-gas Plants; Murthy, K. K.; No. 16, p. 2, December 1976.
UNCSTD 1979: Technology for the Less Developed Countries; Bickel, A. R., and Pundit, N. D.; No. 24, p. 9, December 1978.

Military budgets have been a traditional source of funds for advanced technological development. While this phenomenon may date to the Bronze Age and has subsidized some remarkable inventions, it results in large investment in unproductive goods. Arms limitation treaties provide some hope for relief from this economic burden and might also serve to moderate the likelihood and consequences of war. Even in a peacetime democracy it is possible for military perspectives to conflict with broader social values. Examples of this have occurred in technology transfer, publication of nonmilitary research in mathematics related to cryptology, and IEEE involvement in classified (restricted attendance) meetings.

The Engineer and Military Technology; Barrow, B., Ramberg, E., Davidon, W., and Cory, W. E.; No. 5, p. 14, December 1973.
Secret; Klig, V.; No. 9, p. 3, March 1975.
Privacy, Cryptography and Free Research; Unger, S. H.; No. 20, p. 8, December 1977.
Declaration on the Nuclear Arms Race; Union of Concerned Scientists (Reprint); No. 21, p. 1, March 1978.
SALT II: The Treaty We Can't Do Without; Coalition for a New Foreign and Military Policy (Reprint); No. 24, p. 11, December 1978.
An Affair of Secrecy: On the Uses of Cryptography and Eavesdropping; Harris, R. W.; No. 26, p. 14, June 1979.
Defense through Decentralization; Hulbert, M. and Hasse, P.; vol. 8, No. 3, p. 12, September 1980.

The techniques classified as *systems engineering* have been applied with mixed results to the analysis and design of social systems. The merits and limitations of social systems engineering are as controversial as the case studies themselves, which may simply reflect a premature birth. With time and further study this field may prosper.

The Application of Systems Engineering to Societal Problems; Rabow, G.; No. 13, p. 28, March 1976.
Systems Engineering and Society's Problems; Barus, C; No. 13, p. 31, March 1976.
To the Editor: In Regard to Social Systems Engineering; Sheridan, T. B.; No. 17, p. 16, March 1977.
To the Editor: In Regard to Social Systems Engineering; Vidale, R. F.; No. 17, p. 17, March 1977.
CSIT Position Paper on the Application of Systems Engineering to Societal Problems; Rabow, G.; No. 18, p. 10, June 1977.

Formal (mathematical) socioeconomic modeling has rapidly become a widely applied methodology. Notwithstanding the award of several Nobel Prizes, it is a discipline at present more filled with pretense than promise. Rather fundamental problems have been revealed by contemporary research in differential topology, in particular the results of Smale and others dealing with the structural stability of dynamical systems. However, as with social systems engineering, a clear understanding of the limitations may facilitate certain useful applications.

Limits to Model-Based Prediction of Socioeconomic System Behavior; Bogumil, R. J.; No. 27, p. 7, September 1979.

It is hardly surprising that the views and priorities of energy analysts correlate closely with their frame of reference. Power system engineers, apprehensive about the increasingly long lead times necessary to design, site and implement new facilities, and trained in the tradition and technology of meeting consumer electric power demand, are obligated to plan means of satisfying the full anticipated future market. With available technology, the statistically certain death and destruction from coal-fired generation on the projected scale are viewed as less acceptable than the theoretical (probabilistic) risks associated with currently operational nuclear reactor designs. From their perspective, the contribution of commercially less proven technologies, e.g., coal gasification, nuclear fusion, solar-electric, etc., must be heavily discounted to reflect the considerable present uncertainties regarding large scale implementation.

A different assessment has currency among many outside the commercial electric utility field. In general, they are more willing to hypothesize effective conservation measures which reduce the upperbound on extrapolated demand estimates. This itself is antithetical to American commercial traditions. They are also less concerned with the peculiar intricacies of tariffs, rate-base and other matters of commercial significance, many of which owe their present structure to pre-1970 political socioeconomics. A lower upperbound on estimated demand pressure for several decades and the further assumption that necessary commercial matters can be adequately resolved by the usual political process leads to much different energy system priorities.

Intercon '75 Highlight Session: Social Implications of Nuclear Power; Chapman, S., Hocevar, C. J., Kadak, A. C., Richmond, C. R., and Tamplin, A.; No. 10, p. 1, July 1975.
The California Nuclear Safeguards Initiative and the IEEE, Kotasek, F.; No. 13, p. 4, March 1976.
Environmental Effects of Thermonuclear Fusion Power Reactors; Pocock, R. F.; No. 13, p. 12, March 1976.
Solar Energy: Its Status and Prospects; Redfield, D.; No. 13, p. 15, March 1976.
Surviving the Dinosaurs: Adaptive Energy Systems for New Jersey; Ashkinazy, A.; No. 18, p. 1, June 1977.
Book Review: Nuclear Power Issues and Choices: Report of the Ford Foundation/MITRE Nuclear Energy Policy Study Group; Redfield, D.; No. 19, p. 13, September 1977.
Nuclear Power and Weapons Proliferation - the Thin Link; Starr, C.; (Reprint, Proceedings of the American Power Conference); No. 21, p. 4, March 1978.
Solar Energy and Conservation: Hand and Glove; Redfield, D.; (Reprint, IAS Conference Record); No. 23, p. 4, September 1978.
The Engineer's Role in the Energy Crisis; Casazza, J. A.; (Reprint, Public Utilities Fortnightly); No. 24, p. 5, December 1978.
IEEE Energy Committee Position Statement on Solar Energy; IEEE-EC No. 25, p. 5, March 1979.

Nuclear Power and Some Lessons of TMI; Balabanian, N.; No. 27, p. 1, September 1979.
Book Review: Energy Future—Report of the Energy Project at the Harvard Business School; Redfield, D.; No. 27, p. 14, September 1979.
Book Review: The Poverty of Power; Tudhope, D.; No. 27, p. 15, September 1979.
Statement on Nuclear Power Plant Safety and Reliability; Brown, H. U.; No. 27, p. 20, September 1979.
Nuclear Power in Perspective; Young, M.; vol. 8, No. 1, p. 9, March 1980.
Energy Conservation: A Role for CSIT; Rabow, G.; vol. 8, No. 4, p. 12, December 1980.
Social and Political Perspectives on Nuclear Regulation after Three Mile Island; Del Sesto, S. L.; vol. 9, No. 2, p. 1, June 1981.
In Support of Nuclear Power; Rooney, J. P.; vol. 9, No. 2, p. 5, June 1981.

As outlined in the preamble to this bibliography, virtually every engineering endeavor has significant social consequences. The following articles deal with a wide range of such matters.

Cable Communicaitons; Balabanian, N.; No. 2, p. 4, March 1973.
Technology, Its Control and the Engineer; Schilmoeller N.; No. 7, p. 7, June 1974.
Engineering and Ideology: a Review of *Introduction to Engineering;* Balabanian, N.; No. 12, p. 11, December 1975.
Book Review: The Existential Pleasures of Engineering; Schwarzlander, H.; No. 15, p. 12, September 1976.
The IEEE and the Issue of Personal Information/Privacy; Stine, L. L.; No. 16, p. 5, December 1976.
Book Review: The Conquest of Will: Information Processing in Human Affairs; Kurzweil, J.; No. 16, p. 13, December 1976.
Public Policy Issues and the Application of Computer Technology; Koltun, P.; No. 17, p. 4, March 1977.
Modern Science and Technology: One Person's Position; Turner, F. T.; No. 25, p. 11, March 1979.
Engineering Job Stability and Economic Conversion; Melman, S.; No. 26, p. 4, June 1979.
The Experimental Nature of Engineering and Its Implications for Management; Schinzinger, R.; No. 27, p. 3, September 1979.
Risk and Democracy; Bazelon, D.; vol. 8, No. 1,, p. 1, March 1980
Book Review: Connections; Hewitt, T. L.; vol. 8, No. 1, p. 13, March 1980
The Automobile Fuel Economy Standards: Are They Cost-Effective?; von Hippel, F.; vol. 8, No. 2, p. 1, June 1980.
Stereotyped Images in the Technology/Society Debate; Welchel, R. J.; vol. 8, No. 2, p. 9, June 1980.
Misinformation and Democracy; Balabanian, N.; vol. 8, No. 2, p. 17, June 1980.
Machines Don't Fail—People Do; Shelley, E. F.; vol. 8, No. 3, p. 1, September 1980.
Implications of Computer Use in Politics; Talingdan, A. B.; vol. 8, No. 3, p. 8, September 1980.
Do We Know What "Technology" Means?; Sinclair, G.; vol. 8, No. 4, p. 1, December 1980.
The Social Implications of Technology or the Engineer's Trilemma; Winton, R. C.; vol. 9, No. 1, p. 14, March 1981.

TECHNOLOGY AND SOCIETY: THE FUTURE

Articles in future issues of *Technology and Society Magazine* will deal with a similarly broad range of engineering subjects having important social implications. Several examples of specific matters under consideration are described below.

Reliability (probabilistic risk) assessment and cost/benefit analysis accomplished either by formal techniques or intuitive common sense underlies every modern engineering project. Such analysis involves assumptions equivalent to a mathematical reciprocity between cost (or benefit) and probability of occurrence. Certain current practical applications require that the methodology be applied to circumstances with infinitesimal *a priori* probabilities and associated costs with no well defined upperbound. The classical statistical treatment is indeterminate under these conditions with a finite time frame. This difficulty is repaired by *ad hoc* assumptions which implicitly represent strong social value judgments. The considerable extent to which these mathematical contrivances influence public system development priorities is only dimly perceived.

Microprocessors have made practical the redesign of existing equipment to incorporate programable features. Medical devices, test instruments, home appliances, games and a rapidly growing assortment of other products have been marketed. One distinctive characteristic of these products is, of course, the essential stored program (rather than hard-wired) control. Software certification has presented difficult problems even in the relatively controlled circumstances of large computer facilities. A topic deserving careful study is the possible need for revision of product safety and performance standards to reflect the fact that device performance is no longer solely determined by physical components.

Engineering professional organizations have long played an active, useful role in the development of product safety and performance standards as well as in providing expert technical testimony in courts of law and before legislative bodies. This is a service of great social importance and a role for which these associations appear well qualified. However, it is also a matter in which there may be strong commercial self-interest on the part of individual volunteer officers. There is then some danger that the implicit public trust may be betrayed. Problems of this nature have arisen in the past. A recent notable instance has involved the American Society of Mechanical Engineers (ASME) in a court suit in which it has been fined a sum reportedly in excess of seven million dollars as treble damages for conspiring in the misapplication of a boiler safety standard. The ASME lost at trial and on initial appeal, with the case now submitted to the Supreme Court.

The IEEE, among other organizations, has filed an *amicus curiae* brief. In general terms, the IEEE brief advances the argument that not-for-profit organizations should not be held liable for unratified acts of volunteer members which are not in the interest of the organization, even if they are performed by the volunteer in some capacity as a representative of the organization. (The IEEE brief is actually limited to the application of Sherman Act strict antitrust liability.) This position is buttressed by reasoning that since (in the case at hand) the ASME did not, and could not, benefit in any simple direct manner from the unsupervised actions taken by two among its ninety thousand volunteer members, then it cannot be said to have supported or conspired with them. A contrary view, more consistent with the trial record, is that by creating the standards authority, and opportunity for its abuse, the professional society must share responsibility for the consequences.

The Supreme Court decision, when rendered, will provide a legal precedent that may affect the operation of all engineering associations. A basic question is the extent of the special liberties which should be granted, in the public interest, to an avowedly beneficient association of individuals, each of whom may have strong personal self-interest in matters over which the association has some control. Clearly, this must in part be measured by the demonstrated ability of such organizations to transcend narrow commercial perspectives. CSIT has well served the IEEE in this regard through its efforts to broaden the range of views expressed both in internal Institute correspondence and debate and through Institute publications. It is expected that SSIT will continue this tradition.

Other standards-related matters worthy of detailed analysis are the proposed IEEE program for accreditation of commercial laboratories engaged in the testing and certification of safety equipment used in nuclear power plants and the COMAR position paper on human exposure to microwave electromagnetic fields.

These and other topics of comparable social significance will be analyzed in forthcoming issues of *Technology and Society Magazine.* This is your invitation to participate. Editorial administration of the magazine, manuscript submissions, conference planning, publicity, and additional SSIT activities will provide a great many challenging opportunities. It is our hope that IEEE members and others concerned with social implications of technology will enlist for the task ahead.

Technology & Society Magazine Staff Needed

The successful conversion of Technology & Society to a magazine and the maintenance of a high standard of quality will depend on the cooperation of many people. Working to help produce a quality magazine can be a satisfying and rewarding experience. Staff members are needed in a variety of positions under the titles Associate Editor and Correspondent. Interested members of SSIT are invited to volunteer for one of the positions listed below. Initial periods of appointment will be for two years, 1982–1984, although consideration will be given to one-year appointments also. Send the Editor a brief biographical sketch indicating your specific interests and qualifications.

Associate Editor for Conference Reviews.

This person would become familiar with conferences sponsored by an IEEE entity—including SSIT—or non-IEEE organization, with sessions on subjects within the scope of SSIT, and would locate conference attendees who would agree to write reviews of sessions for publication in Technology & Society Magazine.

Associate Editor for Ethics and Professional Responsibility

This person would gather information for reporting in Technology & Society about specific corporate policies, professional society procedures and actions, legislation and administrative regulations relating to professional employment rights and guidelines. He/she would also handle the reviews of articles in this area.

Associate Editor for Educational Programs

This person would collect information about educational programs, developments, and symposia relating to the social implications of technology at colleges and universities for reporting in Technology & Society.

Associate Editor for "Technical Area"

Specific technical areas will be designated on the basis of the kinds of articles we receive; an initial list might be the areas listed in Calling All Authors on p. 6. Each Associate Editor will handle reviews of articles in the corresponding areas.

Correspondent

Individuals in this category would report, for publication in Technology & Society Magazine, on events and activities within the scope of SSIT taking place in their geographical region outside the United States, or SSIT Chapter, or in other IEEE entities such as USAB.

Advertising Manager

This person would solicit advertisements in the pages of Technology & Society Magazine from appropriate organizations, such as publishers.

Promotions Manager

This person would plan and conduct campaigns to promote membership in SSIT and subscriptions to Technology & Society Magazine by non-IEEE members and organizations.

Managing Editor

This person would be concerned with matters related to the production of the magazine, such as finances and liaison with the production staff at IEEE headquarters. Residence within easy access to New York would be necessary.