IEEE CSIT NEWSLETTER

COMMITTEE on SOCIAL IMPLICATIONS of TECHNOLOGY

DECEMBER 1975 – ISSUE No. 12

ENGINEERING ETHICS: The amicus curiae brief of the Institute of Electrical and Electronics Engineers in the BART Case

Editor's Note: The following is a copy of the brief filed by the attorneys for IEEE (Frank Cummings and Jill Cummings for Gall, Lane, and Powell; and Robert G. Werner) in the case of Hjortsvang vs. San Francisco Bay Area Rapid Transit District and ten Does. The brief was filed on January 9, 1975 in Superior Court of California for the County of Alameda. Three editorial changes have been made: The title page has been omitted; the page footnotes have been numbered and placed at the end of the transcript; the date and signatures at the end of the brief (see above) have been omitted.

The case involved 3 engineers (Holger Hjortsvang, Max Blankenzee, Robert Bruder) who were dismissed after having called attention to poor engineering practices in the BART development project (See the CSIT Newsletter beginning with the September 1973 issue, and Spectrum for 10/74). The case has since been settled out of court. It is unusual that such a brief is filed at the trial level. However, the court (upon application to file by IEEE Attorneys) decided that there were important matters of principle involved, and ordered the brief to be submitted.

The brief itself puts forward an important concept: that the engineer acting professionally to defend the public interest is protected by an implicit contractual clause from arbitrary reprisals by his employer. This could constitute a significant shield for the defense of the ethical practitioner.

The Institute, by intervening in this case, has recognized that it has a role to play in promoting high standards of professional conduct among engineers. It is important that this responsibility be institutionalized through the establishment of procedures that can be invoked at the outset of such cases (see CSIT Newsletter 12/73). Proposals along these lines are now being considered by the Ethics and Employment Practices Committee of the IEEE's US Activities Board. For the IEEE Board of Directors resolution regarding IEEE interventions as amicus curiae (adopted December 5-6, 1974), see page 6 of this issue.

I. STATEMENT

This brief is filed as amicus curiae because, on the basis of the pleadings, it is clear that rulings in this case will involve important questions concerning the proper ethics of an engineer in the employ of a public employer.

The Institute of Electrical and Electronics Engineers ("IEEE") is the largest engineering society in the nation and has a direct concern with the establishment, maintenance, and recognition (including governmental and judicial recognition) of ethics within the engineering field.

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IN THIS ISSUE

NOTICE: Beginning with issue # 13, the Editor of the CSIT Newsletter will be Dr. NORMAN BALABANIAN. Articles and correspondence can be addressed to him at: ECE Dept., 111 Link Hall, Syracuse University, Syracuse, N. Y. 13210.

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The editorial staff invites letters and articles from readers. We are interested in publicizing news of all upcoming meetings, study groups, discussions, lectures, or workshops that in any way relate to the interaction between technology and society. Correspondence may be sent to any of the above editors. "The views expressed in this Newsletter are those of the respective authors and not those of IEEE."

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COMMUNICATIONS & INFORMATION

(Vacant)

This brief is submitted with two limited aims: first, to inform this Court of the existence and terms of established standards and codes of ethics for engineers, in the employment context generally and particularly in the context of public employment;* and, second, to seek the Court's recognition that such standards and codes are relevant and material to this case for the reasons discussed below.**

II SUMMARY OF ARGUMENT

This Court is expected to rule, as the trial proceeds, on questions of law, and this amicus curiae brief is addressed solely to those rulings.

Within that framework, we urge this Court to rule:

1. As to Admissibility of Evidence: That evidence of professional ethics of engineers, as outlined herein and as further developed by the parties, is relevant, material, and admissible;

2. As to Any Motions for Judgment: That, in consideration of any motion to dismiss or for judgment by this Court, the Court should rule that an engineer is obligated to protect the public safety, that every contract of employment of an engineer contains within it an implied term to the effect that such engineer will protect the public safety, and that a discharge of an engineer solely or in substantial part because he acted to protect the public safety is a breach of such implied term; and

3. As to Jury Instructions: In any charge to the jury herein, this Court should instruct the jury that if it finds, based upon the evidence, that an engineer has been discharged solely or in substantial part because of his bona fide efforts to conform to recognized ethics of his profession involving his duty to protect the public safety, then such discharge was in breach of an implied term of his contract of employment.

We base this position upon the cases, statutes and ethical codes discussed below.

POINT I

PROFESSIONAL ETHICS ARE MATERIAL AND RELEVANT

California judicially recognizes that an employee may not be arbitratily discharged where the discharge would be inconsistent with the public good, even if his employment contract is terminable at will. In Petermann v. International Brotherhood of Teamsters, 174 Cal. App. 2d (1959), it was held that an employer may not discharge an employee because the employee refuses to commit perjury. The public has too great a stake in the integrity of the judicial process to permit such a discharge. (1)

* IEEE, moreover, is familiar with and can supply expert evidence concerning the ethical codes of engineers.

** IEEE takes no position on the merits and the claims, as IEEE has no direct evidence to offer as to what the claimants did, what defendants did, or why.

In Petermann, the District Court of Appeal for the Second District noted that the contract of employment did not provide for any fixed period of duration and that such a relationship is generally terminable at will, "for any reason whatsoever". But it also noted that such a right of discharge "may be limited by statute" or "by considerations of public policy". The Court then said at page 188:

> "By 'public policy' is intended that principle of law which holds that no citizen can lawfully do that which has a tendency to be injurious to the public or against the public order..." (emphasis by the Court).

The Court then noted that, because the State has a declared policy against perjury, "the civil law, too, must deny the employer his generally unlimited right to discharge an employee whose employment is for an unspecified duration, when the reason for the dismissal is the employee's refusal to commit perjury." The Court said that "the law must encourage and not discourage truthful testimony. The public policy of this state requires that every impediment, however remote to the above objective, must be struck down when encountered." Id. at 188, 189. The lower court having dismissed, the Court of Appeal reversed.

When questions of public safety are at stake, an engineer's code of ethics stands in the same position as the laws against perjury. If a code of ethics properly requires the protection of the public, a discharge because an employee insisted on following that code would be inconsistent with the public good. Thus compliance with such a code must be deemed an implied term of the employment contract. (2)

California statutes clearly recognize an engineer's obligation to protect the public. California Government Code, Section 835 waives the State's sovereign immunity and makes a public entity liable for conditions dangerous to the public. Section 840.2(b) of the same Code makes a public employee liable if he fails to take adequate measures to protect the public from such conditions. That section obviously encompasses any and all engineers engaged in public employment.

The same recognition is reflected in California statutes governing licensing (3) of professional engineers, including electrical and mechanical engineers. California Business and Professional Code Section 6730 states that the purpose of that Code is "to safeguard life, health, property and public welfare." And Section 6775 provides that a licensed engineer may be disciplined-indeed his registration may be revoked-for "negligence", "incompetency in his practice", or if he "has not a good character".

What is "negligent", under ordinary common law principles, is determined by the scope of the negligent person's duties, and those duties are in part determined by what is generally recognized to be ethical. "Incompetency in his practice" involves failure to adhere to generally accepted standards of conduct and must be taken to include ethical standards, if those standards are widely publicized and generally recognized. And, most important, the notion of "good character", particularly in a professional sense, certainly involves adherence to generally accepted ethical standards, and particularly standards of professional ethics.

California law, then, mandates adherence to ethical and moral standards. Engineers have adopted (see Point II below) proper ethical codes to complement statutory codes. We urge this Court on the Petermann principle to recognize (1) that an engi-

Continued...

neer has an overriding duty to protect the public, and (2) that California law, including statutes and case law, supports the drafting of ethical codes, makes the terms of generally accepted professional ethics relevant and material in a case such as this, and effects a legally enforceable incorporation of such codes into engineering contracts of public employment, insofar as such codes are widely acknowledged to be necessary for the protection of the public.

POINT II

ENGINEERING PROFESSIONAL CODES REQUIRE PROTECTION OF THE PUBLIC

1. A Common Thread: The Duty to Protect the Public.

The various professional engineering societies have, for many years, adopted and published Codes of professional ethics. Such codes contain at least one common thread-that the engineer owes an overriding duty to protect the public safety.

For example, the Canons of Ethics for Engineers was prepared and adopted by the Engineers' Council for Professional Development ("ECPD") in 1946. (4) These Canons were then adopted by the Board of Directors of the National Society of Professional Engineers ("NSPE") in October 1946, and were published in NSPE's Journal, "The American Engineer", in its November 1947 issue.

Section 4 of these Canons provided:

> "He [the engineer] will have due regard for the safety of life and health of public employees who may be affected by the work for which he is responsible."

This code has an even longer history, having been discussed initially in the May 1935 issue of "The American Engineer", although the code was formally adopted in 1946, in a form differing little from the present code. (5)

NSPE's own code of ethics (distinct from ECPD's) was adopted in 1964, and published in the September 1964 issue of "The American Engineer". (6) This code provided, in Section 2:

> "Section 2-The Engineer will have proper regard for the safety, health, and welfare of the public in the performance of his professional duties. If his engineering judgement is overruled by non-technical authority, he will clearly point out the consequences. He will notify the proper authority of any observed conditions which endanger public safety and health.
>
> a. He will regard his duty to the public welfare as paramount.
>
> b. He shall seek opportunities to be of constructive service in civic affairs and work for the advancement of the safety, health and well-being of his community.
>
> c. He will not complete, sign, or seal plans and/or specifications that are not of a design safe to the public health and welfare and in conformity with accepted engineering standards. If the client or employer insists on such unprofessional conduct, he shall notify the proper authorities and withdraw from further service on the project."

We emphasize in this regard the code's injuction to the engineer that he must "notify the proper authority" of anything he observes which may "endanger public safety". We think it fair to say that the ultimate proper authority in the case of public employment is the public itself.

ECPD, meanwhile, adopted revised Canons in September 1963, which stated, in the very opening paragraph:

> "1.1-The Engineer will have proper regard for the safety, health and welfare of the public in the performance of his professional duties."

These Canons were adopted by a variety of professional engineering societies. The American Society of Mechanical Engineers, whose membership now totals close to 70,000, ratified these canons in 1963, and they were published in ASME's magazine, "Mechanical Engineering".

The same principles are carried forward to the current day. For example, a set of "Guidelines to Professional Employment of Engineers and Scientists" published by the IEEE Board of Directors in its national monthly magazine, Spectrum, in April, 1973, (7) contains the following paragraph:

> "The professional employee should have due regard for the safety, life, and health of the public and fellow employees in all work for which he/she is responsible. Where the technical adequacy of a process or product is involved, he/she should protect the public and his/her employer by withholding approval of plans that do not meet accepted professional standards and by presenting clearly the consequences to be expected if his/her professional judgement is not followed."

2. General Acceptance and Publication of the Common Thread.

Because the cited codes have been widely circulated and generally endorsed, it seems eminently reasonable to conclude that every engineer is aware of his obligation to the public. The guidelines published by IEEE, for example, have also been endorsed by over twenty societies. (8)

Even before the engineer's obligation to serve the public was fully codified in writing, moreover, there was an historical recognition of that obligation, discussed in professional journals. (9)

CONCLUSION

Based upon the foregoing, we submit and we urge this Court to acknowledge that an engineer has an overriding obligation to protect the public.

Specifically, we urge this Court:

(1) To rule that evidence of professional ethics is relevant, material and admissible in this case; and

(2) To rule, as to any motions for judgement or any jury instructions, that an engineer is obligated to protect the public safety, that an engineer's contract of employment includes as a matter of law, an implied term that such engineer will protect the public safety, and that a discharge of an engineer solely or in substanial part because he acted to protect the public safety constitutes a breach of such implied term.

Continued...

(1) See also Slochower v. Board of Higher Education of the City of New York, 350 U.S. 551 (1956).

(2) This court may, but need not, decide the extent to which the principles of this case would be applicable in the case of a private employer. The complaint in this case alleges that a public employer discharged public employees because those employees informed the public of a danger to the public safety. In a very real sense, the public at large was the "employer" of the plaintiffs herein; whatever may be the limits of the duties of public disclosure by the engineer in private employment, there is clearly a higher duty in the case of public employment.

(3) Not all members of IEEE or other professional engineering societies are (nor are they all required to be) licensed to practice engineering in their home states. The ethical standards covering both licensed engineers and other engineers are the same, and this is particularly true where both types of engineers are working together on the same project, as was the case, we understand, in the BART situation.

(4) ECPD is an organization founded by a group of professional engineering societies, whose participants and affiliates now include the American Institute of Aeronautics and Astronautics, the American Institute of Chemical Engineers, the American Institute of Industrial Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Nuclear Society, the American Society of Agricultural Engineers, the American Society of Civil Engineers, the American Society for Engineering Education, the American Society of Mechanical Engineers, the Institue of Electrical and Electronics Engineers, National Council of Engineering Examiners, the Society of Automotive Engineers, National Institute of Ceramic Engineers, and the National Society of Professional Engineers.

(5) The ethical proposal originally published by NSPE in the May 1935 issue of "The American Engineer" included the following: "The engineer shall at all times and under all conditions seek to promote the public welfare by safeguarding life, health and property."

(6) NSPE, when it published its code in 1964, had membership of 62,038 engineers, and its journal was circulated, in a addition, to over 1,000 libraries and institutions. Its membership today is approximately 70,000 engineers.

(7) A much earlier code, adopted and published by the American Institute of Electrical Engineers (IEEE's predecessor) in 1912 provided: "An engineer should consider it his duty to make every effort to remedy dangerous defects in apparatus or structures or dangerous conditions of operation, and should bring these to the attention of his client or employer." The "employer", in a case such as this, is first the public entity and ultimately the California general public which is the entity's own employer. IEEE supplemented the 1912 code in 1974 by a new code which includes the following: "Engineers shall, in fulfilling their responsibilities to the community: (1) protect the safety, health and welfare of the public and speak out against abuses in these areas affecting the public interest..."

(8) The endorsing societies include: American Association of Cost Engineers, American Institute of Aeronautics and Astronautics, American Institute of Chemical Engineers, American Institute of Chemists, American Institute of Industrial Engineers, American Institute of Professional Geologists, American Nuclear Society, American Society of Agricultural Engineers, American Society of Engineering Education, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society of Quality Control, Data Processing Management Association, Engineering Societies of New England, Inc., Engineers Council for Professional Development, Engineers Joint Council, Institute of Electrical and Electronics Engineers, Instrument Society of America, Institute of Traffic Engineers, National Association of Corrosion Engineers, National Institute of Ceramic Engineers, National Society of Professional Engineers, Society for Technical Communications, Society for Experimental Stress Analysis, Society of Fire Protection Engineers, Society of Women Engineers, Technical Association of the Pulp & Paper Industry.

(9) The code of ethics of the NSPE, for example, was discussed initially in the May, 1935, issue of the American Engineer although that code was first formally adopted in 1946 (in a form differing little from the present code.)

NEWS, NOTES, AND COMMENT

The Computer Society of India (CSI) is holding its next Annual Convention, CSI 76 at Hyderabad, January 20–23, 1976. The theme for CSI 76 is COMPUTERS AND SOCIAL CHANGE. Those wishing further information should contact:

DVR Vithal
Computer Group
Tata Institute of Fundamental Research
Bombay 400 005, INDIA

Copies of a bibliography on the Impact of Technology on Society may be obtained, at no charge, by writing:

Dr. K.S.P. Kumar
Dean's Office
Institute of Technology
107 Main Engineering
University of Minnesota
Minneapolis, MN 55455

Enrique Kirberg, who had been imprisoned by the Chilean authorities since September 12, 1973, was released on September 8, 1975. An engineer, Professor Kirberg was Rector of the Universidad Tecnica del Estado in Santiago. He presently resides in the United States.

The Center for Defense Information publishes a monthly newsletter, The Defense Monitor, which covers a variety of defense related issues. For further information, contact the above at 122 Maryland Ave., NE, Washington, D.C. 20002.

A directory of equipment related to alternative technolgy (e.g. energy and resource conservation; systems using solar energy, wind power, water power; water distillation equipment, etc.) is available for $2.00 from Alternative Sources of Energy Magazine, Route 2, Box 90A, Milaca, MN 56353.

NOTICE to all CSIT Newsletter recipients: If your Newsletter label is designated TAB (see upper right hand corner) please send your change of address to: Stephanie C. Wolfson, IEEE, 345 East 47th Street, N.Y., N.Y. 10017.

RECOMMENDATIONS IN MATTERS OF ETHICAL PRINCIPLE

Director Saunders presented the three recommendations of the Ad Hoc Committee on Ethical Principles, as discussed the previous day in Minute 101 of these Minutes. The recommendations were approved on December 4th by the Executive Committee for recommendation to the Board of Directors. Director Saunders moved that the Board of Directors approve the following policy:

Recommendations in Matters of Ethical Principle

1. The Executive Committee is empowered by the Board of Directors to enter an amicus curiae brief in any court in the U.S.A. or in cooperation with cognizant national societies in other countries where a member of the profession is involved as a consequence of his taking a position on a matter of ethical principle.

2. The Executive Committee is empowered to publicize actions described in Recommendation 1 in any fashion deemed suitable and appropriate.

3. It is Institute policy that the IEEE will not, as to disputed facts, intervene or take an adversary position on behalf of or against any member involved in a matter of ethical principle.

(Unanimously approved.)

LETTERS

Dear Editor:

1. I have received the September issue of CSIT and I am surprised by most of Mr. Irwin Feerst's answers to your seven questions. Unhappily, I sent my ballot the week before and, seeing Mr. Feerst's mood on the Chilean Engineers issue, I realized that my vote to him should be annulled.

2. Be certain that Mr. Feerst's answer no. 6 was, in general, disgusting but exceptionally incredible in its two last phrases:

> "More importantly, however, I do not believe that IEEE should be an international organization. The overwhelming majority of IEEE members are American and we must recognize that fact of life."

3. ....I am sending a copy to Miss Emily Sirjane for information and on the hope that my ballot will be fully disregarded.

4. If elected Mr. Feerst can be sure that if, by any chance, he would come to Rio de Janeiro he will not find any WASP minded individual here.

Olavo Cabral Ramos Filho

Dear Editor:

The response of Irwin Feerst as printed in Issue No. 11, Sept. 1975, of the IEEE CSIT Newsletter, is positively disgusting. It shows that he is not only ignorant but foolish.

Philip L. Alger

Dear Editor:

.......I'm glad to see IEEE getting to controversial areas in the field of "Social Implications of Technology."......

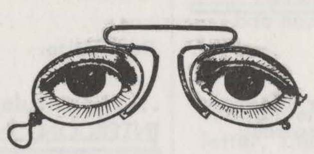
Raymond H. Williamson

Dear Editor:

....I particularly enjoyed the reprint of the nuclear debate at INTERCON, in the last issue. This is getting pretty hot out here, with a moratorium election coming up next June. There are quite a few younger IEEE's who are strongly for the moratorium, and who feel that President Stern overstepped his authority when he concurred with the PES in a resolution condemning the moratorium election.

C.W. Carnahan

SOCIAL IMPLICATIONS OF TECHNOLOGY - TWO VIEWS



Editor's note: In a letter to CSIT working committee members last February, the editor expressed the view that despite an increasing number of solid contributions to the Newsletter, there was considerable room for improvement -- that too many writers tended to be vague (a problem encountered throughout the literature). Several typical areas where contributions would be useful, were then cited. They included:

1. A debate on the role of engineering schools in electrical engineering;
2. A critical review of electrical stimulation of various parts of the human body;
3. A critique of the IEEE policy to limit open admissions to meetings - to permit cosponsorship of classified sessions;
4. An intelligent counterargument (see, for example, H. Goldberg's article in 1/75 IEEE Professional News) of the Institute's function;
5. A discussion of pension plans;
6. A discussion of the engineer as 'employee' vs. the engineer as 'professional';
7. A list of public interest organizations requiring engineering assistance. (Available from the Commission for the Support of Public Interest Organizations, 1825 Connecticut Ave., NW, Washington, D.C.)

Excerpts from Dr. George Sinclair's response and the editor's reply, appear below.

Response by Dr. Sinclair:

....I would maintain that the main reason for the weakness of the contributions being made in the general field of social implications of technology is the vagueness of the term technology itself. It is a term which is widely used under the assumption that it has a definite meaning, but there are good reasons to doubt the validity of the assumption. Most engineers would interpret it to mean, in some sense, 'engineering' or the 'products of engineering activities', but this may not be what the non-engineering community takes it to mean. For example, one widely quoted definition, due to the Harvard historian of technology, E. G. Methene, is that technology is the organization of knowledge for practical purposes. Any exposition on the 'social implications of the organization of knowledge' leaves me in considerable doubt as to what is involved. Perhaps this is why you find a plethora of innocuous and abstract articles permeating the literature.

An article which should be required reading for every member of CSIT is one by Eugene S. Ferguson[1] in which he considers the question: Is the history of technology a proper academic discipline? He concludes that it is not yet, and what is missing according to Ferguson is a serious inquiry into the nature of technology itself![2]. He goes on to point out that the history of technology has little to contribute in the way of wisdom and understanding on the problems of the social implications of technology[3]. The historians are beginning to realize that they are quite unsure of what constitutes the 'technology' whose history they have been busy recording for years. Lacking a clear concept of what is technology, and without a proper history of technology to provide guidelines, articles on the modern social implications of technology are bound to be innocuous and abstract.

Continued...

The fundamental difficulty, which the historians of technology have yet to discover, is not with the word 'technology' but with the word 'engineering'! One has only to read a typical reference work on the history of technology[4] to realize that the major concern of the historians is with the gadgets and processes which are produced by engineers, but the words 'engineer' and 'engineering' are conspicuous by their absence. Some years ago, Robert Multhauf[5] considered the question: Who are the improvers of technology just as the scientist is the improver of science? Multhauf admitted that he couldn't answer the question! The historians do not understand engineering as a profession.

Even the engineer is a bit confused as to what constitutes engineering, as is evident in the problems of CSIT. We do not fully comprehend what is the true meaning of the term 'engineering' because we do not have a philosophy of engineering.[6] Without a philosophy of engineering to provide the necessary guidelines, the engineer is going to have difficulty in assessing his true responsibility in relating his engineering activities to society.[7] It should be noted that the historians of technology make no appeal to the philosophy of technology for the resolution of their problems. The philosophy of technology is certainly not a philosophy of engineering.

Consider the problems mentioned in your letter:

2 (A) A debate on the role of the engineering schools in electrical engineering is meaningless without a philosophy on which to base the debate.

(B) It seems to me that a review on the electrical stimulation of various parts of the human body is basically a technical matter appropriate to the Group on Engineering in Medicine and Biology.

(C) The question of cosponsoring classified sessions is purely a matter of personal opinion and cannot be resolved on a factual basis. The engineer who dedicates his life to working towards the defense of his country finds such sessions important, while the pacificist finds the whole business abhorrent.

(D) Intelligent debates on the function of the IEEE is hardly possible without a philosophy to provide the guidelines.

(E) Pension plans, while they are vitally important to the engineer, are not part of engineering. The engineer is really just covering for the failure of professionals in the pension field.

(F) A philosophy is crucial in discussions of the professional responsibility of the engineer as employee or self-employed.

(G) It is not clear what would be accomplished by publishing a list of public interest organizations.

Before the engineer gets too deeply involved in solving problems in the social areas, he had better make quite certain that he has a firm foundation on which to base his actions. I maintain that he does not have such a base at present.

G. SINCLAIR

REFERENCES

1. Eugene S. Ferguson, "Towards a Discipline of the History of Technology", Technology and Culture, Vol. 15, No. 1, January 1974, pp. 13-30.

2. Reference one, p. 20.

3. Reference one, p. 17.

4. See for example, "Technology in Western Civilization", edited by Kranzberg & Pursell, Vol. 1 and 2, 1967.

5. Robert P. Multhaus, "The Scientist and the Improver of Technology", Technology and Culture, Winter 1959, pp. 38-47.

6. G. Sinclair "Why the Engineer Needs a Philosophy of Engineering", Submitted to the IEEE Transactions on Education.

7. G. Sinclair and W. V. Tilston, "Towards a Philosophy of Engineering", Submitted to the IEEE Transactions on Education.

Reply by the Editor:

....The weakness referred to is in the status of CSIT, and results in difficulty in reaching those doing serious work in the field. They do exist. IEEE Press has recently published a collection of reprints on SIT and one on Energy and Man. The University of Chicago has been publishing Technology and Culture for over 15 years. Within the numerous bibliographies we have publicized, are cited some excellent articles covering a variety of issues. At a minimum, these works would serve a stimulus for thought and debate. At best they would precipitate further serious study.

There exist electrical engineers who, by dint of their training or experience, are concerned with the impact on society of a variety of specific developments related to their field. As in other fields, some will be silent, some will write introspective and innocuous trivia, and a few will make genuine contributions thereby providing further stimulation for thought.

Our problem is that we are presently too few and that our status limits our range of potential contributors (one usually prefers writing for the Proceedings or a Group Transactions-- your references 6 and 7 are a good case in point.) On the plus side, our ability to innovate, to deal with areas not previously considered elsewhere, has had visible effect.

Regarding the vagueness of the term "technology" I believe that things are a bit turned around. Technology is generally regarded as a set of specialized goods and services (e.g. knowledge) organized in a certain way for a specific set of end uses. The interpretation of Methene's definition is a little too abstract and relies on word manipulation to form the conclusion. Moreover, no rational engineer would regard technology as an exclusive engineering phenomenon any more than he would regard the substance of an engineering curriculum as originating exclusively within engineering.

Continued...

SIT could probably be viewed as encompassing several areas:

1) The bilateral relationship between society and the manner in which the knowledge, skills, or goods are organized.

2) The bilateral relationship between society and the set of practical purposes for which the knowledge was adapted.

There is a danger in waiting until we have 'a better idea of what engineering is'. It is that the present philosophies under which engineering is done and technology is created will continue. But you will argue that no philosophy exists. If so, then all the efforts going into making hardware and software for war or peace, must be undirected with no underlying definition or philosophy. In fact the opposite is true. In effect, relatively few people are responsible for the decisions to employ large numbers of "technologists" for very specific practical purposes. Little feedback is tolerated either in relation to the purposes or the method of organization of the effort. A mass of well-trained people are implicitly instructed to not make any waves, to do their jobs, to act professionally, silent -all in the name of dedication to an effort, or on the premise that the practitioner lacks expertise or insight in the larger issues.

The apparent lack of an academically acceptable definition of engineering, technology, or their underlying philosophies does not preclude their existence. It is not useful to wait until these new insights arrive on the scene-not while there are organizers of knowledge making hard decisions as to how skills are to be organized and for what purpose. It is hardly likely that these individuals have any more firm foundations on which to base decisions which clearly affect technology, engineering, and society, than the rest of us.

Consider your responses to the points raised in my original letter.

1. Engineering schools train students according to a set curriculum-a set of directions as to what knowledge is dispersed and how. Industry has some say over its content, segments of society have less, engineers in the field have little, and students have almost none. For example, an increasing number of engineering schools offer SIT related courses. A cursory examination of those offerings indicates a general unwillingness to consider anything more substantive than the use of Bronowski's "The Ascent of Man". While this is well and good, the kind of professional honing found in a medical school or a law school via case studies, moot courts, practica, etc. is absent. Are we so gifted that this is unnecessary or are we out to create a mass of sophisticated sheep who raise no question and do not interact with their shepherds. Further, you will be hard pressed to find a SIT course where the role of academia in Engineering and Technology is even discussed.

A debate, in print, over the role of engineering schools in electrical engineering would be productive and timely. The schools have stated philosophies; both industry, the rank and file EE, government and other segments of society have, at a minimum, de facto philosophies. This is all that is needed for a beginning.

2. Whether a critical review of electrical stimulation of various parts of the human body falls within EMB's purview is irrelevant. EMB does not have monopoly on this type of issue. Moreover, a glance at the EMB Transactions from 1958 on will indicate an almost complete absence of anything even suggestive of a review of government, medicine or industry activities as they affect the field. Must we really wait for a Ribicoff committee to give us an incomplete account of the history of cardiac pacing, for instance? By refusing to deal with anything "sensitive", EMB has adopted an ostrich philosophy of sorts, and is, therefore, not in a position to be considered as the appropriate forum.

3. I refer you to past issues of the Newsletter on the issue of IEEE cosoponsorship of classified sessions (now IEEE policy). Engineers working in "security" related industries have ample forums for "closed" communication. If IEEE lives up to its credo, it cannot lend its blessing to such enterprises. Ironically a Past President of IEEE, R.H.Tanner, would have been barred from these sessions. To turn your remark around, a matter of personal opinion should not be the basis for institutional policy.

4. The fact that IEEE functions in a structured manner is ample grounds for a forum evaluating its manner of operation. The Board of Directors' philosophy may be acceptable or unacceptable to you or me, but it exists.

5. The practice of engineering depends on its practitioners. Their performance will be influenced by the nature of their work, their working conditions, the positions they select, and their prospects for the future. One simply does not get the same performance on the same problem from an academic, an engineer at H-P, an engineer in the Southwest Research Institute, and one in a sweatshop. Pension plans are part of engineering since they affect its practitioner.

6. Of course a philosophy is crucial in discussions of professional responsibility. However, philosophies do not emerge from a vacuum. They represent our observations of what are or should be. In this case a dialogue can only help clarify what should be. At present the overwhelming majority of EE's have been conditioned to wear blinders. Even if the present state of affairs should be maintained, they are entitled to decide that for themselves.

7. The purpose in publishing a list of public interest organizations requiring engineering expertise is the same as with many of the items we publish. A reader can agree, disagree, force a change in the Newsletter Editorial Board, drop their name from the reader list, show the Newsletter to a friend, throw it in the trash bin, read but not care, not be stimulated, etc. However, the opportunity to think or do something is there; that is something IEEE members have had little of before.

VICTOR KLIG

ENGINEERING AND IDEOLOGY

N. Balabanian*

A REVIEW OF: Introduction to Engineering. R.M. Glorioso and F.S. Hill, Jr. Eds. Prentice Hall, 1975.

The book under discussion is an outgrowth of a freshman engineering course at the University of Massachusetts in which students take four 1-semester-unit mini-courses in various areas of engineering. A total of 13 authors have contributed to the book. Each chapter, after the first, deals with a specific area in a relatively broad and interesting way. Examples are: transportation, energy, air pollution, computers, materials, communications, and bridge building. The one anomaly, which clearly is out of place here, is the chapter titled Fundamentals of Electrical Networks, which goes into the usual gory details. This chapter contains more equations than the entire remainder of the book.

Besides writing individual chapters, the two editors (who are both members of IEEE) collaborated in producing the introductory chapter of the book titled: What is Engineering? The function of the chapter is to lay out the role of engineering in society and of the engineer in the technical community; what engineers (as distinguished from scientists) do, the types of jobs they perform and how they should behave in these jobs. Appropriately, a considerable part of this chapter is devoted to the design concept and two specific case studies of design are described. It is this chapter to which the current review is directed.

1. IS ENGINEERING OBJECTIVE AND VALUE-NEUTRAL?

It has been widely held that, unlike politics and art, say, science and engineering are value-neutral activities; that scientists and engineers deal with "facts"-scientists trying to understand and explain these facts through the construction of theories, and engineers objectively applying these facts to the construction of things; that ideology plays no part in engineering. So far as science is concerned, such a view was challenged--successfully in my view--by Thomas Kuhn (1). And now Glorioso and Hill demolish it for engineering.

This, of course, is not their intention. But if ever a demonstration was needed that engineering is far from being value-free and unideological, that it is not simply an objective application of scientific principles, economic laws, and horse-sense, this chapter does an admirable job.

The authors (of the chapter) seem to have hidden agendas and almost every page is replete with messages of a normative, ideological nature.

> An advanced degree in engineering prepares one for more complex and analytical work, thereby allowing him to command a higher salary...those who have higher degrees generally progress faster through the job hierarchy. (p2)

> These talks and papers [at conferences and in journals] ...help to enhance an engineer's reputation. Basically then, an engineer must continually convince others of the value of his ideas and abilities. As in any profession, he must be able to sell himself and his ideas. (p3)

> ...the independent consulting engineer must continually sell himself, for he must convince each potential customer that he is the best man for the job (p20). [All underlining supplied.]

What kind of picture is conveyed by such language to the apprentice-engineer-initiate as to sanctioned attitudes and behavior? What values are given the stamp of approval? Indeed, what outlook is taken for granted and assumed to be a given which one would not even conceive of challenging?

*That a hierarchical structure is the proper way for work to be organized, rather than, say, an egalitarian structure in which responsibility and creative participation are more diffused.

*That a valued social order is one which stresses personal advancement up the "job hierarchy", which imposes wide salary differentials among workers and makes a virtue of the desire "to command a higher salary."

*That the reason for an individual to develop his/her potential through study, writing and speaking is not fulfillment and service, but status-to enhance an engineer's reputation, to progress through the job hierarchy.

*That the modus operandi of everyday commercialism-which seeks to persuade, cajole and sell people on the worth of this or that product-is the preferred behavioral mode; that the preferred way of life is a rat-race and the engineer must be in there pushing, convincing others and selling himself.

Clearly, the authors are not simply describing a set of values, but they are taking sides. They are advocating a particular social ideology although doing it without announcement and so matter-of-factly, so unobtrusively, that the initiate to engineering is indoctrinated with the ideology without having a chance to examine it and debate it up front. This ideology, incidentally, has little to do with engineering as such.

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The descriptive and the normative are so inextricably linked by the authors that we can't tell whether they are claiming something "is" or "should be".

> "The engineer's job is to always come up with better ways of satisfying a need: to satisfy it more safely, reliably and at a lower cost to the user." (p4)

One of the examples given is "the development of the automobile over the last 50 years." Now is this statement about an engineer's job a prescription which specifies what it ought to be or is it a factual description of what it actually is? If the latter, the statement is patently false; most especially so for the example given. Most of the developments in the automobile over the last 35-40 years contributed little to safety and reliability and certainly were not designed to reduce cost, at least to the consumer. So it must be a normative statement, a declaration of the ideal for an engineer. But since an example is given, the authors intend for it to describe what exists in reality. Thus, the false impression is conveyed that what is deemed to be exemplary behavior for an engineer actually occurs in practice within our economic system, that there is no intrusion of the economic system in the manner in which engineers can discharge their responsibilities.

In discussing the rise of engineers in management, the authors say that not only should a project manager be quite familiar with technical details of a project but he must also have a broad understanding of how the project fits into the overall company program,

> "...for he must report his progress to his management and be prepared to defend his requests for more funds or equipment." (p19) [Underlining supplied]

Here, also, we find a taken-for-granted assumption about an engineer's conduct. It is not even considered admissible that-having acquired a broad understanding of the project's relationship to the company's scheme of things-the project manager-engineer would conceivably conclude that the proper thing to do is to reduce the funds and equipment for his/her project! Building an empire, always asking for more; this is the way of life approvingly taken as given.

2. ENGINEERING JUST RESPONDS TO NEEDS?

The next to last quotation points up another factor. Without a doubt the increase in scientific knowledge and its application to the design and development of a large range of devices, systems, and processes has brought our society to its present stage. A way of describing the "advance" of technology is to aver that it is in response to a "need".

> "Why have all these technological advances appeared...? Almost all invention begins with a need. An engineer...recognizes a need and searches for a way to satisfy it." (p4)

Again the example of transportation is given, where a succession of new (and improved)

> "technology has come along to replace the old. In each case the new development answers the need for safe, inexpensive and reliable travel better than the old." (p4)

> "Why do we design something? Generally, a machine, gadget, building, system, bridge, or what have you is designed in response to some real or assumed need. The initial step in the design process is the recognition of a need." (p21)

Again the proposition is false, at least for the example of transportation. Automobile travel is not safer or more reliable than trains; freight transportation by truck is not cheaper than by rail and is more fuel-intensive by a factor of at least four.

In contemporary society this response-to-needs representation of technological growth does not describe present reality but serves as an ideological component of neo-classical economic theory. The answer to "Why do we design something?" most often is "because it will add to sales and increase profits!" Galbraith has described the process well. (2) Research and development are highly organized activities of technology-intensive corporations whose purposes are growth of sales and of profits. Invention and innovation serve these purposes no less than does production. And to do so, innovation does not at all have to serve a need previously perceived by anybody. More often than not, contemporary innovations serve to create a "need" or a "want" not previously perceived. Then the entire arsenal of "persuasion" is unleashed to convince potential consumers that they have this need and that the new product will satisfy it.

A betrayal that the authors understand this occurs when they are describing the design process later in the chapter. After a design is found to be technically feasible, they say, then manufacturing cost, potential selling price, predicted market size, etc., must be studied in detail.

> "It is necessary to determine if the market exists or if it must be developed." (p24) [Underlining added]

"Developing a market" is a euphemism for creating a need. If the market does not exist and must be "developed," then where was "the need?" Only in the corporation's desire for profit!

3. SYSTEM-INDUCED NEEDS

The ideological view that sees engineering as responding to "the needs of society" or to "what people want" is defective in another respect: societal needs or people's wants are system-induced. If the societal system is appropriately changed, the need can be made to disappear.

> "For example, the development of non-polluting washing products...was in response to societal need. The flood of new auto and home burglar alarms that are being marketed is a response to the increase in crime and peoples' natural fear of being robbed." (p21)

Both of these examples beautifully illustrate the point, even though unintended by the authors. In the fifties and sixties, in order to serve the purposes of increased sales and profits, the large washing products corporations introduced variety after variety of detergents to replace the theretofore perfectly acceptable soap. Note the advantages of soap. First of all, the manufacture of soap uses only readily available natural products (fat and alkali). Furthermore, after use, soap is biologically degraded, yielding carbon dioxide and water. So the environmental impact of soap, both in production and following consumption, is minimal.

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There was no discernible societal need for detergents, and people's wants--for a whiter-than-white wash, or cleaner-than-clean underwear--was created through incessant advertising persuasion. Little, if any, thought was given by the manufacturers to the polluting consequences. The first generation of detergents marketed was not biodegradable. Only after tap water began to foam like beer and governmental regulation was threatened were second generation biodegradable detergents introduced. Unlike the earlier detergents, these had unbranched hydrocarbon molecules which included a benzene unit. But, in water, benzene can be converted to carbolic acid, a toxic substance. So, although the second generation detergents didn't foam, they were even more likely to kill fish after being consumed (in washing) and sent down the drain.

Another polluting problem of detergents is their phosphate content. The use of detergents intensified the environmental impact from this source by a factor of 20 compared with soap over the period 1946-1968. Each time others called attention to a serious environmental impact from one generation of detergents, manufacturers introduced a new generation--and made high profits for a while--until others again experienced serious problems of pollution, toxicity, dangers to health, etc. (See Reference 3 for further discussion.) The process is still continuing with corporations seemingly introducing a "new" variant almost every other month with superlative claims for its cleaning prowess. Without the displacement of soap because of profit-seeking, there would have been no societal "need" calling for an engineering response.

The example of the "need" for more sophisticated auto and home security devices--not to mention tougher laws, more escape proof jails, etc.--in response to increased crime and fear is even more illuminating. Suppose--purely hypothetically--that one were to organize the economic and social system so that wealth and income become distributed very unevenly; so that an underclass is created of chronically unemployed individuals with little prospect for improving their condition, while at the same time the mass media portray the bounties of an affluent society. Let it be widely known and felt that justice is also unevenly distributed; that the rich and highly placed can flout the law with impunity; that even government agencies systematically, on a large scale and over many years have violated the law and have been used for political purposes without unpleasant consequences to them. As a consequence, suppose that large numbers of citizens become alienated, lose their sense of belonging, and no longer feel they have a stake in society. If crime and its engendered fear now increase, one might describe the situation by saying there is a "need" for better burglar alarms and stronger jails. Having identified the need, then engineers can be put to work designing hardware to meet it.

But is this a valid description? Should engineers take "increase in crime" as a given and see their problem merely as devising methods for thwarting the crime? Shouldn't they look further at the antecedents of what they are given as the problem? Perhaps the "need" is for a more just, more egalitarian society; this will require measures of an order different from better burglar alarms. In fact, if, through the design efforts of engineers, crime is temporarily contained at a level deemed to be acceptable, then there might be reduced incentive for attacking the real problems engendering crime in the first place. It is again clear that a change in the social order would obviate the need which was claimed to be the origin of the engineer's work.

This is not to say that engineers should refuse to treat symptoms that require immediate attention. A physician might prescribe cold compresses to bring down a patient's high fever-which is a symptom of some more serious problem-so as to permit time for an in-depth attack on the illness. This subsequent step is crucial; the physician's job is not complete with the treatment of the symptoms. So also engineers might treat symptoms-design better burglar alarms, say. But they should understand that this in itself is not an adequate solution. At best, it provides a breathing spell for a more fundamental attack to be made on the problem. Most societal problems, such as crime, do not admit of a simplistic "technological fix."

The same point can be made with reference to one of the two actual design cases described in the chapter. The ultimate product here is a semi-automatic pleating device used in sewing draperies. The impetus for undertaking the design is the desire to reduce labor costs.

> "A significant problem is the high turnover rate of a relatively low-skilled labor force--it is not unusual to hire 100 workers per year in order to maintain a 100-man force. Thus it is important to keep the training period for new workers as short as possible...the training time for pleating and sewing was significant. It took 16 weeks before an operator was producing enough to cover his salary..." (p28)

The engineers took the problem to be one of reducing operator training time and they came up with a machine that cut the time from 16 to 8 weeks. As a bonus, we are told, the machine eliminated an operation and increased production. These are worthwhile outcomes but, again, the problem is too narrowly focussed. As far as the ratio of training time of operators to average length of employment is concerned, the same 50% reduction can be obtained by reducing the turnover rate by a factor of two. And if you could keep operators for an average of ten years instead of one year, you would be much further ahead. So the crucial question is: Why the high turnover rate? Is the corporation running a sweat shop at inadequate rates of pay? Are working conditions so oppressive that no one can tolerate them for more than a year? Is it very difficult to reach the place of employment by convenient means of transportation? Do the operators (who are women) fear for their safety when they arrive and depart because of the location of the factory?

If the reasons for the high turnover rate are because the answers to some of these questions are affirmative, then the social costs of the engineers' quick technological fix will be high indeed. Oppressive sweat shop conditions, inadequate rates of pay, inadequate public transportation, or unsafe streets will continue because, as a result of the engineers' efforts, the incentive to tackle these problems has been reduced.

It is, of course, possible that after examination, all of the preceding questions can be answered in the negative, and the machine was the best solution to the problem. But it is essential for engineers to approach such problems from a broad perspective, and not simply assume that all problems can be solved by designing a piece of hardware. Regrettably, the authors do not provide such a perspective.

(It should be noted here parenthetically that the authors show little consciousness throughout the chapter that engineers, workers, operators, and others can be women, and of the need to modify their terminology appropriately. Especially in the preceding quotation, when several photographs on the facing page in the book show the operators to be women, the termi-

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nology "100 man work force" and "before an operator was producing enough to earn his salary" is decidedly unfortunate.)

4. TECHNOLOGY AND INDIVIDUAL AUTONOMY

There is a certain lack of understanding and confusion about the nature of contemporary technological society, of the benefits technology provides, and the possible roles and desires of individuals in accepting, using, or refusing to use the available technology.

> "Our society is highly technological and is rapidly becoming more so...It is very unlikely that our civilization will ever turn around and become less technological: People want comfortable living, easy communications and travel, health care, and recreation too much to turn back...everyone is using energy (in heating, lighting, travel, entertainment, etc.) at an ever increasing rate, and very few people are seriously willing to give up the devices that consume this energy." (p4) [All underlining supplied.]

Historically, the social philosophy of "progress" developed from the vision of a utopian life which emerging science and technology were seen as ushering in. The experience of the last decade or two has demonstrated that we got more than we bargained for; with all the benefits we also reaped substantial drawbacks so that the old vision is now very cloudy. Yet there remains what can only be described as an ideological attachment to "high"-and advancingly higher-technology as the source of a wide range of beneficences.

A century ago, "comfortable living" to most people probably meant far less than most Americans currently enjoy. The extent to which such "comfortable living" is not now available to all can be ascribed not to a lack of technology, but to social and political failure in evenness of distribution. It is folly to imagine that, beyond a certain level of satisfaction, comfort in living is greatly increased through "high technology." Snowmobiles, electric carving knives, spray deodorants, and many of the other products of such technology contribute little to a joyful and fulfilling life. To claim that comfort in living comes from some generalized increasingly high technology is specious.

As for "health care", of course people want it, but in what ways does high technology contribute to health care? The general concept of "health care" can be thought of under two categories: "well-care" and "sick-care". Almost all people are normally well: what they need is care that will keep them well. "High technology" does make a contribution here mainly in the form of innoculations against disease. But high technology has little positive to do with the maintenance of a healthy body through proper nutrition, appropriate physical activities, and general peace of mind, which are the most essential ingredients of well-care.

If anything, a case can be made that high technology might have a negative impact on well-care. Space does not permit adequate elaboration of this point but two illustrations may be briefly cited. The technological organization of society prevents people from having adequate physical activity; this not only contributes to obesity and detracts from well-being but is conducive to certain diseases. Secondly, "high technology" applied to food and eating habits has led to the highly processed foods which Americans eat from which important ingredients (such as fibers) have been removed. It is suspected that this is an important contributory cause of a number of major diseases. (4)

Of course, people do become ill; what they need then is care that will make them well. It is here, perhaps, that high technology makes its greatest contribution. The highly publicized heart transplants, kidney dialysis machines, iron lungs and similar creations of high technology provide sick care for perhaps 10 thousand individuals annually in the U.S. But what bearing, for example, does high technology have on health care for expectant mothers and young infants (of which there are some 3 million annually), so that infant mortality in the U.S. can be reduced from its current high level? The United States ranks worse than 16 other countries in this respect, including a number of countries not endowed with our high technology. Other examples can be multiplied. The uncritical application of high technology to health care can lead to the ultimate horror described in a Vonnegut fantasy. (5)

The authors' claim that, because people want health care, ergo, society must become increasingly more highly technological, does not follow from the facts and cannot survive critical examination. If a final argument is needed in this regard, one might focus on life expectancy. If life expectancy is any measure of the health care received by a people then, with all our higher and higher technology, Americans are not receiving more and more care: average life expectancy in the U.S. has not increased in 20 years.

In the evolution of technology, Ivan Illich distinguishes two periods. (6) In the early stages, new knowledge is applied to the solution of problems and progress is made. At a later point, as an area of technology becomes further developed, it can begin to become destructive of human values. (The level of technology yielding muscle-operated toothbrushes is highly beneficial; the stage of technological development that gives us electrically-operated toothbrushes is far less so.) A number of threats are posed by such highly advanced technology. Perhaps the most serious is what Illich calls a radical monopoly. A radical monopoly is exerted when a technology exercises exclusive control over the satisfaction of an important human or societal need, and excludes alternative methods from competing to satisfy this need. Such a monopoly exists when a technology rules out the natural competence of people and imposes compulsory consumption of this technology, thereby restricting personal autonomy.

For example, motorized transportation exerts such a monopoly. Automobiles so shape the entire life of a city that individuals find it difficult, if not impossible to participate in all aspects of community life without the use of a car. People must have a car in order to go to work, to the drive-in, to church, to the supermarket. They are not at liberty voluntarily to give up "the devices that consume this energy"-unless they also give up normal life in the community. It adds insult to injury, first to arrange it so that people are compelled to use the existing technology, and then to chide them for not being "seriously willing" to give it up.

Other examples are inorganic fertilizers and pesticides. In the presence of inorganic nitrogen compounds, nitrogen fixation by bacteria that naturally inhabit the soil tends to stop. After continuous and intensive use of such fertilizers, soil bacteria are drastically reduced. Thenceforth, a farmer must continue to use inorganic fertilizers-this "high technology" exerts a radical monopoly. As for general inorganic pesticides, they also eliminate the predators which tend to check the pests. So after continual use of such pesticides, a farmer cannot be "seriously willing" to give them up-unless he also wants to give up farming-because the pests' natural predators have been killed off. Like a drug addict the farmer becomes hooked on technology.

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A recent study of the Center for the Biology of Natural Systems shows up how ironic it is to be touting the use of high technology, specifically chemical technology in agriculture, and disparaging anything less as primitive. (7) The study showed that the organically operated farms studied in several midwestern states had net returns per acre not less than (and even slightly higher than) comparable farms in the study which utilized inorganic fertilizers and pesticides ($134 as against $132 per acre). Furthermore, the organic farms were less energy intensive by a factor of 3. And of course, they do not have the strong polluting effects on surface waters which the inorganic fertilizer and pesticide using farms do.

There is no intellectual merit to the simplistic argument that, unless one "buys" all advanced technology, one is advocating a return to primitive conditions of life. Generalized terms like "high" or "more" technology, as opposed to "low" or "less", are inadequate categories for discussion. What is needed is appropriate technology. For some purposes, the appropriate technology might be more advanced, for other purposes, less. The uncritical advocacy of advanced technology as the solution to all problems-not to mention its acceptance as an article of faith, without debate-may be understandable in the ideologue; but can it be accepted in those who educate future engineers?

Almost as an anticlimax, one more point merits attention. The discussion of patents by Glorioso and Hill at first seemed surprising. In the context of the sequence of events following the invention of something new by an engineer, they say:

> "Frequently an engineer signs an agreement with his company to assign all patent rights to the company, recognizing that the company supported the work that led to the idea." (p18)

The impression is created that, following an engineer's working and inventing something, he/she "frequently" makes an independent decision (which means that sometimes the decision made is not) to sign the patent rights over to the company. This is a totally erroneous impression. The reality almost universally is that, upon first being employed, engineers are compelled to assign patent rights to the employing corporation. Otherwise, they wouldn't even be hired. Furthermore, the rights are to all inventions during the period of employment, whether or not the company supported the work that led to the idea. One wonders why this tilt in favor of the interests of corporations as opposed to those of individual engineers. But it is consistent with their general approach of presenting their particular views as not-to-be-discussed givens.

5. THE END OF IDEOLOGY?

The book under discussion is supposed to be a textbook for student use, not a political tract which ideologically upholds a particular set of views. Perhaps the simplistic picture of technology, of the economic system, and of the functioning of engineering in society as presented by Glorioso and Hill is the correct one, and some or all of the critical comments made here are invalid. But these are certainly matters to be debated and argued, not tactily taken for granted and treated as givens. Even a set of discussion questions at the end of the chapter (none is given) would at least have permitted the idea to arise that there are things to be questioned and debated here, and not simply to be accepted as one accepts Ohm's law, curves of oil production plotted against time, or the computer flow charts discussed elsewhere in the book.

The approach of the authors is consistent with a primary goal of engineering education enunciated by a distinguished committee of engineering educators: "To prepare the student, ideologically, for constructive participation in the competitive, profit-motivated economy." (8) If teachers and authors are to prepare students-ideologically-then students should not be permitted to question the premises of that economy, nor of those who advance a particular view about technology. And what better way is there to do so than to conceal their nature as premises, assumptions, articles of faith, and ideological non-sequiturs?

Discussions with the following people have been helpful in the preparation of this essay: Martin Rothenberg, Harry Schwarzlander, Steve Unger and Victor Klig.

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REVIEWS OF WESCON SESSIONS

Session 31: ELECTRONIC IDENTIFICATION SYSTEMS

This session was billed as covering the major approaches to electronic identification systems; fingerprints, speech, and handwriting. The session organizer and chairperson, John Riganati of Rockwell, started by noting that these approaches use either anatomical characteristics or learned and repeatable actions. There is a market potential of $500 million over the next ten years in these areas and in support areas such as data storage, transmission equipment, and computers.

The first speaker, Robert Stock of the FBI, mentioned some of the needs of law enforcement. He concentrated on fingerprints as opposed to handwriting or speech because fingerprints are accepted by all courts. He noted that the rights of arrestees are important, the FBI must remain cognizant of these rights, and the courts are more and more holding the FBI responsible for this. Since there is no legal precedent for using signatures or voice prints, the FBI prefers to stick with fingerprints.

As to the needs of law enforcement for identification, Stock echoed the FBI party line that it was necessary for the FBI to maintain a complete central file of arrestees (not convicted persons). He did not mention the opposing LEAA argument that the states should maintain state repositories which could be electronically transferred when necessary.

Improvements in recording fingerprints are necessary, Stock said. Solid state, non-mechanical scanners for fingerprints would be best; there are also needs in data storage, data communication, and perhaps mini- or microcomputers, as searching chews up a great deal of computer time right now.

Rockwell is currently building a reader for the FBI which will scan a standard 8" by 8" fingerprint card and produce "enhanced binary fingerprints" ready to be searched against a databank of possible matches.

Stock, when asked about the privacy problem, answered with the usual responses. When asked about the measures used to safeguard FBI data, he cited the regulations promulgated by the FBI's National Crime Information Center. The reviewer notes that these have been criticized by law enforcement for being too strong and civil libertarians for being too weak.

The next speaker was Dr. George Doddington from Texas Instruments. He discussed a speaker verification system built by TI for an in-house application. The main sources of error here are speaker variability (mood, colds, laryngitis), similarity between speakers (natural, mimicry, tape recording), and problems in measurement and processing. To handle the tape recorder problem, TI randomizes the verification utterance: The system chooses one word from each of four lists and the computer generates that word in speech; the user then is required to repeat it within four seconds. Since different words are given every time, there is no way of knowing in advance where to position a tape recorder in order to fool the system. TI uses voice prompting instead of CRT's for human factors reasons: the speaker is less tense since (s)he is used to responding to a voice but not to a cathode-ray-tube in ordinary discourse. Time for the entire action (computer utterance, user response, processing, and admission) is about six seconds (although the system can require multiple utterances if it isn't sure of the speaker's identity).

Each user must first "enroll" by uttering twenty or twenty-five phrases. The system adapts itself to gradual changes in the speaker voice over time. The system database keeps not only the speech characteristics of the user but also his or her weight. This is used to allow several people through a "man-trap" room with doubly interlocked doors at the same time. The floor of the room is not just an ordinary floor; it is a scale. Upon acceptance, each speaker's weight is added into the accumulating total until the sum of the weights of people in the room approximately equals the sum of the recorded weights.

Jacob Sternberg of Veripen, Inc. discussed automated signature verification using handwriting pressure. There is minimal user resistance to signatures since people are used to signing their name for all sorts of reasons. There is almost no learning required, unlike other methods, and the changes in a signature are gradual. This technique also lends itself to automatic updating.

Sternberg's pens compare pressure rather than graphics with stored data because 1) there are a lot of graphics (signatures) on stolen cards, in stolen wallets, etc.; 2) many people already are experienced with graphic forgery; in fact, 10% of a random sample of people can be trained to become very good graphical forgers; and 3) pressure generates electronic signatures which leave no samples on which to practice. Pressue signals can be converted to a number of measures such as signature length.

It only takes six signatures to enroll in the system. Unfortunately, approximately up to 5% of all people are "ghosts", i.e., they do not have consistent signatures. This is being further explored.

Finally, R. J. Rennick of Rockwell International discussed MUFTI, a Multi-Functional Identification system. Here is truly a case of technology gone mad. Rennick proposed a multi-functional identification system to serve small to medium law enforcement agencies. He wants to take the techniques of latent search, speaker matching, badge reading, and remote file access and connect them all via a minicomputer and CRT. Whether the system would be (cost-) effective (and at what) was not answered. The proposal is shockingly reminiscent of less ambitious previous debacles in the area of criminal justice computer systems. Very few agencies would be able to afford this technological overkill and although MUFTI would sell a lot of computer hardware, it is unclear whether any criminal justice problem would be solved. Whether any of the identification would stand up in a court of law was not discussed, unlike Stock's earlier presentation.

L. J. Hoffman

Continued...

Session 23: "PROMOTING WOMEN? WHAT'S THE PROBLEM?"

The session was a series of five talks. The session was opened by Mr. L. Fitzsimmons, Convention Director of WESCON, who said that he considered this session one of the most important of the convention. There were approximately 100 in attendance.

Esther H. Williams, a metalurgist at Lockheed, gave a general summary of common situations of cultural bias and in stereotyping, and suggested sources of qualified women such as those returning to the workforce and women who have demonstrated managerial competence in volunteer organizations.

Jim Harper, a personnel manager at Tektronix in Oregon, expressed his opinion that promoting women was perceived as a greater problem than it really is, and that the problems involved of ambition, availability, and qualification were common also to minorities and to men. He described the extensive in-house training available and the tuition aids through which his company fosters upward mobility, which in his company is uniquely important because its plant is not close to a large skilled labor market. Mr. Harper, in concert with most of the other speakers, sees that stereotyping of women into previously traditional roles is a major handicap to promotion, not only in the eyes of the person making the promotion decision, but also in the woman's image of herself. He said that women must continually upgrade themselves and make clearly known their desire to compete. Other potential problems to be faced are those women who state that they would not work for another women, and the phenomenon of a position losing some of its status when first filled by a woman.

Jean Wright, of the Department of Defense, reiterated many sources of problems, and possible solutions. She has been proposing a Cadet Program, which aims to recruit high school seniors into companies as part-time employees while they acquire a college degree. The object of this program is to obtain people before stereotyping has taken hold. An admitted limitation of her program is a rather rigid career plan, which may be more practical in stable governmental organizations than in industry. Ms. Wright also cautioned that even apparently highly qualified women cannot be complacent, because industry does not seem to be making great efforts to seek them out.

Mr. Stuart Parsons, a psychologist at Lockheed, did not have a printed paper, but generally reaffirmed opinions of other speakers. A new point he discussed was the method of answering the white male backlash to affirmative action programs, which method is to explain that many opportunities still exist, and that the careers of white males will not be significantly affected. It is the opinion of this writer that Mr. Parsons glosses over a very real problem. Companies with well-developed Affirmative Action programs are reporting to the government their goals of promoting very substantial percentages of non-white males. Opportunities for white males are in fact being substantially lessened, and these individuals' attitudes must be recognized and responded to.

Carolyn Morris, of Hewlett-Packard, gave a stimulating and often humorous talk and skit on covert discrimination, stereotyping, and "white male club rules". She described her problems and success in organizing a non-threatening women's-interest group within her company. One of her interesting challenges was to "try sending flowers to a man!"

Ms. Morris presented a clever role-reversal skit involving two women executives of a lingerie manufacturer handling a male sewing machine operator who wanted to be promoted. Their ultimate advice to the man was to get married so that he could stay home with the kids and not have to worry about a career!

C. L. Ostrofe

Session 14: ENERGY POLICY DECISIONS IN THE NEXT 1000 Days

The next 1000 days will require decisions on fundamental questions of energy policy at the local, state and national level. These decisions will be of profound importance to companies and individual engineers. Customers will be increasingly aware of the efficiency and energy consumption of goods and lifetime energy consumption will become a major design criterion. As a result of increased cost of energy many existing products will no longer be competitive. These problems and issues were discussed from a variety of viewpoints.

Summary: Altogether there were six papers presented in this session. They are:

1. Future Energy Sources - By H. L. Berk, R. F. Post, J. Rinde, A. Laird, J. Stanley, and H. Zullinger.

This paper presents a brief survey of energy generation methods, which includes petrified fuel, solar energy, fission and fusion. It points out the available energy resources in the United States, the virtues and problems of each energy generation method.

Coal is by far the most abundant energy resource in the U.S. It may supply 89% of our future energy need. At present the transportation market is almost entirely dependent on oil. Liquification or gasification of coal is possible, but the problem is cost. In situ coal gasification may provide the answer.

Solar energy is unlimited in supply and non-polluting, but climatic conditions, its low intensity, and hardware costs are big problems.

Nuclear energy may provide a short term solution, but safety, waste, and weapon material by-products are all problems. Nuclear power plants are already competitive pricewise.

Fusion may be the answer to all energy problems. It is relatively clean, its fuel supply is virtually limitless, and it does not produce weapon materials as by-products. So far its feasibility has not been demonstrated, and it may involve very high capital expenditures.

The paper in general is informative.

Continued...

2. Energy and Growth - By Gary G. Williams.

The author started with the history of development and presented some data on U.S. consumption. The U.S. has 6% of world population, consumes 35% of world's energy, 42% of aluminum, 63% of gas and 33% of petroleum. In the period 1950-70 the percapita change in U.S. consumption are illustrated by the following data:

Synthetic Fibers	+1890%
Population	+ 35%
Plastics	+ 556%
Electric Power	+ 207%

The data for percapita consumption of energy in two other industrialized nations are: West Germany 46% of U.S. and Japan 26% of U.S. In order to meet the U.S. growth the capital requirement on energy development for 1975 - 2000 will be $1,720 billion. The fact is we don't have that much money. The only solution is conservation. We should concentrate on the quality of life rather than quantity. The author noted that the quality of life in the U.S. is lower than in many countries that consume much less energy. He also pointed out that we can actually cut 10%-25% of our energy without any noticeable effect on our life and employment.

3. Strict Liability: Nemesis for the Nuclear Electronic Component Supplier - By Donald F. Lundgren, and Paul C. Valentine.

The purpose of this talk was to alert the nuclear electronic component suppliers to the unprecedented, enormous liability which may confront them in case of a nuclear accident. The speaker started by defining the term "strict liability". Our common concept of liability is often associated with negligence. But, one may still be liable even where there is no negligence involved. A manufacturer may show that he has taken all precautions to prevent a bad product, but he is still liable for damage caused by his product. Strict liability means liability without fault. Hence, by strict liability, all manufacturers are liable for their products. In case of a nuclear reactor accident the subcontractors may face enormous liabilities. The operators of nuclear reactors are covered by the 1957 Price-Anderson Act, which limits their liabilities to $250 million. The Price-Anderson Act only covers the licenses or the operators but does not cover the subcontractors or the suppliers. The Price-Anderson Act will expire in 1977 after which Congress may extend its coverage to subcontractors as well. Even then, the constitutionality of the act has never been tested.

4. The Case for Conservation - By R. Michael Evans, and Gail B. Boyd.

The authors made a study of the companies which responded to the need for energy conservation. Their effort consisted mainly of removing some lighting, installing timers, and changing thermostat settings. Varian Associates reported a 50% saving in natural gas and a 15% reduction in electricity use. IBM made a vigorous effort which included the establishment of a nation-wide energy data bank. The result was a 31% saving of fuel and a 22% saving of electricity. It cost $200,000, but its first year saving was $500,000. Hewlett-Packard went one step further, constructing its own solar system. The system reduced fuel consumption by 40% and paid for itself in 18 months. It occupies only 10% of the roof area. Everything seems to indicate that conservation pays.

5. Electronics - An Alternative to Energy Consumption - By Glenn Bacon, and Malcolm McWhorter.

While the cost of energy is going up, the cost/unit of electronics is going down. Electronics is potentially the key to energy conservation by its ability to control consumption and to replace transportation. In the area of control, the speaker envisioned the control of peak load, airline or truck scheduling and routing, and traffic control (to reduce idling). The Ford microprocessor control system is known to save fuel by 5%. In the area of replacing transportation, the speaker enumerated Tele-conference, Cable TV for shopping, adult evening courses, etc. The side effects will be decentralization of growth, and bringing work and culture to rural areas. The solar cell research may result in a demonstration model of 10 MW by 1980, and 500 MW by the mid 1980's. Electronics can be a major force toward an energy-efficient society.

6. A Survey of Probable Futures - By Willis W. Harman.

This speaker contends that conservation can only lower the growth curve but does not change its exponential shape, and that conventional forecasts are probably wrong because they are done from the point of continuity with little consideration of the attitude of the people.

Kenneth K. Mei

Session 7: ESOP'S AND THE HIGH TECHNOLOGY CO.

The papers were all offered by investment counselors and were intended for owners and executives of new emerging companies who are considering ways of increasing employee income through methods other than salary changes.

Employee Stock Ownership Plans are profit sharing pension plans designed for investing primarily in employer securities. Such plans must qualify under the Internal Revenue Code of 1954 as amended by the Employee Retirement Income Security Act of 1974.

The first plan of this general type was started by Sears Roebuck and Co. in the early 1900's but the current ESOP concept was started in the San Francisco Bay Area in the early 1950's. A trust is set up and a percentage of company income before taxes goes to the trust to buy company stock.

All plans must qualify under numerous Federal regulations, including:

1. Coverage must be broad based.
2. There must be a formula for allocating stock proportional to salary.
3. Tax deduction limitation.
4. Limitation on total contribution for individuals.

These brief comments are only an introduction. Details are in the Employee Retirement Income Security Act of 1974, or available from investment counselors.

H. E. Hulse

PROTECTION OF INFORMATION IN COMPUTER SYSTEMS

By Jerome H. Saltzer and Michael D. Schroeder

Proceedings of the IEEE
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A Review - By Howard Eskin*

The topics of protection of information, data security, and privacy in the domain of computer systems are of particular significance in our society, which is increasingly keeping its records in computer based systems. This paper is an excellent technical survey of the mechanics of protecting computer-stored information from unauthorized use or modifications, with a focus on the conceptual framework necessary to enforce data security.

The development is in three sections: I, Basic Principles of Information Protection; II, Descriptor Based Protection Systems; and III, State of the Art.

The authors begin with a glossary of terms used in the context of information protection and end with an extensive bibliography divided nicely into the following subtopics:

1. Privacy and the impact of computers;
2. Case studies of protection systems;
3. Protected objects and protected subsystems;
4. Protection with encipherment;
5. Military security and nondiscretionary controls;
6. Comprehensive discussions of all aspects of computer security;
7. Surveys of work in progress;
8. Bibliographies and collections on protection and privacy.

The paper is a good starting point for a reader familiar with computers and interested in the nature of data security and protection mechanisms in general. If the reader is concerned mostly with the social implications, he may be somewhat disappointed. Here privacy is defined in social terms whereas security describes techniques. The discussion is explicitly concerned with (data) security---"the techniques that control who may use or modify the computer or the information contained in it"---and superficially with privacy---"a socially defined ability of an individual (or organization) to determine whether, when, and to whom personal (or organizational) information is to be released."

Particular attention is given to one approach---descriptor based systems. This section requires considerably more attention and understanding on the part of the reader than do the other two sections.

Though not the main thrust of this paper, many "privacy" related philosophic issues appear.

Three security breaches are enumerated:

unauthorized 1) information release
2) information modification
3) denial of use.

Several examples of the functional levels of security are given, ranging from no protection to elaborate schemes for protection. Examples are:

1. unprotected systems (e.g., IBM DOS)
2. all or nothing (e.g., VM/370)
3. controlled sharing (e.g., DEC System 10, TENEX)
4. more elaborate (e.g., MULTICS, UNIX).

Of the several design principles presented (economy of mechanism, failsafe defaults, complete mediation, etc.) one is noteworthy here---open design.

The principle of open design is that the mechanism for enforcing protection should not be secret. It should not depend on ignorance on the part of the potential intruders, but rather on the possession of specific keys or passwords which are easily protected. In addition to making the whole mechanism more trustworthy, this open approach permits the whole process to be examined by many reviewers without concern that the review may itself compromise the safeguards. A skeptical user may then determine if the approach is adequate to his purpose, whether the purpose be that of a corporation protecting proprietary information or of a taxpayer attempting to keep his tax return out of the hands of others.

Another point conveyed in this work is that the static protection of information is not the only goal. In general we wish to protect the integrity of the information while at the same time allowing accessability under carefully controlled authorizations. For instance, a hierarchical system is proposed in which higher levels grant authorization to the next lower levels. As is pointed out, this leads to the unacceptable concentration of authority. It is suggested that power of the highest levels be moderated with special procedures so that the exerciser of high authority is effectively prevented from abusing this authority. This is a concept of checks and balances that has long been recognized in our (democratic) social systems but it is often overlooked in computer systems which tend to be authoritarian, ruled often by system programmers. One strategy is discussed in this vein.

On the whole this paper presents quite a good survey of many security techniques and references others.

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