The Engineer's Professional Role:

Universities, Corporations, and Professional Societies

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THE THEME of this Middle Atlantic Section meeting of the American Society for Engineering Education is "Engineering Education in a Changing Society." Perhaps a more realistic title would be, "The Engineering Crisis in a Changing Society"—a crisis which comprises university, industry, and technical society circles. Visible to all of us are the consequences of this crisis—the endemic pollution of air and waterways, the contamination of soils and food products, the traumatic epidemic on the highways, the old and new forms of industrial dangers to workers, chemical and radiation hazards, and many others which are accumulating into a massive assault on the human biosphere. Not so visible are the attitudes, conditions and disincentives which have prevented a comprehensive development of remedial engineering to reduce markedly the social costs of private enterprise and ameliorate the painful by-products of great engineering accomplishments.

Technology Out of Control

At the outset, it is useful to frame our inquiry in concrete terms. People are being killed, injured, and inconvenienced by the products and processes of technology. Many of these casualties are overtly traumatic and therefore promptly observable. Others, and this is the trend of the affliction, are much more insidious in their impact and increasing debilitation—to wit, cigarettes. Insofar as technology does things to us that we do not want to endure, to that extent can it be called out of control. As long as there is undue and parochial attention paid to the short range economic utility of product and process at the same time that the short and long range biological consequences are treated with indifference or contempt, our society is going to plunge into deeper collective cruelties.

What is now out of control may soon be running amuck in an arena of macabre anarchy so enmeshed in giant bureaucratic structures whirling in furious activities over *means*, that the accountabilities for the *ends* of human welfare are blurring more and more. And with the jet-paced growth of new technologies, full of potential for both ease and unease, the lag between a framework of responsibility for the safety of the man-made environment and the increasingly far-reaching impact of corporate decision-makers threatens to render the future significantly more challenging to our humane values than the past.

All this may sound inexorable, as did the dreary projection of traffic death and injury statistics until very recently. After decades of inaction, the Nation has begun to establish a more rigorous framework of responsibility for reducing highway casualties. Fundamental to the emergence of this national policy on motor vehicle safety is the recognition of *a value* and *a capability*. The value was the right of individuals not to have their physical integrity violated by hazardous vehicles—whether by product design or construction. The capability is an engineering one—the capability to invent the technological future once we decide that we want the benefits of such a future.

The coupling of deeply felt values with graspable remedies represents a very dynamic impulse to reform. Yet, why did auto safety reform occur so late—in 1966—and not two or three or four decades ago? Why have there been so few programs—and so late—to counteract other environmental and consumer hazards developed by the hand of man? Why do we continue to wait for disasters or near disasters before some action commences? Why have the "bodily rights" of people against the incursions of old and new technology been so inadequately articulated and protected?

Where Are the Engineers?

One summary of these questions is another question: *Where are the engineers?* This audience should be the last to think that such a question attributes to engineers a mission of unattainable grandeur. But it certainly is a grandeur unattained. The role of the engineer, as befits professionalism, should be a dual one—to meet empirical human needs and to insure that the human costs of meeting these needs are kept to the barest minimum. The contribution of his expertise is to foresee and forestall the risks of his innovations, both individually and, as in the case of pollution, cumulatively.

But what is the practice? On one public safety frontier after another, the engineer is not in the vanguard. In-

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deed, it is the rare occasion when he can be found reluctantly bringing up the rear. Reporters, public servants, lawyers, physicians, artists, poets, even scientists precede him. But the peculiar role which he has rendered a vacuum cannot be so easily usurped. The engineer is not expendable. He is crucial. And his lack of action to pave the way for the genius of his techniques is consequential in terms of death, injury, torment, waste, sorrow consequential in terms of decades of delay before the adoption of remedies.

I believe the time has come when we can no longer ignore the plight of the engineer as minion to corporate management or other allegiances to which he is chattel. For this plight is fast becoming a serious affront to the public. In the near future, it will be the subject of rising indignation as the realization spreads of what the engineer *can* do in contrast to what he *does* do to diminish the hazards to life and limb and to accelerate the adoption of more efficient, cheaper and aesthetic technologies, be it in transportation, building, communications, or many other areas.

An instructive inquiry to increase our understanding of what is holding back engineering statesmanship and involvement in the social problems of technology centers around the institutional framework through which engineers are engineered. This framework includes universities, corporations and technical societies.

Problems of University Engineering Education

Universities afford the young engineering student his first exposure to what is to be expected of him when he goes to work after graduation. Thus, he is grilled in the general tools of the trade but, by and large, not in the demands of the profession. Numerous academic commentators have deplored the narrowness of the curriculum and have urged a little more liberal education. The important reason for such urgings in my judgment, is that, presumably, studies in the arts and social sciences can enable the engineer to know and appreciate a wider array of values so that he can bring them to bear, along with the technical values, on his search for and choice of engineering alternatives to a given problem. These are the values that are most jeopardized by the "social costs" of a narrowly conceived technology.

Although there are interesting experiments at work, such as at Princeton University, the broadening of the conventional engineering education has not been done well. It has been formalistic, adding a course option or two and letting the student "get a little culture." Tack-on courses cannot be expected to do more. Fusing these varied inputs around a social problem of great engineering content might be a more productive approach. Studying mass transit systems and air pollution control systems offers the kind of very real, concrete attachment that demands the broadest, professional engineering embrace. These are problems where engineering choices and priorities become very different under one set of values, as expressed by a particular industry, or another set of values insisted upon by virtue of professional stamina. Further, under joint, interdepartmental ventures, the student engineer, as well as the student economist, psychologist, sociologist, etc., can learn how whole a man must be if he is to be a skilled practitioner of his discipline, and how related skills and institutions must become for problems to come nearer to solutions.

Lack of Automotive Engineering in the Curriculum

The problems of the engineering curriculum are certainly not foreign to this distinguished gathering. I should like, however, to note my astonishment at engineering schools (regarding the subject of motor vehicles) which began during my student days at Harvard Law School in the mid-fifties. After realizing that there were no physical laws which required people to be killed or severely injured in automobile collisions, I went about the Cambridge environs to study what was available about automotive safety. Not at M.I.T. or Harvard's engineering departments, but at the Harvard School of Public Health did I find relevant material and people interested in a more humane automotive technology, a more forgiving automobile.

Consider the situation years later, during which nearly 500,000 people perished and some 40 million were injured in motor vehicle collisions. Not a single university or college in this country gives an undergraduate or graduate degree in automotive engineering. A professor recently tried to interest book publishers in a proposed text on automotive engineering and received the reply that there was no market for such a volume. In an era of specialized engineering degrees, it is jolting to know that the biggest technology in this country—the motor vehicle transport system which yearly takes 1 out of every 5 retail dollars—does not derive the nourishment of engineering research and policy leadership from our institutions of higher education.

As a leading institution, the Massachusetts Institute of Technology cannot be a poor sampling of this wasteland. What has this great center of engineering learning contributed to automotive safety? Its technical output can be generously described as trivial. Its journal, *Technology Review*, though consistently containing automotive industry advertisements, has not devoted articles to this great problem confronting engineering. Its posture has been one of aloofness to the kind of challenge posed in 1961 by a graduate of M.I.T. Dr. William Haddon, who told the Society of Automotive Engineers: ". . . The success of your profession in the present decade will largely be weighed in terms of its success in handling this overwhelming problem." Only in the past year, spurred by a four-year, million dollar grant from General Motors, hastily announced on the eve of the first Senate hearing, did that institution begin to awaken to its potential. A one-million-dollar grant, spaced over four years, which GM said was for a "long-range, in-depth, quantitative analysis of all facets of the safety problem—the car, the road, the driver, and their various interactions," does not have much stretch. But it did begin to interest some of the gentlemen on the banks of the Charles in M.I.T.'s relevance to the vehicular safety of millions of people on the roads.

Consequences of Automotive Engineering Inactivity

It is not difficult to point to some of the consequences of this national inactivity on the engineering campus. The technical literature of quality in automotive engineering has been pitifully small. No independent centers of basic and applied research exist, with the exception of a few sporadic and spotty projects. The understanding, for example, of the closed loop car-driver servomechanism under varied highway conditions is primitive. There

is shocking theoretical ignorance of vehicle dynamics. Participation by faculty members in the decisional work of automobile technical societies is little more than nominal.

Contributions to public policy by the country's engineering faculties can be measured by their total absence during the voluminous testimony on auto safety before Senate and House committees in the past year. They can be measured by a governmental contribution to safety work in this field during 1965 of less than $2 million. They can be measured by the utter lack of critical review of the automobile industry's legendary avoidance of safety research and development. They can be measured by the obsessive but successfully preserved secrecy of the auto companies and the non-existence of a professional society for research, communication, and criticism dealing with traffic safety problems and their solutions. Finally, they can be measured by the stagnating technology represented in contemporary automobiles and expressed ultimately in avoidable accidents and injuries on the highways.

The automobile industry has not displayed concern over this state of affairs at university engineering departments. The policy of automobile companies over the years has been to take the engineer out of college or technical institute and teach him "the industry way." This is a process of acculturation to the status quo that is to be expected from a management policy that has relegated the engineering function to a state of conditioned response. Quite basically, the issue here can be viewed on two levels: 1. The degree to which engineers feel free to dissent, innovate, and advocate innovation through open channels of communication to top management, and be naysayers to ruthless cost analysts, whimsical stylists and remote executives, in a genuine attempt to improve the overall corporate performance; and 2. The degree to which engineers can live professional lives of their own in technical societies and public forums apart from their employee status and without fear of overt or covert retaliation whether in the form of dismissal, demotion, or the freezing of promotion.

How Free Is an Engineer?

In essence, how free is an engineer within a large corporate government, whose primary mission is profit-maximization via all possible shortcuts, and whose bureaucratic structures pose real problems for individual expression and initiative both in matters of skill and conscience? A study of postwar automobiles indicates that he has been neither very free nor effective. Change has come about primarily as a result of external, not internal, pressures on the companies, chiefly by the threat or passage of legislation. The engineer's subordination to the stylist over the years in such areas as external vehicle design, or design of instrument panel, door, roof, and seat structures—where the stylist operates with full approval of management as quack engineer—is another syndrome of his degraded professional status. At the bottom of the hierarchy are the safety research engineers (apparently now more in demand), whose frustrations and powerlessness constituted their occupational hazards. They have had facilities and funds to work with up to the level of their primary utility—impressing visiting legislative and other delegations with a few crashes of rejected automobiles on company lots.

It was not surprising then to hear Ford Motor Company's Vice President, Donald Frey, tell an engineering gathering not long ago: "I believe that the amount of product innovation successfully introduced into the automobile is smaller today than in previous times and is still falling. The automatic transmission was the last major innovation of the industry." (The automatic transmission was first adopted on a mass-production basis in 1938-39.)

Mr. Frey can be a refreshingly candid executive at times. Addressing a national industrial research conference at Purdue University January 10, 1966, he stated:

"It's a sad commentary, but some of the most reactionary people in industry are engineers. Fresh new departures that require creative thinking and innovation can wind up in the file marked NIH—Not Invented Here. It is up to management to prevent this waste by creative engineering organizations that are mentally attuned to trying the new."

Then, as a former professor of engineering, Mr. Frey uttered the words so long awaited from a top auto industry executive.

"Invention can be predicted with a fair degree of accuracy and it can be scheduled. In the automobile industry, our technology has advanced to the stage that our engineers can invent practically on demand. Almost any device we can dream up, the engineers can make."

Perhaps in the future other auto industry executives will tell us candidly about management's responsibility to encourage with full backing the engineers' contribution to rapid cost reduction of these innovations for prompt mass production. They may also explore the proposition that many of the "reactionary" traits of engineers in corporations are induced by a management policy of disinterest, contempt, and obstinancy which is filtered downward in authoritarian patterns.

Even in the most elemental freedom of communication between company and outside researchers on non-trade-secret matters—a cardinal canon of scientific and technological progress—the strictures are unrelenting. Complaints to me by a number of academic researchers over the intense difficulty in communication over safety principles illustrate the compromising situation in which a professional scientist or engineer finds himself in the industry.

Anyone who reads, for example, GM's "corporate procedure for approval of technical publicity" will understand how such incommunicados are enforced. The printed output of auto company research in operating and crashworthy safety of the vehicle is so small as to leave even the cynical person incredulous. One can read all the public papers written by GM researchers in the past 15 years on vehicle crashworthiness in a short afternoon, even allowing for their redundancy.

Professional Commitment vs Corporate Allegiance

The conflict between professional commitment and blanket corporate allegiance raises the more encompassing question of corporate constitutionalism, particularly the rights and recourses of professional employees within the private government of the corporation. It is encouraging to see some attention to this problem given by the *American Engineer* for October 1966 in an article by Robert T. Howard, entitled, "A Bill of Professional Rights for Employed Engineers?"

The malaise of extreme corporate discipline over engineers who take their professional dictates seriously infects the performance and very structure of the so-called professional engineering societies. These societies, such as the Society of Automotive Engineers (SAE) and the American Society of Mechanical Engineers (ASME), behave like manufacturers' associations.

Society of Automotive Engineers. In the motor vehicle area, the SAE is a technical society dominated by the auto industry. SAE committee members are mostly engineers on company missions and company time; they utilize company facilities for SAE standards work; they are expected to advance company interests, not to further their own profession's directions when they conflict with company imperatives. Vehicle safety standards are issued by SAE without any published technical justification. SAE members-at-large, outside the particular committee issuing the standard, are not permitted to see proposed standards so that they can comment on them before promulgation. Where it infrequently exists, consumer representation—broadly meaning nonindustry representation—is little more than window dressing without the remotest potential of influencing the outcome of the standard, much less having the votes to defeat it. Auto company representatives largely decide what topics and papers are selected at the technical meetings and largely determine which are published.

The auto industry's SAE representatives refused, for example, to publish the afore-mentioned address by Dr. William Haddon, presently the National Highway Safety Agency's administrator. Obviously, the absence of any technical paper critical of specific auto company products and policies is entirely consistent with the industry's dominance in SAE's programming. So is the absence of any written code of ethics for the SAE. So was the recent ban on any recording of presentations or discussions at last year's Stapp car crash conference, conducted by the SAE—a remarkable restriction on an open scientific and engineering conference.

American Society of Mechanical Engineers. The American Society of Mechanical Engineers has higher pretensions than SAE. It possesses a code of ethics, yet it has denied long-time, distinguished members access to minutes of standards committee meetings. Its constitution and bylaws tread ground familiar to other engineering organizations, by assuring a self-perpetuating control to a small number of entrenched officials. There are members of these engineering societies who know that if they do the right things, they are quite likely to become presidents of their respective organizations at such and such a year. The lines of succession are reasonably clear for anyone who starts up the hierarchy and singlemindedly persists in the practice of "getting along by going along." The path of ascension is more in the form of an escalator than a ladder. A ladder requires some individual effort to climb, while an escalator demands only that you get on it and up you go.

It is sad enough to observe how little due process there is for the dissenting member to rely upon in trying to secure his rights within these organizations. More important is that the defects and defaults of these organizations have ceased to be private vagaries and have become public menaces. This is becoming increasingly the situation, owing to the recent determined effort by industry to obtain a governmental imprimitur on the safety and other standards set by these technical societies and rubber-stamped by the American Standards Association. ASA was renamed and reorganized in 1966 as the United States of America Standards Institute (USASI), but remains convincingly dominated by these technical societies.

United States of America Standards Institute. The saga of USASI and its portentous consequences for public safety, innovation, small business, competition, foreign trade and other key issues are beginning to unfold. What is at stake is whether there is to be an officially recognized institution of private government that decisively controls public functions.

The control of a standards-setting process carries with it significant power. When this control is in the hands of industry-dominated technical societies, with no real consumer representation, problems arise. The fact that these standards are designated to be voluntary is of little comfort, for the principle of "consensus" by which they are adopted insures a great deal of economic power behind their acceptance. Since the principle of consensus is a principle of economic power, the political repercussions are there as well. Note how frequently the SAE standards have found their way into legislation.

However serious this concentration of private standards power has been up until now, at least there was the potential of government moving in to correct abuses and fill needs that were being clearly neglected. Such a movement reached a climax September 1966 with the enactment of motor vehicle safety legislation requiring the government to set safety standards. Pending is a bill in Congress to have the Federal Power Commission set safety standards for natural gas pipelines. In both these areas the voluntary industry standards have failed to afford adequate protection to the public.

USASI Strategy

Consider the latest strategy by the industry-dominated USASI. There is every indication that USASI will ask Congress to grant it a Congressional Charter—giving it a quasi-official status and recognition, together with possibly an explicit congressional endorsement of USASI to represent the United States in international standards negotiations and activities. Additional legislation has already been offered, and is presently pending, by the Secretary of Commerce which, among other objectives, would permit the government to make grants to, or contracts with, USASI and would place Congress on record as recognizing the system of voluntary standardization based on the consensus principle as expressive of the public interest.

The restructuring of USASI, from the old American Standards Association, is a formal maneuver to create the image that it has meaningfully broadened its representation and *modus operandi* to include consumer and government representatives on its councils. A reading of USASI's constitution and bylaws will dispell any illusions. The same industry dominance via the technical societies who are members of USASI and set the standards for USASI to give its *pro forma* label of approval to are in charge. The consumer council on USASI serves only in an advisory capacity and, by the bylaws, could be overwhelmingly dominated, in numerical terms, by industry and commerce. To presumptously designate the old ASA

standards and new ones forthcoming under USASI as U.S.A. Standards amounts to a deceptive trade label.

To permit the USASI proposal before Congress to prevail would constitute a radical assumption of governmental functions by private monopolies and wither away the potential of public options for mandatory government standards. Above all, this little known but exceedingly significant drive, if successful, will further violate a cardinal principle of the integrity of democratic government; namely, that business or any other special interest group be prevented from differential access to the governmental process and policymaking councils under official cognizance.

At the very least, the decision for or against the USASI proposal in Congress should not be made without a complete airing of the facts and issues so that the public can understand what the situation imports. Engineers can play an important role in clarifying the issues and presenting the judgments, so that USASI's greatest asset—the esoteric nature of the subject matter as far as the public is concerned—is rendered ineffective.

I wish to thank the members of the Middle Atlantic Section of ASEE for this invitation to candor.

In Aristophanes' play, *The Birds*, an unbound Prometheus is shown to believe that he can escape the attention of Zeus by staying under an umbrella. Engineers can no longer operate under a comparable impression that their activities will be shielded from the lay public's severe scrutiny. This is partly so, because engineers have shown this public in recent decades how very much they can contribute to man's progress. But progress frequently brings with it terrible costs. And the public is more and more realizing something rather new—that the engineering remedy to eliminate or diminish these costs can be as impressive as the engineering achievement that developed the technology.

It is the recognition of this gap between promise and performance that is producing the pressures which will continue to mount on the engineering profession and demand that it assert itself toward its most magnificent aspirations—for so much of our future is in your trust.

New ASEE Branch in Venezuela

THE FIRST ASEE BRANCH established outside of the United States, was officially chartered in Venezuela December 8, 1966, as part of the Southeastern Section. The organization was the culmination of a year's discussion by several Venezuelan ASEE members of the need for, and advantages of, formally organizing the engineering teachers of Venezuela, yet maintaining a direct affiliation with ASEE.

About 80 people attended the meeting at which 33 charter members were recognized. ASEE Past President W. L. Everitt and Past Vice President R. A. Morgen were among those present. The meeting took place during the Third Venezuelan Congress of Electrical and Mechanical Engineering.

ASEE Vice President J. M. Pettit and Executive Secretary W. Leighton Collins were attending the Congress as invited guests from the United States. For this reason, a time during the Congress was selected as appropriate for installing this first ASEE branch outside the United States. Alberto Mendez Arocha, President of the Congress, presided; Vladimir Yackovlev read the bylaws; and ASEE Vice President Pettit presented a plaque to Dean Hector Isava E. of Central University, the first President of the branch.

In a short address, Vice President Pettit reviewed the major international activities with which the Society has been involved, expressed the recorded interest of the Board of Directors of ASEE as wanting to be of assistance to the Latin American colleges of engineering, and extended the greetings, congratulations, and best wishes of President R. H. Roy and the Board of Directors.

Executive Secretary Collins said that the most significant factor in establishing the branch was that the desire to retain an ASEE affiliation came from within the group itself. He noted that this desire indicated that the faculties of the Venezuelan colleges of engineering have developed an enthusiasm for teaching as a career, have recognized the importance of the teaching-learning relationships in improving the quality of teaching, have a desire to know about the use of the new devices provided by modern technology to make learning and teaching more efficient, and realize a need for a continuing forum to discuss problems to the end that the best possible engineering education can be developed in Venezuela.

The officers of the branch are: Hector Isava E., President, Dean of Engineering, Central University, Caracas; Noel Vidal B., Vice President, Dean of Engineering, Zulia University, Maracaibo; Eudoro E. Lopez L., Secretary; Roberto Chang Mota, Treasurer; and Vladimir Yackovlev, Executive Secretary. Messrs. Lopez, Mota, and Yackovlev are on the faculty of Central University. Mr. Yackovlev, the new Executive Secretary, is charged with the responsibility of maintaining relations with the Southeastern Section and ASEE headquarters. ■

Statistics on Engineering Degrees and Enrollment

A STATISTICAL REPORT on engineering degrees and enrollment has been a feature of the February issue of ENGINEERING EDUCATION for many years. The gathering and publication of the data have been a joint effort of the U. S. Office of Education and ASEE.

The OOE has completely reorganized its entire system of collecting college and university data, now sending out one huge questionnaire each year, with various return dates for major segments. The returns are then run through a scanner which reads and records the data on tape.

Because of delays of various sorts in getting the questionnaire prepared, mailed, etc., no report was available for inclusion in this issue. Degree data will be published as soon as they become available.

The present OOE plan is to publish degree data, both undergraduate and graduate, each year. Enrollment data will be gathered in alternate years, starting with the academic year 1967-68. ■