TECHNOETHICS

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"Only morality in our actions can give beauty and dignity to life."

Albert Einstein

1. INTRODUCTION

In 1765 the Royal Basque Society of the Friends of the Country was founded by the Count of Peñaflorida. Scientific studies came alive and were stimulated during the Enlightenment by this Society. The first article of the Society's baylaws states that the purpose of the organization is "to cultivate the inclination and the tastes of the Basque Nation toward the Sciences, Letters and Arts". I think this Society may serve as a timely example of the way we ought to conduct our scientific research in the future.

This work tries to bridge the gap between the so-called "two cultures" —the sciences and the humanities —in the spirit of the above mentioned enlightened Society in order to deal with the ethical problems raised by modern technological applications and implementations (1).

2. MORAL, CODES

There are no moral codes other than those of mankind. Only our complex intelligence has been able to elaborate norms of conduct. Ethics refers to desirable social behavior. Ethics is not a science. Nevertheless, to know what

(1) These problems vary from the development of nuclear energy for peace or war to genetic engineering to control of people's behavior. (See Goodpaster and Sayre 1979 for a sample of the main ethical problems of the 21st century. On environmental ethics and duties to future generations and to nonhuman beings from a technological point of view see Barbour 1980 Ch. 4).

is good or bad for mankind, we do need scientific studies, from biology to anthropology to psychology to sociology to politology to economics to history. Ethics can use the findings of these particular sciences.

Here I adopt a humanistic and scientific approach to ethics. Humanistic in line with the Canadian poet F. R. Scott's creed: "The world is my country / the human is my race / The spirit of man is my god / the future of man is my heaven". Scientific in the sense that science aims to produce maximally true conceptual models of reality, hence of mankind himself.

Although it is admitted that norms of social behavior are necessary (otherwise life would be chaos), trouble arises when characterizing what good or evil is, or what moral or immoral means, when valuating things, processes, actions, or anything else. What is good for one person may be indifferent or even evil for another. Further, what is good for a person in some circumstances and at a given time, may be not so good, indifferent or even bad for that same person in other (political, cultural, social) circumstances, or at some other period of time. I.e., values are not only person-dependent but also circumstance-and time-dependent.

The analysis of an absolute morality, whether negative (Epicurean or Popperian) or positive (following Kant's categorical imperative) goes beyond the scope of this work. I shall criticize them only tangentially, for in my view, since ethics refers to what "ought to be" and not to what "is", the "Thou shalt not do A" of a negative (and authoritarian) ethic should give way to a positive and persuasive ethic where values, ends and means ought to be justified in the light of the best and deepest scientific knowledge at hand. If this is so, it is clear that ethics are relative to particular individuals (through their levels of knowledge) and to specific circumstances.

Moral norms are then relative and culturally bounded (2). The fact that moral norms are relative does not mean that they are unnecessary. On the contrary, the goals are set by mankind in a clear response to a given social and physical environment. Therefore, the study of the environmental constraints —natural and social (political, cultural, economic and military) — as well as the study of mankind himself — his wants and needs — are imperative before an action, and in particular a technological action, may be judged as good, indifferent, or evil.

Ethical norms as such may be treated as a specific field of our general approach to norms outlined elsewhere (Tobar-Arbulu 1985a). I.e., we can reformulate the moral imperatives as propositions proper, as conclusions of

(2) There is no culture without values. From the Basques of both sides of the Pyrenees to the Mohawk indians of the United States and Canada, people behave according to some system of values. The problem is how to identify the major values of any human community and how to quantify them. This brings us to empirical studies of value systems.

law-statements and value jugments. This way we cross the value/fact distinction. *(Law statement;* If means *M* is implemented then goal G is attainable with a certain probability *p. Value judgment:* Goal G is good (valuable and desirable) for some people in some given circumstances. Therefore, *M* ought to be implemented).

Conceiving ethics as a branch of technology, we also cross the barrier between Sir Snow's "two cultures". Indeed, there is a place where the two cultures meet, i.e., modern technology. This way we may continue to cherish science, which "ennobles anyone who is engaged in it, whether scholar or merely student" (Einstein, quoted in Press 1980 p. 512) and whose "intellectual depth, complexity and articulation (is) the most beautiful and wonderful collective work of the mind of man" (Snow 1969 p. 14)). While we distinguish some intrinsic values (such as knowledge, peace, freedom, love and justice) from instrumental ones, we do not draw a clear line between the two. Indeed, intrinsic values such as peace, freedom and justice can be the keys to happiness, just as science (the knowledge we cherish the most) is the foundation of modern technology. We therefore do not espouse an absolute morality (given by whom, anyhow?). We care about the different moral codes (explicit or not) according to which we, human beings, behave.

I claim that *explicit* moral codes should contribute to the guidance of actions, especially in the realm of technology where we take decisions having to do with issues affecting other persons (present and future) and the environment.

Here is a list of some open ethical problems raised by modern technology:

I Who has the right to the use of natural resources?

II Who is responsible for preserving the environment?

III Will some unborn generations not have the resources they will probably need in order to live?

IV On what basis can we justify the preserving of animals of endangered species while people are starving all over the world?

V Is it morally proper that a few individuals or nations should live in great comfort while others are starving and dying?

VI How should we approach decisions having to do with certain broad types of issues affecting other persons, other conscious sentient beings, and the environment?

VII How can public policy be related to human rights, environmental protection — water, air, natural beauty, energy use and natural resources?

The clarification of these, or similar problems (see a broad view of moral problems in Goodpaster and Sayre 1979) is not intended as an appeal to stop

the technological progress and development, but as a call to understand it better and to use it wisely. Not only the scientist and the technologist should be exposed to this *problématique* but also the layman, in order that reason be separated from hysteria in the popular press: I.e., to recognize the fact that technology can lead, though not deterministically, to evil, destroying or poisoning the world. Otherwise, "Justification of a technical arrogance toward nature on the basis of dividends and profits is not just bad economics — it is basically an immoral act" (Means 1967 p. 12).

2. SCIENTIFIC AND TECHNOLOGICAL VALUES

Science tells technology what can be done (and what cannot), but not what should be done. Science tells us what the world is like, and technology what we can do in it, but neither gives sufficient guidance for life. The driving force of technology is the design of artifacts, from machines to social plans. The task of designing a desired artifact from given components and resources, and respecting given constraints is a problem of synthesis. Synthesis can be conceptual or factual. The technologist performs conceptual synthesis of forms (architecture), circuits (electrical engineering), molecules (chemical engineering) or social systems (social engineering). In this sense the task of the technologist is the mirror image of that of the scientist, who analyzes systems into components and structures. The technologist uses such analysis. Analysis is for him a means to an end: it is a means for synthesis.

Technology is an end for the technologist and should be a means for everybody else; it is a means for developing or maintaining the economy, which in turn is, or should be, at the service of society at large. But technology by itself is not the whole of development; in particular, technology by itself cannot fill the gap between the rich and the poor countries. In developing countries, "The principal limits to sustained economic growth and accelerated development are political, social and institutional in character rather than physical. (...) Investment resources coming from abroad would be important but are secondary as compared to internal sources" (Leontief *et al.* 1977 p. 11). Therefore, it is a mistake to adopt new technologies just because they are more advanced, in particular because they save on labor. Development is a more complex issue than the implementation of advanced (or soft) technologies for the sake of saving labor. The level of technological innovation should be adjusted to the level of employment within the framework of the specific development process of the society in question, not the other way around.

Further, while the goal of the scientist is the search for truth by itself, that of the technologist is utilitarian, for he is a pragmatist (Tobar-Arbulu 1985b) (3).

(3) This pragmatic aspect of technologists must not be confused with pragmatism, which maintains that the sole criterion for truth is practice, witness Marxism. (See more on the pragmatic aspects of the technologist in Tobar-Arbulu 1985b.)

As for the ethos of technology it is the same as that of science, i.e., the search for truth, the correction of error, the justification of belief and a concern for testing. It does, however, display some differences: 1. for technology utility is the maximal value, and truth has only an instrumental value; and 2. scientific research is open to public scrutiny, whereas technology is often secret (both in the civil and in the military enterprises) and protected by patents.

In science we praise exactness, maximal truth, logical consistency and testability. In technology we take into account exactness, truth (not necessarily maximal), logical consistency, testability, efficiency, safety, reliability, practical applicability, *plus* the moral code concerning the use of human and natural resources (Tobar-Arbulu 1985c, d).

This is essential, especially if we keep in mind the fact that technological knowledge can be used for good or for evil: to create wants instead of satisfying needs, and to build weapons (nuclear or not) for mass murder. Moreover, any technological innovation is bound to be risky. It may be culturally, politically, socially, economically or biologically harmful to society. Therefore, analyses of risk situations, evaluations of risks, designs of safety systems, information to the public and public participation in deciding acceptable risks (4) are part and parcel of technology-guided actions as we attempted to show elsewhere (Tobar-Arbulu 1986). (On 'acceptable risk' see Fischchoff *et al.* 1981, Lowrance 1976, Otway 1976).

Since technology can be used both for welfare and warfare, any technological innovation and its implementation *should make explicit the code of values upon which it is based* so that the citizen can have a clear reference when valueing and judging social plans and programs of action. In my view, when an action, in particular a technological action, has or brings with it a moral element, this should be included or taken into consideration for valuation reasons. (In fact, when defining technology as a field of knowledge oriented toward action, the codes by which technologists are guided have been included (Tobar-Arbulu 1985c, d), so that the technologist himself brings his system of values into the open).

This system of values of the technologist requires a rational justification, which is better if it is scientific and has been elaborated through the different social sciences. Although both science and technology have their own codes of norms, these are not enough to guide everyday behavior. The system of values, as such, is given neither by science nor by technology. It is part of the ideology of the individual. Ideology determines the systems of values and

(4) Risk analyses should go beyond all that is observed in current risk-analytic procedures —the ratio of expected utility (benefit) to the concomitant disutility, which has been taken into account (risk)—, i.e., beyond the so-called 'risk-benefit ratio'. See Kunreuther and Ley (1982) on present-day risk analysis controversy.

goals concerning what a good society is and what good social behavior is, by decreeing what is worth doing and what must be avoided (5).

Although different social groups have different moral codes within the communities of technologists, all these partial codes ought to share a minimal moral code, a kind of *universal morality* to be gathered in a comprehensive oath of the technologist, similar to the Hippocratic oath. Such a code would be but a special application to technological research of the kind of humanistic and scientific ethics proposed above. (More on this Hippocratic code in Section 3.2.)

3. RESPONSIBILITY

Our approach to society is not an atomistic one, i.e., one where society is the sum of every and each of its individual components. On the contrary, we see society as a composite of individuals who have relationships both among themshelves and with the external environment. There are no individual humans in a vacuum.

We have dealt elsewhere with development and human needs (Tobar-Arbulu 1985e). Needs have been characterized within a general framework. This general framework must be specified to the particular (social, political, economic and cultural) conditions of the group or society under study. Further, I submit that there are group needs, as there are individual needs. Witness the United Nations resolutions on People's Rights. Despite naive economic analysis, the will to national independence, if not "the most powerful force in our time" (Galbraith 1983a p. 36), is a real social force. Therefore, we should elucidate the notion of "individual responsibility" and "group or social responsibility" (6).

Responsibility implies knowledge. A responsible human being is one who performs an action on the following bases: 1. the knowledge that the action is likely to bring about the desired outcome; 2. the knowledge that this

(5) No one can be free from ideology. The key is to elaborate a kind of ideology in tune whit both the deepest possible knowledge, i.e., the natural and social sciences, and the genuine and realistic aspirations of the greatest number of people. Thus elsewhere (Tobar-Arbulu 1985e) it has been suggested a basis for the ordering of values in a hierarchy of human needs: 1. survival (physiological needs): food, shelter, health; 2. security (safety needs): protection from danger and threat; 3. belonging (social needs): friendship, acceptance, love; 4. self-esteem (ego needs): self-respect, recognition, status; 5. self-actuation (fulfillment needs): creativity, realization of individual potentialities. (See also Galtung 1980, ILO 1977, Mailman 1980 on aspirations, wants, and basic needs.)

(6) One must neither attribute properties of persons to groups, nor deny that these have properties some of which are shared by their members (i.e., group interests, group values) and others which are not (i.e., private interest).

outcome does not violate any of the norms of social behavior adopted by the group to which the performer belongs; and 3. freedom, for he who acts compulsorily (by force of the circumstances) does not act responsibly.

In our view, whoever is in charge of an event or process whose outcome is beneficial (or harmful) to others, is responsible for that outcome.

Remarks

1. A "group action" is the action performed b y *all* members of a set of individuals.
2. Responsibility is individual not collective (7).
3. He who has the control of the occurrence of the event is responsible.
4. There are degrees of responsibility: the one who has the ultimate control (7) is more responsible.

When dealing with responsibility we should ask then the following questions:

1. who makes the decision?; 2. who chooses the course of action?; 3. who performs the action?

In our struggle to deepen science and to improve technology, there is room for decision-makers, scientists, technologists, technicians, laymen and computers, but at different levels and with different tasks and responsibilities. These responsibilities should be undertaken consciously. As Born (1971 p. 233) stated: "Even if one does not earn one's living by science, but (nonetheless) publishes the results of one's research, one cannot rid oneself of the responsibilities for the use which is made of them. I have stuck to this point of view right up to the present". (See more on Einstein's "plumber question" in Tobar-Arbulu 1984a.)

As for computers, it is true that computers do make decision at certain levels. However, since a computer indulges in no spontaneous activity, such decisions are computer-aided decisions made by the computer-programmer system. Therefore a computer is not responsible for any decision made by it. Further, computers do not decide what our basic goals and values (and uriorities) are. These goals and values, such as the promotion of human life

(7) The German pilots who, in 1937 bombed the little Basque town of Guernica (that Picasso immortalized) had control over their planes, although they were obeying orders from their commanders. They were as responsible as was Franco for all they destroyed ("Guernica was not bombed by my air force... it was destroyed with fire and gasoline by the Basques themselves", Thomas and Morgan 1975, p. 12) and Hitler ("An international investigation of Guernica is to be rejected under all circumstances" , *op. cit.* p. 12). (See Galbraith (1967-78, p. 62) on "accorded responsibility" in modern economic corporations.)

and happiness, decrease in suffering and search for truth and understanding, provide us with the ultimate norms for directing and judging actions and decision-making. Such computer-aided decisions are not free decisions (Tobar-Arbulu 1984b). Computers are not legally or morally responsible for their "decisions". Responsibility rests upon the user or the programmer.

As for the responsibility for external costs (such as pollution and the hazards of work, consumption, and the general environment), this is still very much at issue in the public arena, and business is fighting strenuously to prevent the internalization of these costs that are being pressed upon it (Herman 1981 p. 263). The costs involved are potentially enormous and although the pressures on business have built up, its resistance also has intensified (8).

3.1. $E=mc^2$

On August 6, 1985, the 40th anniversary of the destruction of Hiroshima was commemorated. Such a technologically and politically monstrous act is considered by some people as the "logical" consequence of Einstein's work.

Indeed, in November 1905 Einstein published three pages in *Annalen der Physik.* Using electromagnetic equations taken from a previous work of his on relativity (Einstein 1905a), he showed that "if a body gives an amount *E* (actually, he wrote *L)* of energy in the form of radiation, its mass dismisses by an amount E/c^2, thas is, "The mass of the body is a measure of its energy content" (Einstein 1905b).

Although there has been some misunderstanding related to the development of Einstein's famous and popular formula, the mass-energy equivalence relation "$E=mc^2$", is but a necessary, consequence of the following four premises: 1. the principle of relativity; 2. the law of conservation of energy; 3. the relativistic equation of the motion of a particle; and 4. the relativistic law of transformation of the energy of an electromagnetic wave.

Taking into account such premises ant the fact that the principle of relativity (Einstein 1905a), in turn, implies that a) the laws of physics take the same form in all inertial frames, and b) in any given inertial frame, the velocity of light c is the same whether the light be emitted by a body at rest or

(8) "The drive to preserve and expand profits remains to be reinforced by competitive pressures. Because environmental controls vary in different parts of the United States, as well as between domestic and foreign producers, they not only add the burden of higher costs, but they also threaten competitive disadvantage. This adds to the intensity of resistance to environmental controls and readiness to move production facilities to superior investment climates" (Hetman 1981, p. 263-264). For an important illustration on the export of hazardous enterprises see Castleman 1978.

by a body in uniform motion, Einstein came out with the equivalence relation between mass at rest and energy.

This equation was not verified quantitatively until some twenty-five years later. If it is added the fact that the Hungarian Szilard proposed, in 1934, the idea of a "chain reaction", it is clear that Einstein could not foresee the tragic events that would arise out of this $E = mc^2$.

Einstein, however, was aware of the uses, misuses, and abuses of technology. In fact, in 1931, at the California Institute of Technology Einstein (Nathan and Norden 1960, p. 122) stated: "...If you want your life's work to be useful to mankind, it is not enough that you understand applied science as such. Concern for man himself must always constitute the chief objetive of all technological effort, concern for the big, unsolved problems of how to organize human work and the distribution of commodities in such a manner as to assure that the results of our scientific thinking may be a blessing to mankind, and not a curse.

"Never forget this when you are pondering over your diagrams and equations!"

As for the responsibility of the use of basic science for technological purposes, and in particular for the use of the mass-energy equivalence relation in the development of nuclear weapons, Einstein (Nathan and Norden 1960, p. 569) replied, in 1952, to a Hungarian survivor of the concentration camp of Dachau: "You are mistaken in regarding me as a kind of chieftain of those scientists who abuse science for military purposes. I have never worked in the field of applied science, let alone for the military.

"I condemn the military mentality of our times as you do (...).

"My name is linked to the atomic bomb in two different ways. Almost fifty years ago I discovered the equivalence of mass and energy, a relationship which served as the guiding principle in the work leading to the release of atomic energy. Secondly, I signed a letter to President Roosevelt, stressing the need for work in the field of the atomic bomb. I felt this was necessary because of the dreadful danger that the Nazi regime might be the first to come into possession of the atomic bomb."

This signature was, however, considered by Einstein himself as a "great mistake" (Tobar-Arbulu 1984a).

As for the relation between basic science and technology; when Professor Jules Isaac (Nathan and Northen 1960, p. 622) asked Einstein whether he should not have had the foresight to predict the possible dangerous technological "consequences of his equations" when he first published the Theory of Relativity in 1905, Einstein (Nathan and Norden 1960, p. 623) answered as follows: "Now you seem to believe that I, poor fellow that I am, by discovering and publishing the relationship between mass and energy, made an

important contribution to the lamentable situation in which we find ourselves today. You suggest that I should then, in 1905, have foressen the possible development of atomic bombs. But this was quite impossible since the accomplishment of a "chain reaction" was dependent on the existence of empirical data that could hardly have been anticipated in 1905. But even if such knowledge had been available, it would have been ridiculous to attempt to conceal the particular conclusion resulting from the Special Theory of Relativity. Once the theory existed, the conclusion also existed and could not have remained concealed for any length of time. As for the theory itself, it owes its existence to the efforts to discover the properties of the "lumiferous ether"! There was never even the slightest indication of any potential technological application."

What in Einstein's later years was the tip of the iceber of ethical concern, is today one of the main issues in scientific and technological research. Nowadays, some professional societies of scientists and technologists have become notably involved in questions of ethics and human values: the access to science of previously disadvantaged groups (see Salam 1984), the rights of scientists to object to unethical practices, the desperate need for arms control, the human rights of colleagues in totalitarian regimes, the sharing of scientific and technological resources with Third World countries, and so on.

Basic science is a good in itself (9), although it can be used instrumentally through technology. Technology itself, and not just its owners —be they entrepreneurs, politicians or military men— may be good or evil.

When applying technological knowledge we face two kinds of situation: a) we may encounter unexpected evil (this is why in risky situations we deal with safety systems); b) we may encounter expected evil. The technology of expected evil (from mass manipulation to the desing of concentration camps) is itself evil. Most of the time, however, a technology-guided action will produce good and bad effects at the same time. This is why we have to evaluate both (Tobar-Arbulu 1985a) and subject the application of technological knowledge to social and moral controls.

3.2. Moral codes in technology

Professionals have a very special social contract. Society expects them to serve it by serving their clients. Society in exchange gives them license to

(9) For pure science as the core of culture see Rabi (1970). A modern concept of development implies the appropriation of science and technology: "Genuine appropriation of science and technology is both a basic prerequisite for any progress towards growth, and an integral part of the multi-dimensional development process, linked, through a complex network of interactions, with the other components of that process (economic, political, social and cultural, and involving institutions as much as practice)" (UNESCO 1979, p. 12).

practice. Regarding morality, the clients' morality may differ greatly from that of the majority of society. (So much so, since we support a pluralistic approach to ethics, if only because different social groups may have different systems of values. To this fact, the professionals' own morality must be added.) Therefore, the professional is placed in a conflicting situation: a) either he sacrifices the interest of his client(s) in favor of those of society; b) or he sacrifices the interests of society in favor of those of his client(s).

Diverting interest among technologists, among clients, among societies and nations, poses the same sort of conflict but at a different, and usually more complex level. Such conflicts are too alive to exemplify here. Consensus and negotiation is mandatory in such cases.

Since the professional is regarded as the person who knows, society, i.e., the citizens, should know and understand what it may expect from him as bases for professional decisions. It is his professional duty to made public his principles, even more if we take into consideration the fact that professional communities are usually legislated by moral codes of behavior. Green (1967) has raised the question: Can our legal system impose effective social control over new technologies before they inflict substantial injuries upon society? The trouble is that pending legislation to establish a technological assessment board such as Green proposes is not longer a possible solution for there are "experts" on both sides of the fence —not to mention experts with different world views and value systems— in practically all of the major ethical problems in modern technology. Indeed, it is not rare to encounter a situation wherein the interests of two social groups are at odds, while both groups have technical experts to support their opposing views: examples are the debates on the so-called "nuclear winter" ,on nuclear weapons, on bio-genetical engineering, on nuclear waste and so on. Therefore, the old prescription —when experts disagree, suspend judgment— is no longer of much use.

Consensus is the issue in question, apart from the elucidation of what "public interest" is. (Incidentally, one of the tasks of the "Technology Assessment" agencies would be precisely to debote themselves to this important social issue, i.e., the elucidation of the notion of "public interest".) Further advances in the social sciences (from antropology to sociology to economics to politology to law and history) are needed in order to provide the foundations for a definition of the "public interest" and "quality of life" beyond the notions of the utilitarians on general welfare (Susskind 1973 p. 129-131).).

In orden to reach consensus, I claim that technologists, both at the individual and at the social level, must bring their value systems into the open —what value they place on human life, what importance they recognize in the well-being of members of other nations. The question is even more critical if we take into consideration that legislation is a public affair and that different moral codes are usually legislated, for it is society's privilege and duty

to use its best human resources to judge the adequacy of these preferences and to negotiate with professional communities. It is in this framework that moral codes may be discussed, negotiated and eventually legislated. This approach is independent from the particular social concern of each individual technologist. However, I also claim that one important aspect of a technologist's education is to become aware of the character and needs of the society in which he will live and develop his skills.

We are, therefore, in need of new moral codes for the different branches of technology. Technological processes ought to be guided by new axiological or moral maxims, among which are the following:

I Man and nature are not at odds. Both are valuable, although in different degress. (Therefore, man is responsible not only to nature but also to future generations of human beings.)

II The task of technology is not the exploitation of nature and human resources *per se,* or for the sake of increasing the GNP. Social, political, cultural, environmental and moral considerations must be taken into account as well as economic analyses.

III Technologits, are morally responsible. Moral issues do not concern only the technologists' bosses —entrepreneurs, politicians and military men.

These axiological maxims have to be justified. Indeed, we have tried to show some desiderata (through the basis needs approach in Tobar-Arbulu 1985e) based upon scientific knowledge of nature, human beings and society. Further, the notion of global development has been related to this basic needs approach (Tobar-Arbulu 1985e) as a dynamic process. This process, as a means of continuously (and endlessly) improving the quality of life of citizens is the framework against which any technological moral code has to be contrasted. What helps and improves global development is socially "good" and what stops, blocks or kills development is socially "evil".

Since, in my view, the basis needs approach is a sort of universal framework (Tobar-Arbulu 1985e), I am in favor of enforcing a kind of universal moral code for technologists, something similar to Susskind's "An Engineer's Hippocratic Oath" (1973 p. 118) but expanded to all the differente branches of technology, so that evil components and negative side-effects at the individual and social levels may be minimized. This kind of *universal moral code* must be, of course, a general framework given the width of the different branches of technology, and taking into account the different value systems of each and every technologist. However, the minimun core shared by technologists should be the explicit lyrics of this "The Technologist's Hippocratic Oath". (See Baron 1984, Curd and May 1984, Flores and Baum 1980, Martin and Schinzinger 1983, Schaub and Paulovic 1983, Unger 1982, Weil 1983, where the personal responsibility of engineers in their professional work is discussed.)

Both the general Hippocratic Oath of the technologist *(see Appendix)* and the specific moral code for the particular technology should be implemented with continuous (and never-ending) studies on human needs so that social desiderata can be clearly defined, evaluated, and chosen through the democratic participation of all the people likely to be affected by the implementation of any technology. The imposition of restrictions on any technological process in view of the desiderata and goals, its outcome and side-effects belongs, therefore, to the citizens.

In my view, the task of technologists goes beyond "whistleblowing" (10) (Weil 1983) to a more responsible position in a broader and more modern conception of technology. In fact, it behooves "Technology Assessment" to assume the task of evaluating different projects before, during and after implementation (Tobar-Arbulu 1985f). Further, it behooves citizens to claim their right and duty to decide the kind of development, i.e. of society and quality of life, that they are willing to live with, and to light for. Technology, then, can be good or bad according to the practical ends it serves. Technologists as bearers of technological knowledge have a special social and moral duty to society. In particular they have the duty to control —through design- the outputs of technological implementations so as to minimize any evil side-effects. On the other hand, it is the citizens who should demand legislation aimed not only at public and private corporations (so that social interests may be preserved) but also at technologists' societies with respect to their public professional work.

Since responsibility is personal, every technologist is responsible for what he does or recommends should be done. The technologist is, therefore, responsible to: 1. his employer; 2. his peers, i.e., his own profession; 3. his society. As pointed out by different authors (Goodpaster and Sayre 1979, Barbour 1980), the technologist, like any other human being involved in performing some action, is also responsible to: a) mankind in general, i.e., his contemporaries; and b) the generations to come (DeGeorge 1979).

Therefore, the technologist when designing any technological project should keep in mind all the people who may be affected by it, the living and those yet to be born.

4. PLANNING AND FREEDOM

Planning consists of a) designing a desirable future, and b) inventing ways of bringing it, or some close approximation of it about. It must be: 1. techno-

(10) Technologists who "blow the whistle" on their employers are vulnerable to retaliation. Professional societies should provide legal assistance to members who have been fired or transferred for speaking out in the public interest.

logically feasible; and 2. participatory, for participation tends to generate consensus on what the system should be, stimulating creativity.

In order to convert the apparently impossible into the possible it is necessary to remove or relax constraints. These are imposed both from within and from without. "The critical constraints are seldom economic, environmental, or technological. They are usually social, moral, political" (Ackoff 1977 p. 53).

What is interesting about actions is not only the valuation of their outcomes and the efficiency of the means, but also the weight of their unintended consequences. Since a) there are no known laws of history, *pace* Marx, b) we fight for an open society, and c) any social action is bound to have side-effects that can be harmful for some people, planning can make the future possible, i.e. men —not Platonic forces or gods— can make their own histories.

Freedom, on the other hand, requires opportunities for choice. It is not freedom from constraints, but freedom to choose among genuine alternatives —i.e., choices not disvaluable—, which requires a range of real options and the power to act to further the alternative chosen.

Remarks

1. The above requirement for freedom is a necessary condition not a sufficient one. In fact, the actual choices may be penalized.
2. Even in the absence of external constraints, unequal power results in unequal opportunities to choose.
3. We, humans, are born with certain propensities that can be activated (or inhibited) by natural and social environmental inputs (or lack of them). Therefore, our behavior is conditioned —though not determined— by our genetic inheritance and the particular society in which it is allowed to develop. We are, therefore, free within certain bounds.
4. Freedom is not inborn, but acquired. It must be learned and fought for.
5. Responsibility (recall Section 3) requires not only the knowledge that an undertaken action is likely to bring about the desired outcome without violating any norm of social or group behavior, but also freedom.

People vary widely in their awareness of alternatives, their personal initiative and their ability to make deliberate choices. In dealing with public policy, we are concerned not only with internal but also with external conditions and

in particular with the social structures and social constraints within which people can have some control over their own future. Freedom should, therefore, be understood as free participation in the political, cultural, economic, technological and social decisions that affect our lives.

I claim that freedom can and must be planned. Freedom is the result of a designing triad consisting of 1. the planner's assumptions, 2. the planning system's conditions and 3. the opportunities and/or barriers which enhance or hinder the exercise of freedom.

As for the planner's assumptions, they shape the world view or way in which the planner views the system. Thus a plan is the result of a planner's interpretation of a set of data, which in turn depends on the planner's value system or assumptions about the outer world, leading to some predictions about the configuration of the plan.

As for the conditions prevailing in the planning system, they can be characterized along the following criteria:

I *rationality,* which describes the role of reason in the planning system;

II *equity,* which describes how privileges and expertise are distributed among members;

III *experts,* whose influence is the direct result of whether equity or inequity prevails in the system;

IV *participation,* which establishes the extent to which individual members can meaningfully contribute to the. system's welfare;

V change, which states the attitudes, toward the preservation of institutions which are embedded in the planner's value system;

VI *control,* which belongs to all the people, to experts, or to certain factions depending on the degree to which participation and equality are regarded as a basis of the system's allocative mechanism;

VII *responsiveness,* which shows how the system is influenced by the needs and demands of its members;

VIII *conflict,* which describes the way in which disputes are settled and how divergent opinions are taken into account;

IX *technology,* which describes the "state of the art", i.e., the particular form of tools, instruments, methodologies, advancements and capabilities through which it is organized;

X *morality,* which explains where the "ultimate goal" and the interests of the individual citizen lie relative to those of the entire society (11);

(11) The nature of the "ultimate goal" depends on the value placed on the welfare of the "private man", the interests of society and the power of special groups.

XI the *optimum,* which is the value of the system's objetive function.

(In order to reach the optimum the system should rely on a completely decentralized adjustment process where all subsystems make individual decisions contributing to the welfare of the total system.)

As for the opportunities and barriers, they flow directly from the two other elements of the triad, i.e., planner's assumptions and the conditions existing in each system.

So, in my view there is no contradiction between planning and freedom. More planning does not necessarily lead to less freedom. Rather, different kinds of planning spell different kinds of freedom. Further, better and more realistic planning can lead to more freedom. Knowledge, thereforme, and in particular the most genuine kind of knowledge —i.e., science— is the key to attaining freedom. We need to know ourselves and our environment in order to make freer decisions.

5. QUALITY OF LIFE

Quality of life is the joint product of development and the resources available (Tobar-Arbulu 1985e). "Quality of life" calls for defining one's own 'quality of life', for planning one's own approach to the problem through learning and participation.

Speculation about ends brings us to ethics, since ethics has been largely concerned with a search for the "Ultimate Goal" —that is, a criterion that can be used for ethical evaluation of each act by any entity (individual or group) that can display a choice. Purposeful ethics attempts to define the "Ultimate Goal" in terms of wants and consequences. In doing so, ethics can be reduced to a special branch of technology (Ackoff and Emery 1972 p. 239, Tobar-Arbulu 1985a).

One attempt to overcome conflict within or between individuals consists of defining the "Ultimate Goal" in terms of what a community (or a majority of its members) wants. This leaves us with the difficulty of defining 'the greatest good for the greatest number' (Churchman 1961 Ch. 2).

The social objetive of utilitarians is to maximize the sum of the measurable utilities of all individuals in a given society. The utilitarian ethic has a pragmatic character: if the utility gain of an action exceeds the utility loss across society, the action is "right". If the utility gain is less than the utility loss across society, the action is "wrong".

5.1. Utilitarians on the quality of life

What the utilitarians called the 'greatest happiness of the greatest number' presents some problems. To begin with, how do we define the degree of

"happiness"? Second, though in utilitarian theory happiness and utility coincide, in general they do not: not all individuals try systematically to make those decisions or prefer those states which they believe would maximize their own happiness; further, an individual cannot always predict his happiness in future states. Third, for some utilitarians, utility is a linear function of the expected effects of decisions on the happiness of sentient beings; felicity is taken to be a scalar measure of happiness in the same way that utility measures subjetive preference. Thus Edgeworth (1967) argues that the rich have more sensitivity and can better enjoy money than the poor. Obviously, then, depending on beliefs about measurable utility functions, any distribution of income can be "justified", ranging from a relatively egalitarian viewpoint to a relatively elitist viewpoint.

Related to this vast *problématique* is the rise of the "social indicators" movement (Bauer 1967). Its literature is filled with references to social indicators, partial system models, which try to bring economic, political, cultural and social variables together into a general systems theory.

Here are some of the open methodological problems in the "social indicators" movement:

I what is a social indicator?

II what kinds of variable does it relate?

III how does it relate the different variables?

As Lilienfeld (1978 p. 120) points out, "social indicators are simply old-fashioned statistics in a new dress (...) whose virtues as well as limitations, are well known". These "objetive measures" of the public good are relative, value-laden, culturally defined, and subjectively conceptualized and are therefore simply unattainable. This being the case, what may pass for and be accepted as social indicators may be so prejudiced, so biased, and so contrived as to be downright dangerous (Hoos 1982 p. 79). Further, the usefulness and appropriateness of an index depends on how well it correlates with the measure for which it is a substitute.

5.2. Ideals of mankind and quality of life

Clearly science and technology have worked miracles, despite some ugly side-effects. It is natural to ask whether all their effects have been favorable, and whether they increase our happiness and the quality of life. Science and technology have surely had one wonderful effect in this regard: the acquisition of knowledge is both elevating and elating. It is satisfying to work for it, and the success of such work brightens the lives of many people. But is our society now on the average happier than it was 100 years ago? For some

people this is questionable, even more so if we consider the so-called Third World countries, or some of the traditional cultures in the so-called developed countries. Are the Mohawk people happier nowaddays than they were 100 years ago? Are the unemployed really happy people? Is the worker happy in his boring routine job?

I am an engineer, a technologist. I learned about the good sides of technology. I am proud of belonging to this profession. But the purpose of technology should change to some qualitative degree. We as technologists should ask ourselves what the future applications of technological knowledge are. What should we strive for in general? We should try to avoid suffering all over the world —starting at home (12)— through the production of goods and services. We should try to help people to organize themselves-giving recommendations and putting our skills and knowledge at their service, by not commanding them —in the pursuit of their own goals, for they themselves are the only judges of the quality of their lives. Moreover, we should try to develop technological knowledge itself, using deeper scientific theories and applying the so-called scientific method more realistically to new and more complex social systems. In particular, we should strive for a technology that includes human, social and environmental values as well as technical feasibility, efficiency and economic profitability. We should put more emphasis on technologies aimed at fulfilling human needs, on technologies that provide employment and job satisfaction, and that are ecologically sound and subject to the democratic control and participatory decision-making of all the citizens likely to be affected by such technologies.

At present, we cannot, or I cannot define "happiness". It is clear that happiness does not mean having everything provided. This is a necessary condition not a sufficient one. Man wants to do something he feels to be worthwhile. Thus, the researcher's objective is not so much to solve problems as it is to create more challenging and important ones. Therefore, the continuous pursuit of more desirable ends is an end in itself, and hence attainment of a specific end can be conceptualized as a means to such pursuit.

The quality of life has been related to the pursuit of the ancient triad of ideals —the "true", the "good", and the "beautiful" —to which some authors (Ackoff and Emery 1972 Ch. 14) have added the pursuit of the "plenty". I cannot agree with Ackoff and Emery (1982 p. 246) when they state that, "it (would) be willing to *sacrifice* a short-run and immediate source of satisfaction

(12) Terentius' *"Homo sum: humani nil a me allienum puto"* as a humanistic maxim for a universal dedication —*"Ad majorem Humanitatis gloriam"*— passes inevitably through national values. Refusing to acknowledge where you come from is an act of amputation. To be sure, there are values beyond national ones. Nobody owns the air, at least for the time being; we all breathe it. I claim that technology must be deeply rooted in national, and regional, developmental issues, which do not deny international values. There is no regional, or international development aside from a national one.

for a longer-range one. An ideal-seeking system must be willing to sacrifice the present for the future, because progress toward an ideal cannot take place along a straight line". One must remember different Gulags, different dictators, different prophets, different "ideals" and different "paradises".

I submit that the present cannot and must not be mortgaged in the name of future paradises, if only because such paradises do not exist at all. I claim, on the contrary, that development is a process, an endless process where public participation is essential. This does not deny the tasks of technogists in such a process as has been emphasized throughout this work.

As early as 1948, Waddington wrote: "...The fundamental problem of to-day lies far more in the sphere of ideals and values (...) than in the technological. We already have all, or at least most, of the techniques we need to provide a decent civilized life for everybody. They are not yet producing that result (...) partly because the old political and economic machine was unsuitable (...) We now have to decide for what purposes the new organisation shall be designed. And to the discussion of these social ends, science has a good deal more to contribute that has been recognized hitherto". I would add that although the "technique" we have are not perfect (Tobar-Arbulu 1986c) they can indeed be used for "providing a decent civilized life for everybody" provided "the old political and economic machine" is changed, not only at the academic level —Eichner 1983, Thurow 1983— but in real, tangible, life (13).

Ackoff (1975) has insistently proposed "participative planning" as an alternative to measuring the quality of life. But participative planning by itself is not a solution either. We need, at least as reference frames for contrast, some kind of social indicators despide their limitations. By the time being, while we are in need of better and deeper studies on the nature of man and his social environment, we support the kind of list of social indicators proposed by the OECD (see Tobar-Arbulu 1985e) (14).

(13) Does anybody in his right mind think that the less developed countries can afford their huge external debt? Is it not necessary, more than ever, to renegotiate the debt burden carried by less developed countries? This issue, however, will bring us beyond the scope of present work. Further development of some of the present work is of particular interest, for example an analysis of the problem of *power,* which is closely related to development. Third World countries have been suffering for centuries from the chronic malaise of (political, economic, cultural, and military) dependence. Any analysis of the problems confronting these countries which disregards the problem of dependence, and its converse power, is merely self-serving academic chop-logic. (On power see Russell 1938, Galbraith 1967-78; 1973-75, 1983b.)

(14) I would like to thank Julio Caro Baroja whose independent thinking and intelectual honesty have influenced me for a long time.

APPENDIX: THE TECHNOLOGIST'S HIPPOCRATIC OATH

I solemnly pledge myself to consecrate my skill to the service of humanity.

I will be loyal to muy profession and practice it in uprightness and honor; whatever project I shall undertake, it shall be for the good of mankind to the utmost of my power.

I will keep far aloof from wrong, corruption, and from tempting others to vicious practice.

I will exercise my profession solely for the benefit of humanity and perform no act for a criminal purpose, even if solicited, far less suggest it.

I will speak out against evil and unjust practice wheresoever I encounter it.

I will not permit considerations of religion, race, party policies, or social standing to intervene between my duty and my work; even under threat.

I will not use my professional knowledge contrary to the laws of humanity.

I will endeavor to avoid waste and the depletion of non-renewable resources.

I make these promises solemnly, freely, and upon my honor.
(Adapted from Susskind 1973 p. 118).

BIBLIOGRAPHY

ACKOFF, R. L. (1975) Does quality of life have to be quantified? *General Systems, XX:* 213-219.

—(1977) On Growth and Development of Social Systems, in R. L.

ACKOFF *et al.* (eds.) *The Zucker Lectures* 1975-1977. Ontario, Canada: McMaster University.

ACKOFF, R. L. and F. E. EMERY (1972) *On Purposeful Systems.* Chicago: Aldine.

BARBOUR, I. G. (1980): *Technology, Environment, and Human Values.* New York: Praeger.

BARON, M. (1984) *The Moral Status of Loyalty.* Dubuque: Kendall/Hunt.

BAUER, R. A. (ed.) (1967) *Social Indicators.* Cambridge, Ma.: MIT Press.

BORN, M. (1971) *The Born-Einstein Letters.* London: Macmillan.

CASTLEMAN, B. I. *(1978) The Export of Hazardous Factories to Developing Countries.* Washinghton, D. C.: Environmental Defense Fund.

CHURCHMAN, C. W. (1961) *Prediction and Optimal Decision.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

CURD, M. and L. MARY (1984): *Professional Responsibility for Harmful Actions.*

Dubuque: Kendall/Hunt.

DEGEORGE, P. T. (1979) The Environment, Rights, and Future Generations, in Goodpaster and Sayre (eds.) p. 93-105.

EDGEWORTH, F. (1967): *An Essay on the Application of Mathematics to the Moral Science. New* York: A. M. Kelley.

EICHNER, A. S. (ed.) (1983) *Why Economics is not yet* a *Science.* New York: M. E. Sharpe, Inc.

EINSTEIN, A. (1905a) On the electrodynamics of moving bodies, in A. Einstein *et al.* (eds.) (1952).

— (1905b) Does the inertia of a body depend upon its energy-content?, in A. Einstein *et al.* (eds.) (1952).

EINSTEIN, A. *et al.* (eds.) (1952) *The Principle of Relativity. New* York: Dover.

FISCHCHOFF , B. *et al.* (eds.) (1981) *Acceptable Risk.* Cambridge: Cambridge University Press.

FLORES, A. and R. J. BAUM (eds.) (1980) *Ethical Problems in Engineering.* 2 vols. Troy, New York: Rensselaer Polytechnic Institute.

GALBRAITH, J. K. (1967-78) *The New Industrial State.* New York: Mentor Books.

—(1973-75) *Economics and the Public Purpose.* New York: Mentor Books.

—(1983a) *The Voice of the Poor.* Cambridge, Ma.: Harvard University Press.

—(1983b) *The Anatomy of Power.* Boston: Houghton Mifflin Co.

GALTUNG, J. (1980) The Basic Need Approach, In K. Lederer (ed.) *Human Needs. A Contribution to the Current Debate.* Cambridge, Ma.: Oesgeschlager, Gunn and Hain, Pub. Inc.

GOODPASTER, K. E. and K. M. SAYRE (eds.) (1979) *Ethics and Problems of 21st Century.* London: Notre Dame University Press.

GREEN, H. P. (1967) The new technological era: A view from the law. *Bull. Atom. Scientist,* Nov.

HERMAN, E. S. (1981) *Corporate Control, Corporate Power.* Cambridge: Cambridge University Press.

HOOS, I. R. (1972) *Systems Analysis in Public Policy.* Berkeley: University of California Press.

ILO (1977) *Employment, Growth and Basic Needs: A One World Problem.* New York: Praeger.

KUNREUTHER, H. C. and E. V. LEY (eds.) (1982) *The Risk Analysis Controversy.* New York: Springer-Verlag.

LEONTIEF, W. *et. al.* (1977) *The Future of the World Economy.* New York: Oxford University Press.

LILIENFELD, R. (1978) *The Rise of Systems Theory.* New York: Wiley.

LOWRANCE, W. W. (1976) *Of Acceptable Risk.* California: Los Altos.

MALLMANN, C. A. (1980) Society, Needs, and Rights: A Systemic Approach, in K. Lederer (ed.).

MARTIN, M. and R. SCHINZINGER (1983) *Ethics in Engineering.* New York: McGraw-Hill.

MEANS, R. (1967) Why worry about Nature? *Saturday Review,* Dec. 6, p. 12.

NATHAN, O. and H. NORDEN (1960) *Einstein of Peace.* New York: Simon and Schuster.

OTWAY, H. (1976) Risk Assessment, *Future, 12:* 122-134.

PRESS, F. (1980 in H. Woolf (ed.) *Some Strangeness in the Proportion. A Centenial Symposium to Celebrate the Achievements of Albert Einstein.* Massachusetts: Addison-Wesley Pub. Co.

RABI, I. I. (1970) *Science: The Center of Culture.* New York: The World Pub. Co.

RUSSELL, B. (1938) *Power: A New Social Analysis.* London: G. Allen and Unwin.

SALAM, A. (1984) *Ideals and Realities.* Singapore: World Scientific.

SCHAUB, J. H. *et al.* (eds.) (1983) *Engineering Professionalism and Ethics.* New York: John Wiley.

SNOW, C. P. (1969) *The Two Cultures: A Second Look.* Cambridge: Cambridge University Press.

SUSSKIND, C. (1973) *Understanding technology.* Baltimore: The Johns Hopkins University Press.

THOMAS, G. and M. MORGAN WITTS (1975) *Guernica.* New York: Stein and Day.

TUROW, L. C. (1983) *Dangerous Currents. The State of Economics.* New York: Random House.

TOBAR-ARBULU, J. F. (1984a) Plumbers, technologists, and scientists, *Research in Phil and Tech.,* Vol. 7: 5-17.

—(1984b) Purposeful machines, robotics and the like, *Theoria* (Spain) (forthcoming).

—(1985a) A value theory of actions, *Philosophy and Social Action* (India) (forthcoming).

—(1985b) Technological truth and modern empiricism, *Contextos* (Spain).

—(1985c) Technology: A Field of Knowledge, *Theori a* (Spain).

—(1985d) Tecnología: Campo de Conocimiento Orientado hacia la Acción, *DYNA ,* (Spain).

—(1985e) Human needs and development, *RIEV.*

—(1985f) Evaluation of tecnology and technology assessment, *RIEV.*

—(1986) *Technopraxiology: Action Theory from a Technological Point of View* Ph. D. Dissertation, McGill University. Canada.

UNESCO (1979) *New Perspectives in International Scientic and Technological Co-operation* Paris: Unesco.

UNGER, S. H. (1982) *Controlling Technology: Ethics and the Responsible Engineer* New York: Holt, Rinehart, and Winston.

WADDINGTON, C. H. (1948) *The Scientific Attitude* 2nd. ed., West Drayton: Pelican Books.

WEIL, V. (ed.) (1983) *Beyond the Whistleblowing: Defining Engineers' Responsibilities* Chicago: CSEP, Illinois Institute of Technology Center.