
RESPONSIBILITY AND ETHICS IN SCIENCE AND ENGINEERING

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INTRODUCTION

To avoid possible mistake while discussing concepts of ethics and responsibility, to be able to feel differences between them and eventual similarities and identicalness, let's remember their definitions:

Ethics is a science on morality and rules people what have to obey during their lives and work. It defines morality, discusses rules about it, the goal of moral living, measure of man's deeds and he should behave in society.

The above-summarized definition primarily relates to opinion, life and work of a man in relation to other members of human community, as well as to the whole community. If it were not so, if a man were not outstanding and human community put above everything else in nature, all his acts would be immoral, opposite to what's ethical. For most of a man has done in his history, everything that has contributed to the development of his civilization could be considered unethical. During his development, people constructed buildings and towns, roads and hydro power- plants, dug mines and thus changed nature and its aspects destroying many plant and animal classes, and many other factors in our environment. Without ethics and necessary codes on behaviour and acting of human race toward his species and society, most human acts that are results of his intelligence could be annihilated; Most of his achievements that have come as result of his mental abilities and his skills, results of his struggle for survival, easier, comfortable and more effective life, have put him in some gegree above the nature. A man is a dominant being on this planet and is its "master". That is why ethics is a concept relating primarily to human life and work, and after that to man's relationship with everything else on Earth. And it's becoming more important with the passing of each single day, as all human activities reflect upon the whole nature in our surrounding, and the boomerang effect upon human life, too, and, finally, upon human survival.

Responsibility, however, is a term that defines an individual's attitude to some of the obligations he has taken upon himself and must fulfill. Responsibility, of course, can be a group one, but it still remains the individual liability. Responsibility is an assurance or a guarantee of a person taking some obligation upon him. It can apply to another person, or an institution where a person works, or is engaged by, but also to oneself i.e. one's conscience.

PARTICULARITIES OF ETHICS AND RESPONSIBILITY IN SCIENCE AND ENGINEERING

Science and technology have brought development to civilization, and their results shouldn't be used against humanity. At the Assembly of Engineers and scientist at the California Technology University (CALTECH) in 1931, Einstein said: "Care for a man and his destiny must always be prior interest of all technical undertakings so that our minds' creations can be a blessing, and not a curse for mankind. Don't you forget this while you are working with diagrams and equations!" (3).

We can be sure that in most cases an ideal scientific and engineers' attitude has prevailed, that each of their undertakings may be useful and bring pleasure and satisfaction to people. However, there have always been the ones who have used the results and achievements of scientific researches against mankind, and we can say this is obvious more and more nowadays. Aren't in the today's world, more than before, results of researches and projects aimed as treat to a part of mankind being financed? Haven't the recent decades been marked with high militaristic degree of technical and scientific achievements?

A list of scientific and technical achievements that have transformed the world during the 20th century is impressive and, why not to say, fantastic. Let's mention just lasers, television, computers, nuclear energy, and cosmos-technology. On the other hand, almost all listed achievements, some to smaller and some to a great extent, have been also misused. And that's always been so. Hasn't Archimedes used focused sunbeams and reflection of mirrors to destroy an enemy fleet, done today in much more destructive way with lasers, such an important discovery for human health? Nuclear energy, similar to the misuse of dynamite that Nobel intended for the useful application, has become a mortal weapon of our time. And with consequences not even foreseen, but anyway dreadful, left as terrible heritage to next generations. All these manifestations are the result of aggressive and exploiting politics of economically and technically leading countries, but also of others, as a counter-measure in case one people have to confront another one. And not only wars have provoked catastrophes. It is well known now that experimental nuclear explosions endanger mankind, causing meteorological changes, radioactive radiation, leaving dangerous waste materials. Even the use of nuclear energy for the most human purposes, to the advantage of human kind - in order to get electricity - has dangerous consequences, quite opposite to the demands of sustainable development. Let's also mention the satellite network around the Earth, equipped with devices for laser emission, that is controlling every point of our planet with mortal treat.

Examples of the application of technical achievements for destruction and killing are nowadays mentioned in connection with the recent wars and different attacks. Devastating consequences of wars in Iraq are more and more obvious. Or the most current example - consequences of NATO bombing in Yugoslavia, where bombs with depleted uranium and bombs with delate explosion have been used..

By its nature, television is also a human discovery, aimed to bring the world into every home, fun and pleasure to its users. It gets culture, art and science closer to every individual. However, it has its dark side. Edited faked images and manipulated information have been broadcasted in order to shape the public opinion and form desired point of view among audience. Or, better still, in order to carry out clearly unethical actions. That's why Umberto Eco points out intellectuals' obligation to speak about medias' distortion they may notice.

It is not necessary to mention other examples of unethical misuse of essentially ethical achievements of science and technology; it can ba only said they are numerous, and that

estrangement from essential ethical principles is greater every day. On the other hand, it cannot be claimed that scientists, engineers and all other participators in realization of these achievement have taken part in their unethical misuse. They surely have not. Although even this medal has its dark side, since there are examples that the scientists knew for sure what they were doing and why, and still continued with it. Just remember the rocket programs from the World War II, creation of atom bomb, genetic researches on people and guinea pigs, people cloning talked about so much today.

ENERGY, ECOLOGY, ETHICS AND RESPONSIBILITY

Regarding energy, an excellent engineer and expert for its application for humanitarian purposes, participant at the previous KGH assemblies, Mr. William Coad of St. Louis indicated that engineers are nonetheless the ones to blame for negative reactions of nature to enormous energy consumption (4). Let's explain that we are not talking here about the energy consumption for war purposes, but for human use in order to get light, engine power, heating and cooling, food preservation and continuation of the most useful technological processes. Because engineers are the ones who have designed and made possible ways to turn natural energy resources into the power moving "man's slaves", giving "muscles" and "life" to levers, belts and wheels, all in order to move machines that serve men. Term "man's slaves" was used by Oscar Wilde who wrote: "It is a fact that civilization needs slaves. If there are no slaves doing ugly, disgusting and uninteresting jobs, culture and progress of civilization would be impossible". However, Wilde added that human slavery is wrong, insecure and demoralizing, so that the world's future depends on mechanical slaves, machines. And certainly, mechanical slaves have appeared that transport people and goods, cook, wash dishes and clothes, clean houses, entertain us and calculate for us, adjust climate in our habitats. They are all results of science and engineering, and engineers can be proud of their contribution to the mankind. But mechanical slave, just like a human-slave, must be fed. And his food is energy. Then again, energy resources of the planet Earth have been so much and so often used that their absolute exhaustion is at hand. Coal and oil, as the most exploited natural resources represent the so-called unrestorable energy resources, and they will soon disappear. So, working for the benefit of mankind, engineers have made our civilization dependable on resources that feed our mechanical slaves.

Everybody is trying to provide energy, especially industrially developed countries, and at the same time to control what's left of natural resources. And that's what's fueling militaristic aspirations, and there you are: location of almost every center of disorder and international interests today coincides with the energy resources: Middle East, Russia and neighboring countries, and somewhat poorer resources in Serbia, on Kosovo.

In the meantime, some new energy resources are being studied at full steam. Yes, we are talking about the use of renewable energy resources, the "clean" ones including solar energy, wind energy, geo-thermal and sea-waves, tide and ebb energy. On the other hand, the other, more powerful at the moment, whose dreadful consequences have been experienced, are being researched as well. People still invest in them, and use them in unethical and irresponsible ways. With the subjective explanation of those involved in such projects that their engagement is motivated by great scientific challenge that could probably solve the energy shortage, but also the problems the use of such an energy cause.

Enormous consumption of energy, logical consequence of technological development in the world and population growth, as its consequence had the destruction of environment we

belong to. Every day, millions of tons of carbon monoxide, carbon dioxide, sulfur and nitrogen oxides are being thrown into the Earth's atmosphere. During the air-conditioning process, cooling systems use cooling agents (chloro-fluoro-carbonates) that reach the upper layers of the atmosphere, claimed to destroy the ozone layer that protects the living world on the Earth from the dangerous, ultra-violet radiation of the Sun. Not mentioning all the other disturbances in nature, but having in mind just the ones in its atmosphere caused by the energy consumption, the consequences are quite enough to endanger our survival: greenhouse effect, global warming of the Earth and its atmosphere, destruction of the protective ozone layer.

Engineers are the ones responsible for the development of civilization. But they also have a moral obligation to solve the problems their fantastic achievements have caused, and to provide further advancement of civilization, which means further development of mechanical slaves and their availability to all. Taking care, of course, that the existing energy resources are saved and that time may be gained to discover new resources that will not be a threat to nature and mankind. And protecting our environment at the same time. That's why the control of energy consumption and the quality of environment, i.e. energy and ecology, are becoming primary concern of politicians, economists, and of each individual, but first of all, of engineers.

Yes, the engineers could find, and they are already finding, ways to reduce CO₂ production. But then comes military actions like the one on Yugoslavia, and hundreds of planes fly non-stop 90 days. Just imagine what quantity of carbon dioxide was emitted in upper layers of our atmosphere? And if we mention destroyed tanks of petroleum industry in Pancevo and Novi Sad, reservoirs of heating oil in Belgrade, then it is clear that engineers can ensure sustainable development only in a society of peaceful world. Just peaceful, not only civilized.

Energy was considered through expenses it demanded and its consequences were ignored, that was unethical and irresponsible. That's why today it is necessary to turn these two life important factors, energy and environment, from project parameters into the level of ethical postulates. For, as W. Coad says, energy resources cannot be treated as economic product with a certain price, and therefore energy preservation must be understood as purely ethical concept.

Regarding the importance of Earth's energetic potentials, necessity of their rational use, both for the dragging out of the rest of existing resources and for the reduction of the environment pollution, there is a lot of talk on that since the fifties. Summary of all those talks is as follows:

- reserves of classical energy resources, coal and oil, are estimated to last barely till the end of the next century with the current trend of consumption growth;
- shortage of energy for economic and everyday needs would cause an economic and social crisis, both in countries of industrial production and in those that are primarily consumers;
- the remaining energy resources are mainly out of control of countries that are the biggest energy consumers, the fact that essentially directs present political tendencies;
- engineering is able to design machines, devices and equipment with reduced need for energy but the same final results;
- science, too, can research new energy resources with good results, but the problem may be the time regarding the resources in use today.

CONCLUSION

In medical circles, an oath is well known, written by Hippocrates many centuries ago, taken by doctors prior to beginning medical practice, affirming their obligations and proper conduct. There is no evidence that similar oath has been defined for engineers and scientists, though it may be believed that some professional associations do have it. And for scientists and engineers of KGH profession, and scientific fields of its origin, it may go like this "In my work, I shall accept those tasks that I may, with my education, knowledge, experience and will, fulfill successfully. Accordingly, I shall accept only those duties that are not aimed against people and their existence, taking care of environment protection, rational use of natural energy resources, and heritage to future generations. My working principles shall be ethical and not material. I shall constantly improve my skills following advancements of science and technology, while I selflessly hand over my knowledge and experience to others".

LITERATURE

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