

# Science, Technology And Society in Engineering Education

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**Abstract:** This paper brings up for discussion some relevant subjects related to the implications of science and technology in the contemporary society, emphasizing the importance these themes should have at the engineering schools. It aims to promote deep reflections about the relationship between the unsatisfactory level of education and the performance of the future engineer, not only as a professional but also as a citizen. By showing to the teachers the importance of a sound formation in this new area of knowledge it intends, in reality, to reach the students, leading them to think about the impact of their actions in the society. In the meantime, using some basic concepts about the implications and effects of the science and technology developments on society, throughout the times, it aims to give evidences that the awareness of these subjects can be used as a motivational agent to keep the students in the school classes. Besides pursuing these targets, by looking objectively at the problems, it also tries to identify reasons for the little attention given to these subjects in the teaching departments and also justifications for the inclusion of these matters in the program content, so they could contribute for the formation of professionals more concerned with their role in society.

## 1. The Idea

The educational process in the Brazilian engineering schools, up to now, is strongly attached to competent technical conceptions, losing sight, the deep and radical changes that have been processed in the last decades. Many of them related to social problems that came out because of the countless scientific-technological progresses that are happening daily. This aspect that in some way, has been soothed in another countries through studies of the relationship among science, technology and society (CTS), should be characterizing the need of new definitions for the educational process at the engineering schools, so it could be adjusted to the growing complexity of the contemporary social reality. This can mean strong transformations in the current teaching practice, provoking some scare and move away from this problem analysis those that for long time are ingrained in the focus of the science and the technology as neutral agents in this intricate process of human development. So, it is argued here in favor of a proposal that should be introduced CTS subjects in the engineering graduation courses, associated to the 'neutral' technical contents, already out of context, consolidated in the school curricula.

To propose a study with such focus can constitute a difficult task in a country that swells its curricula, many times, with training disciplines with an innocuous attempt of accompanying the overpowering scientific-technological development. Other countries, unlike Brazil, always betting, now are doubling their efforts, in the citizens' basic formation, based on the scientific-technological development.

## 2. Technology is Human Development

The habitual and confusing speeches in which one affirms that the social progresses is highly dependent on the incisive action of the technology is also highlighted and exalted by us engineering teachers. Justifying such positions, among many arguments that ennoble the supremacy of the technology, stands out those that consider the technology as creator of material conditions for the human subsistence. With this logic and in this direction, based on the intricate relationship between them, the science would enter as basic support to the technology. These

presuppositions that seem to give support the engineering and its teaching, probably have their roots in the cultural process that has been developed from the old European schools that worked with technology,

Observing technical products, if we stop ourselves in its pragmatic purposes, undressing completely of reflexive analyses from its social and ecological potentialities, we could conclude that this premise is convincing and probable. Even so, analyzing all these technology reflexes, also including here the economic ones, that seem to be now the managing elements of this “globalized” world, just as we understand and practice it today independently of the different contexts, certainly, even with the vehement defense practiced by the neo liberal speech, some incongruities will emerge from this supposed positivism.

Wakened up by recent accusations, that started during the sixties, concerning the possible noxious aspects of the technology, different social communities start slowly facing it with more caution. The explosion of the atomic bombs in Nagasaki and Hiroshima, the discovery of the stove effect (probably provoked by the men's action), the seemingly uncontrollable pollution problem in countless cities worldwide, the extensive oil spills that provoke strong environmental degradations, catastrophic accidents with industrial plants and civil constructions – all related directly with engineering applications – among so many others, are endless examples events that disturb and worry those that contemplate the future. These facts put in check the credibility of the technical and scientific knowledge. Can be added to all this the current frightening results of the unemployment wave that have been sweeping many countries creating serious social problems, as a result of the relentless progresses of the science and technology. All this can be partly due to the inadequacy of the traditional position assumed in the schools, especially between engineers and technologists, concerning the science and technology roles.

In spite of the pessimistic picture of this context, much has already been done in this field, trying to show the misunderstandings brought by the lack of deeper analyses on similar subjects. As example, one can point the studies realized by Jacques Ellul's writings, Lewis Mumford, Carl Mitcham, Langdon Winner, Arnold Pacey, Martin Heidegger, José Ortega y Gasset, among others[1].

In addition to all this, reinforcing with vehemence the need of these reflections, a new world order is drawn recently by events as the fall of the wall of Berlin, happened in 1989, the crisis in Asia, begun with exchange problems in Thailand, provoking strong oscillations in the stocks exchange in several parts of the world. This new aspect also denounces problems that afflict us directly, as the street manifestations in the stabilized Geneva, shouting against globalization, the attempts of closing China and Iran to capitalist world disorders in its domains provided by the internet, the social protests for government deprivation in several countries as the ones that affected general Suharto in Indonesia, in 1998, until recent ones – although from secular origin – ethnic conflicts in Kosovo, and so many others that continue happening daily.

It is patent the evidence that, in spite of the attractive promises of the scientific and technological developments – perhaps one of the largest paradoxes of our era - social subjects as the hunger, the wars, the degrading income distributions and the strong environmental degradations continue worsening day by day. Although the communication media and political systems keep on insisting that would be in the technical apparatuses production the well-being of the future generations.

The educational system as the main source of any society can't take place far from the technological somnambulism: it is its victim and its ally. Unfortunately, even knowing about this school dubiety and education responsibility considering the problems related to the CTS studies, the educators responsible for the programs development, following the secular technological schools rules, continues to bet in the classic remodeling based on curricula changes without concerning with the philosophical, sociological and pedagogical postures.

### **3. The Technological Education Under New Focuses**

If the socio-cultural environment changes, if the power relationship among the nations suffer adjustments, if concepts as nation and company become different from their traditional conceptions, why not to rethink the technological education process with another focuses? All this should serve as a alert for us, to begin to understand that the traditional model of engineering teaching, perhaps well adapted for another historical moment, can today be needing deeper reflections on its practice, so it can adjust in the new social perspectives.

The challenges nowadays in terms of the science and technology implications extrapolate the pure techniques field, because actually doesn't exist neutrality in the technique [2]. However, in general lines, many attempts of tracing new ‘roads’ for the educational systems, up to now, are based on the lineal adaptation based on the industrial productive system, resulting in a very poor imitation model with high inefficiency. This position seems to dominate the discussions among those persons responsible for such tasks. Looking at the results already seen we

can conclude that the adopted targets and policies seem not to have enough depth for an effective attack to the problem.

If we evaluate the technical world based on its material accomplishments and the multiplicity and usefulness of its products available nowadays for consumption market, it is not difficult to see it as a winner because of the assumed benefits it provide us. This assumptions are taken probably because the agreement way sounds much more convenient and according to the power of progress than the confrontation situation. In spite of our anxious desire of seeing 'progress' in everything around, we are always trying to guess what future reserves for us instead of building up our own future. A reorientation in the structure and in the logic of the technological education by approaching it in a wider and integrated way the CTS subjects, could be a good beginning for a renewal in this process.

The engineering schools are graduating students with great unpreparedness for working in the society and it has been denounced in a lot of opportunities. Although many authors that discuss this subject usually impute this problem to the technical inefficacy of the engineering courses, or to the students' bad quality and lack of motivation, we believe that there is something else beyond these interpretations. The justifications and solutions for this could be sought in the epistemological and pedagogical areas, or even in the philosophies that set up – sometimes unconsciously – the courses.

A possible reason for these interpretations can be reputed to the dynamics undertaken by the new moments of the civilization that provokes strong disorders when we analyze the current reality under old references on which were settled the social balance. Alvin Toffler[3] in *The third wave and Shock of the future*, had already registered a similar understanding to this, when he referred to the disconcerting momentary unbalances in which we get involved when living under great social changes. Such verification has been constituting concern factor for those that are responsible for the planning, execution and evaluation of the teaching processes in the educational institutions. Unfortunately, even with the best intentions, we continue, in many situations, just implementing actions that end for worsening these serious social subjects when we choose the effectiveness of the scientific and technological production as the focus of the problem.

#### **4. A Proposal for the Subject Approaching**

If there are many misunderstandings among the science, technology and society relationship and also among the consequences of these developments, these cannot be simply imputed to the educational process faults, taking as reference a supposed inefficiency in the knowledge 'transmission'.

So, we don't believe that attempts of the educational improvement can be confined in more rigid ways for students' selection, curricula optimizations or in simple processes modernization of 'knowledge transmission', believing that with all, the 'learning' will be happen in a more effective way. The possible solutions for these problems should be sought beyond these techniques tools.

Here there is a proposal, based into two conceptions, that seems to offer promising exits for the current technological education problems. On one side, we understand that in the schools, science and technology should be related and analyzed together, covering not only the classic technical treatments, but also the cause and effect relationships with the society. For that is necessary the transdisciplinary conception. On the other hand, so that to become that in reality is needed an indispensable new engineering teachers formation[1].

#### **5. CTS in Engineering Teaching**

Two different traditions related to the studies CTS are recognized. One of them, the North American tradition, more practical and evaluative emphasizes much more the social consequences and prioritizes the technology. It is marked by the ethical and educational subjects. The other line, the European, more theoretical and descriptive, emphasizes the antecedent social factors and prioritizes the science. It is marked by the sociological, psychological and anthropological subjects.

In consonance with the transdisciplinary characteristic, the CTS studies integrate several areas of traditional academic knowledge, that nowadays are approached fragmentally and out of context. It is also a target when incorporating the CTS concerns, analysis about the social phenomenon and the conditions of the human existence

under the perspective of the science and the technique. A third axis of this studies field is to analyze the social dimensions of the technological development [4].

These concerns have as base understandings that, usually, inside of the whirl of tasks that one is submitted in the contemporary society through routine works, it don't find time for deepened the analyses and for those questionings about the repercussions, the contributions and the consequences of the science and the technology. So, that is why is so important a conscious deliberation in questioning what indeed has been our daily concerns. And be armed with the proper instruments for working with this brand new field that has been opened for the technological education.

The attempts already taken worldwide, through many different types of CTS focuses, should be taken as anchors for an understanding of this problematic. To aid designing a structure capable to facilitate the elaboration of contents inside this new knowledge field of the engineering teaching—at least in Brazil – the insert of several contemporary authors' works, with its sociological and epistemological analyses and researchers that are deeply involved with the social and technological problems has got fundamental importance.

Besides this indispensable understanding for any citizen, the critical analysis of the existent relationship among science, technology and society and the way as students and teachers of the engineering courses face social progress and technological development, can aid the transformation of the pedagogic relationship developed in the didactic activities and the renewing of our fragmentary curricula.

This determination in pursuing this CTS subject in the engineering professionals' formation comes from a strong conviction that the technology is a social product, configured in ways of living forms and social goals that change from time to time. This panorama aims for the need of showing that in the democratic societies is not only necessary to consider the mechanisms and repercussions of the technology but also to propitiate the construction of structures to guide the technologies into a more acceptable direction.

This can imply the inclusion of disciplines in the courses curricula, but as already argued in the beginning of this paper, it is not the tonic we defend with this thesis. However, rescuing initial justifications, if the inclusion of disciplines were necessary or inevitable, that should be done strict and essentially so it can serve as support for the main idea that is getting the CTS focus on technological teaching.. The real idea is to get the CTS subjects interrelated with the classic technical matters. To reach such intent, it will be necessary enormous efforts in the sense of implanting a continuous process for renewing the teachers' formation.

The introduction of the CTS subjects in the traditional engineering technical area, besides serving as motivational agent in the learning process, will serve as catalyst of the human being reflexive and critical capacity of thinking about those subjects. Considering this focus and analysis two points should be mentioned and related to the teachers' acting:

a) As in any other area of studies, the technological teaching depends on an intimate relationship among the education process and the conscience that the human being has of himself. That is why the teachers should become aware that for the construction of answers to these subjects is an incisive contribution, for example, the study of the education history, an understanding of building knowledge process, a minimum notion of the values and the ideology that our actions are based on, and precisely nowadays, the knowledge of the relationship between the new technologies with the human being social behavior.

b) The CTS subjects are still to be focused – although some just need to be rescued – in the technological teaching, in particular in the engineering. Perhaps the lake of these subjects creates a misunderstanding of the human being as individual and as member of a collective, imposing us an acceleration of procedures, same the routine ones, and an anxiety of appropriation of new technologies, placing us continually facing a disconcerting sensation of being out of date with everything that surrounds us, including our feelings and life projects.

To delineate a strategy for contents elaboration that could provide the wanted teachers' formation for the engineering schools is not the proposal of this work. However, when pointing the problem alerting for the importance of its solution we suggest some experiences developed at universities and researches institutes that have being working with CTS subjects. These experiences will help the elaboration, for our reality and context, of suggestions, proposals and also some and programs that can provide a starting point in this difficult task[1, 5].

## 6. References

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