THE UNIVERSITY IN TIMES OF CULTURAL SCHOCK

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The age of cultural shock

Technological and scientific advances have overcome all predictions and projected scenarios proposed in the course of the last century. Reality has eventually surpassed fiction. Among the most important driving forces that boost up those extraordinary transformations, I would say, unexpected knowledge explosion, two are to be highlighted:

1. The extraordinary capacity to scrutinize the microcosms and the macrocosms
    a. Images of individual atoms can be obtained with high resolution atomic force microscopes. Particle physics, nano-materials developments and molecular biology could achieve unprecedented advance due to new powerful microscopes.
    b. Huge telescopes installed on earth or on satellites – Hubble – covering a very large spectrum range allowed obtaining images of the early universe. Unknown cosmic objects like pulsars, neutron stars and planets in other galaxies could be spotted with sophisticated equipments.

2. The extraordinary capacity to calculate
    a. The second column that sustains the uninterrupted advance of science and technology is the growing capacity of storing data and processing speed. Parallel processing powerful and “computer farms” enhanced extraordinarily the calculation capacity. It would be impossible to design particle collision experiments without a huge computation

capacity. Imaging and patterns recognition are also among the most important contributions to science and technology advances.

The progress resulting from the converging advancements of observation and calculation capacities gave rise to a renewed methodology to deal with science. Windows were opened among several knowledge compartments that used to grow without any or with very few communication and interaction. This new approach to deal with scientific and technological challenges is called multi- inter- or trans-disciplinarily. Several areas of scientific knowledge could not be at the stage they presently are without the contribution coming from quite different backgrounds. Biology, ecology, medicine, economics, archeology and so on were able to accomplish big leaps due to the association with other disciplines as physics, chemistry and mathematics.

But the more astonishing event that we are living nowadays is not the knowledge accumulation properly but the speed in which it develops. The acceleration impelled by the successive jumps in science and technology surpassed our ability to control the path of the progress. Past seems to force the way through the present and mangle the future. We are simultaneously observers and former users of objects displayed in a Science and Technology Museum. When things try to accumulate without any possible control in time we are in the presence of a shock wave. We are in the middle of a cultural shock wave. Traveling along a shock wave requires a completely different strategy as those employed to progress along calm waters. Nowadays we have to surf along the wild cultural shock wave. It is not swimming anymore. Surfing is not an advanced style of swimming it is a completely different locomotion mode. Surfing see waves needs a board, similarly, surfing along science and technology needs new instruments. The information technology is certainly one of those key instruments that have to be wisely used. Concerning the impact of this new cultural environment on Universities I would say that it implies substantial modifications, it is not only a question of reviewing the curriculum, introducing or suppressing a couple of disciplines.

We are living a new age very much similar to the times of Alexandria. As like as climbing up an ascent spiral we are overflying the same cultural ebullition occurred little less than 2500 years ago. Alexandria may well be a source of inspiration for this new age. If tradition becomes almost meaningless considering the rapid change of culture and

customs considering short periods of time it is necessary to dig deeper to reach the very fundamental roots and recover the appreciation for the knowledge in itself. We are above all “thinkers” not “consumers”. If our civilization doesn’t put “thinkers” above “consumers” there is no possible solution to save the planet earth. Keeping business as usual will not suffice even with the adoption of mitigating measures. It is necessary a change in values to reduce the voracity to consume.

The University for the XI century.

After more than 100 years of continuing and accelerating advancement of science and technology, boosted by the extraordinary capacity to scrutinize both the macrocosms and the microcosms, and the almost unlimited capacity to calculate with more and more powerful machines, very few has been done to adapt the universities` academic structure to this new era. The barriers once dividing the different knowledge fields have been falling down one after another, however, departmental organization still prevails and people grab obstinately their piece of knowledge as private property closing their eyes before the birth of a new science with the unavoidable consequences on technology. A very clear signal of this new era is the growing number of initiatives merging different fields of knowledge leading to interdisciplinary research.

I believe that the classical organization that breaks up the so called hard sciences into physics, chemistry, biology, computer science, mathematics, social sciences and humanities in order to design university courses should be reviewed. The interdisciplinary research growing very fast as a consequence of converging scientific interest has to be translated into new guide lines. Why not reshuffle the topics composing this large set of scientific knowledge within a new framework more adequate to the new stage of knowledge. Why not trying a new distribution as:

- Structure of matter
- Energy
- Transformation processes
- Information and communication

- Representation and simulation (mathematics)
- Humanities and social sciences

Courses following this new scheme would foster the interaction among people with different backgrounds. It is possible also that it would help implementing collaborative and interdisciplinary research. It would certainly avoid, for instance, the harmful split of several fundamental science courses in branches with professional specificities like: thermodynamics for engineers, quantum mechanics for chemists, relativity for biologists and so on, as if the fundamental concepts were dependent on different view points.

The departmental barriers have to be broken up. The ideal University would be one where there would be no departments, no schools and no centers. If this is not feasible due to some administrative constraints at least the organization in centers, the minimum possible would be satisfactory. In a science and engineering oriented university three centers would be enough.

1. Natural Sciences and Humanities. *Discovering*
2. Mathematics, Computation Sciences and Modeling. *Criticizing*
3. Engineering and social sciences. *Inventing*

These three centers could be associated to the main attitude towards knowledge, discovering that drives the interest of the people in natural sciences, criticizing meaning the use of rigorous logic reasoning that drives the interest of people in mathematics and inventing that drives the interest of people in engineering.

Students admitted to the University, not to a specific course, should be exposed to a basic education covering three types of coursework:

1. A minimum of required credits along new guidelines in science and humanities as those listed above: matter, energy, transformation processes, mathematics, computation, communication and information, humanities and social sciences.
2. A given credit load comprising courses dealing with open themes, that is, effervescent themes containing more open questions them well consolidated answers. Themes related to global changes, quantum physics, cognition, complex

systems, modeling natural and social phenomena, life sciences, religion and myths, and the like.

3. A third credit load may be associated to a set of free choice courses closing the credit requirements. .

After a successful accomplishment of the credit requirements covering the three different groups the student would be granted a BSc.Tech, bachelor in science and technology.

This scheme certainly will not grant any official certificate to exercise one of the classical professions, but the competence acquired along three year of a coursework that would expose the students to the fundamental concepts of natural sciences, open their minds to consider unsolved problems and supplying then with modern analytical and computational tools, is a prerequisite for the education in any professional denomination. After this first stage the student could either go to the labor market, could start maybe a new company, or could follow other university paths.

The student will be given more freedom in this system but will be required to be more responsible with respect to his own carrier. He or she would be stimulated to take risks. Making difficult decisions is a fact of life that everyone has to experience sooner or later. Exercising the choice before two or more options during the university period is benefit and not very much harmful if the wrong way is selected. There are lots of opportunities to fix mistakes.

Courses should minimize the time spent in classrooms. The students should be required to study by themselves, to learn. The sharp division between graduate and undergraduate students should vanish. Undergraduate students are today smarter than in past times. They are much closer to professors nowadays and not seldom they dominate certain subjects even better than professors. It is necessary to break the sharp stratification, professors, graduate students, technicians, undergraduate students and build up a more open and fruitful academic community. Creativity should be the focus of this new era. Freedom to risk new ideas breaking down old paradigms.

Engineering education has to be centered on the less obsolescent subjects, that is, basic sciences. The speed of the technological development doesn’t allow organizing

curricula and the respective contents to guarantee a long-lasting competence for the new graduates. The maximum we are able to do is to provide the students with the necessary tools to open their own ways. Automation and the continued sophistication of software designed to perform very complex analysis require from the engineers a deep knowledge of mathematics, computation and of the fundamental concepts related to physics, chemistry and biology, otherwise they run the risk of misusing the modern engineering tools. To partly minimize the difficulty posed by the accelerated technological development applied disciplines in the engineering curricula should be taught by competent engineers working in the industry as part time collaborators.

The world has turned to be smaller and smaller. Collaborative research should be encouraged and the respective funds should be allocated to make it possible the exchange of visiting professors, scientists and engineers for relatively large periods of time. Student mobility should also be stimulated among national and foreign universities as well. The accreditation of courses taken in recognized universities should be freed from the heavy bureaucratic requirements existing today.

I would like to say some words about extension programs. This kind of commitment of the University towards society in general is carried on through three main activities:

1. Response to industry demands to solve challenging and open problems. It is important to point out that the university's role in this kind of activity is not to substitute industry's responsibility but to advance applied knowledge. The University can not turn out to be a development division of any industry, but its mission is to foster invention and to discover new and innovative processes. We believe however that one of the most important contributions of any university to the industrial and economic development stays on the education of new generations of engineers educated for creative thinking and apt to face new and challenging problems.

2. Another contribution of the University is to offer special courses designed to supply specific demands of certain segments of society and to promote continuing education.

3. A third activity also very important is science diffusion programs. I believe that it is one of the University's obligations to translate into a language accessible to all educated citizens even those that have had the opportunity to acquire only the most basic education the new advances of science. Implementation of cultural programs in cooperation with other organizations should also be within the University's scope.

The Research University for the 21st century requires a turning point in the academic life. To successfully accomplish its mission it takes not only the almost unconditional support from the State, but it is essential the support of several critical segments of our society. I would mention, our students who are embedded in a completely new cultural environment, the Industry that has to see the University within its proper mission primarily as an actor responsible for the advancement of knowledge, society in general that has to understand that the University is not a bureaucratic institution that confer a diploma after completion of a certain number of credits but is a place proper to acquire knowledge and competence and to gain human experience living in a community with a very broad cultural spectrum.

The ultimate commitment of the University toward society in general is to recover the appreciation for scientific learning, to show the beauty inherent in the mysteries of nature and hidden in a mathematical object. The University was founded on the assumption that knowledge is not only a means to response to market demands but above all to enhance the enlightenment of the human spirit.

The project of a new university for the twenty first century should be sustained by the freedom to explore new paths that will lead the University closer to its original and universal purpose: to discover, to invent and to think critically. While electing research as the main instrument to achieve its main target, the University should provide an education system that encourages students to make their own choices, to take risks, to accept challenges and to think creatively. Education embedded into a research environment.

New initiatives proposing alternative paths in the academic life usually raise harsh criticism and we hear heavy advises previewing ˝unavoidable catastrophes˝. Despite of that we are living in an era that some of us have to take the risk even if our destiny is to be buried as seeds for future flourishing. History is being dramatically squeezed in time.

There is no time for long discussions. It is time for surfing, that is, a continuous adaptation to the new circumstances and the state of art. This new attitude requires courage to face the criticism of the corporative stance prevailing in most of the Universities. But this is not a novelty. Ewin Shrödinger, one of the most important scientists of the last century, faced similar challenges. He wrote in 1944 as preface of his book "What is life":

" …. But the spread, both in width and depth, of the multifarious branches of knowledge during the last hundred odd years has confronted us with a queer dilemma. We feel clearly that we are only now beginning to acquire reliable material for welding together the sum-total of what is known into a whole; but, on the other hand, it has become next to impossible for a single mind fully to command more than a small specialized portion of it. I can see no other escape from this dilemma (lest our true aim be lost for ever) than that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them, and at the risk of making fools of themselves. So much for my apologize"

The Brazilian cultural environment

As much important as the universal Cultural Revolution that we are living is the general cultural foundations underlying the industrial and educational policies adopted by the Brazilian Government for several decades. I believe that without taking into account this factor all analysis and projections for future development of this country will run the risk to fail.

Three characteristics that must be straighten up to help a quicker improvement of the Brazilian higher education system, particularly in which concerns engineering.

1. Predominance of diploma over competence. Unfortunately for most of the Brazilian institutions and the society in general a diploma is a kind of authorization to obtain best salaries. People are rewarded more by their diploma rather than by the competence as professionals.

2. Lack of self-confidence leading to the tendency to super- valorize foreign products of all different orders, policies, manufacture, technological solutions, evaluation procedures, curricula and so on.
3. Agreement among persons and institutions are established under a suspicious attitude. The fundamental hypothesis frequently is that people will act to maximize their own interests rather than working towards the society benefit.

Higher education encompasses a broad range of education and training options. Universities and I mean by that research universities are only one of the possible structures. Engineering education tends to concentrate on just a single type of model, namely a course embedded in research universities. But most of the Brazilian Universities are not rally research universities. We need in Brazil a large number of colleges offering excellent professional training in engineering. The faculty should be predominantly part time professionals with excellent experience in industry or consulting companies. Students graduating from those institutions should be able to solve practical problems with high technical efficiency. Of course this type of education is narrower but highly specialized and meets the urgent needs of some sectors in industry. Unfortunately till recently only a few colleges were oriented towards this objective and instead fostering a technical training they would prefer to be converted into a University. That is instead of an excellent technical education some of them prefer to turn into a weak University.
This is partly due to the prestige of the name “University” associated with the institution and partly because the students know that a university engineering diploma means better salaries as compared with a college engineering diploma. Fortunately the present Administration is trying to promote the valorization of technological education and supporting the implementation of several colleges around the country.

This action must however be coupled with a new rewarding system both in the public sector and private sector as well. This means that an excellent technician may earn the same salary as a good engineer or an associate professor or even a full professor.
Another difficulty is the exaggerated bureaucracy requiring sometimes meaningless amount of papers is the delay in the implementation of new courses and new professional orientation required by the rapid development of science and technology. This obstacle

posed by the professional associations – like the CREA in the engineering sector – has delayed considerably the implementation of new engineering denominations and forced universities to extend credit requirements to cover traditional denominations while simultaneously providing the complementary education in new fields. This attitude coming from the professional organizations in engineering is partly understood because students once getting a university diploma are authorized to exert professional activities. I believe that this practice has to be changed urgently particularly in times of very quick transformation that we are living nowadays. The authorization of professional activity should be obtained through proper exams conducted by the professional organizations.

The lack of self-confidence has been terribly harmful to Brazil. On the higher education field despite all the successful projects and academic achievements obtained in the course of the last 30 years even people with very expressive curriculum seems to classify the knowledge output in a relatively low rank as compared with other countries. They don't feel proud of their own achievements and tend to put themselves and their colleagues consistently at an inferior rank. Science and engineering periodicals that were just a few in the middle sixties jumped to approximately 250 recognized by a joint committee CAPES/CNPq as have reached a good editorial standard. From these 27 belong to engineering fields approximately 11% of the total.

The participation of engineering publications in the Brazilian total output is around 9%. Even with this positive demonstration of vitality most of the Brazilian scientists and engineers prefer to send their best articles to foreign periodicals. They don't feel that matters published in national periodicals will outreach the worldwide academic community. But if we don't believe in the quality level of our periodicals who outside of the country will? The priority given to non-Brazilian periodicals is less critical today than 20 years ago but still exists and influences individual and departmental performance evaluation.

This attitude prevailed also in the industrial sector till recently. The history of industrial development is frequently associated to investments and governmental policies. There are several thesis and dissertations focusing those variables. Of course these variables play an important role in industrial development. But I believe that equally important is the cultural background. The typical attitude of our entrepreneurs and

industrial elite was skepticism about the capacity of our technicians and engineers to solve complex problems and an almost unlimited thrust on foreign products, design and engineering analysis. The so called Brazilian Industry leaders were more commerce oriented rather than industry oriented. The risks involved in the design of a new product, the effort to maximize quality, the proud of a flawless product was frequently overshadowed by the maximization of profits, even if this decision would be unsuitable to the country's technological development. This attitude is changing at least with respect to some key engineering sectors.

It is natural to expect that government investments and development policies follow the same guidelines. Industry Associations and Academic Associations as well some times complain about the investment orientation of the government but they ultimately reflects the general cultural attitude of the Brazilian elite. An example of this exaggerated risk aversion was the decision of the funding agencies not to support the emergent national automobile industry about thirty years ago. The reason given to support this decision was the assumed weakness to compete with external markets despite the arguments of the leaders trying to start a Brazilian automobile industry.[1] Korea and India decided to take the opposite direction. Fortunately more recently the aeronautic industry in Brazil was able to take a quite different direction and is very much competitive in the international market. Some experts acknowledge this success to the initial management orientation of this industry under the Air Force and therefore able to obtain public investment and the association with ITA a leading Technological Institute.

The era of globalization brought different effects to Brazilian Industries. Some were favorable and others detrimental. The general Brazilian culture is favorable to globalization unfortunately considering us as a minor player and able to enter the international market almost exclusively with raw materials, agriculture products and commodities. The underlying cultural foundation of the decision makers pulled back the Brazilian development initiatives to open room to external more developed companies presenting immediate commercial and socio-economic returns with no consideration of the negative effects on the long run. The inevitably of globalization was taken as a kind of stratification at an inferior position. Apparently this conception has been changing and

[1] The nascent automobile industry was Gurgel Ltda.

some progress is being achieved with the industry-university partnership. A country the size of Brazil with excellent internal market potentiality can certainly take calculated risks.

A signal that a new mentality is about to come out, is the attitude of the industrial community. It is true that the support given by private institutions and foundations to good Brazilian universities has been much lower than it could possibly be. Some wealthy people have donated millions of dollars to foreign universities but ignored the needs and the efforts of the best Brazilian Institutions. Recently however initiatives coming from private foundations, industrial conglomerate and wealthy entrepreneurs are promising.

I would also like to mention that the so called technology transfer has been recursively used trying to booster autonomous technological development. But I am very skeptical about most of these initiatives. There are several conditions necessary to achieve a positive and standing reward in the process of technology transfer. Usually the partner in charge of transferring the knowledge is the main beneficiary in the process.

Considering the overall sum of positive and negative contributions to the development of a favorable cultural environment I would say that we are following a promising trajectory. Hopefully this general attitude prevails. And I believe that the future role of Brazil in the globalized world depends very much on us. This assembly certainly gathers people playing different rules in our society, but all of them contributing to the engineering education, industrial innovation, scientific and technological advances. We should be more optimistic regarding our own potentiality to contribute decisively to the autonomy of our country.

A final word

A word about our future and I speak about ABCM. After more than 30 years of hard work ABCM is reaching a position to effectively contribute not only with academic issues but also with industrial and educational policies. We should be more present in assemblies and institutions were key decisions are taken concerning the fields of our competence. ABCM has been steered by people with extraordinary strength and competence. I am one of several people present here that has followed up the ABCM`s progress.

We should also be present in the discussion about the future of our planet This is a problem that concerns all of us. While trying to develop and implement means to mitigate the negative effects of a uncontrolled industrialization we should also to foster the appreciation for knowledge. Science, art, philosophy, history are also part of our lives. The voracity to consume should be counterbalanced by the joy of learning. I believe that we could contribute with several actions in this direction as the development of equipments, software and game to be part of the achievements of live or virtual museums for instance.

But to accomplish all the tasks that we think it is necessary, including here the strengthening of our publications and our meetings we should be much more committed to our association. This means to be ready to cooperate with the different activities, to help expanding the number of fellows, to increase the number of institutional members, to increase amount of our income. I urge that we all work together to promote this jump of presence and influence of ABCM in the Brazilian society. Let us overcome small differences in the benefit of a global gain that will contribute to a better industrial and educational policy.

Our presence in the international community is equally important. Let us not ignore that the industrialized countries cannot avoid expanding their influence all over the world. We must also be present to defend our legitimate interests. We should not be a passive observer but an active member of the international engineering society. It is necessary to strength our cooperation among Latin American countries.

We have in our hands all the tools necessary to contribute to the progress of our country. It takes courage, it is necessary to dare and to be ready, some times, to deviate from the common sense. As once said Bernard Schaw, progress depends only on people that are ready to leave the track previously established by the common sense. Let us do it.