ENGINEERING EDUCATION –
A FUTURE MANAGEMENT OF THE FUTURE

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Abstract ¾ Processes and structures of current engineering praxis, as well as those of the present university engineering education, are closely related to progress and stasis of modern nation state, and modernity as such. In the current post-modern knowledge society, the engineering education needs to redefine its priorities and find a new footing. In the knowledge society, the higher education has become of supreme importance for the functioning of its structures rooted in learning. Structural rigidity of higher education based on the authority and financial resources of the nation state in stasis does not correspond to dynamics of present culture development. Institutions of higher education need to be de-nationalised, as they need freedom for employment of their resources in an effort to reach goals set by regional and global standards. Contemporary societies are characterised by self generated structures and the capacity to determine their own future. Knowledge is a fundamental organisational principle of the way we live. Generation, reproduction, distribution, and realisation of knowledge, i.e. education, represent corner stones of contemporary social order. This has been especially apparent since the violence and intimidation of the 11th September 2001 in the United States. An access to education per se does not guarantee that the education will be accomplished. Education is primarily a cultural phenomenon. The post-modern engineering education should aim at teaching a flexible, target oriented, and responsible individual who is able to distinguish in the chaos of data generated by the Net. Future oriented engineering education means not only the development of rational thinking, logical analysis, and action directed conclusion making but also facilitating of understanding the functioning of the complex culture of post-modernity.

Index Terms ¾ Conflation of art and sciences, engineering education structures, higher education strategies, knowledge society, nation state, post-modern higher education, 11-09-2001 phenomenon.

INCIPIENT NOTE

1872, 130 years ago, Philias Fogg decided to go around the world in 80 days – not too an ambitious plan from the point of a satellite view, and an easy option of transcontinental transport. Philias, comfortably rooted in top modernity, could avail himself of relying heavily on the unstoppable progress, and the authority of Western culture. Its domination was a platitude taken as a kind of universal system of plenty best for adoption by all humankind – rather a difficult concept for our post-modern existence.

A lot has changed but panacea of progress through science and incantation of nationality still represent powerful movers of present day realities – both relics of the past era of modernity based on ideas of the Enlightenment.

BLESSED ENLIGHTENMENT

It is still science that currently controls exclusively the process of understanding the realities in the world around us, and it is a blessed outcome of the Enlightenment that there is no esoteric basis for the State. The State, as we know it nowadays, is conditioned by secular morality. This defines parameters of authority for the state and as such creates grounds for plurality, patience, and tolerance. But nowadays, aware of the environmental risks and possible disintegration, we have little use for any secularisation that would annihilate our hope for future – we have to face the insidious entropy of the world shrinking resources, both material and spiritual. A trust in disinterested knowledge, in which objective description might not only complete but also exclude individual understanding, does not represent any science but a bad philosophy (J Habermas).

11-09-2001 PHENOMENON

There is no doubt that a belief in reason and distrust of superstition is the key to human knowledge, but we need more than a traditional sense of religious tolerance. After the 11th September 2001, we need religion to be not only tolerated but also faced with an action of decision. A new balance between forces of knowledge and belief, rationality and feeling is to be found. We do not need to revise the Enlightenment concept of communicative reason. We need to redefine hierarchies in which the open reasoning could play its essential role. The role that is fatal to life or to success of sustaining human conditions for our existence. We exist in the world that has shrunk to a terrifying reality of a spherical body drifting in space.

An ideal of the United Nations has become an obsolete conception. An effective global co-operation and partnership development is more likely to develop within individual cultures than across cultures. Cultural liberalism is a naivety ready to be misused by many. This does not mean – on the contrary – that no effort should be made in identifying elements of culture commonality and learn the ways of coexistence. In fact the art of global coexistence represents a

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major intellectual and political challenge for the future. Our world is made of knowledge but we should be aware of the fact that the dominance of this cyberspace has been challenged. It has not been attacked by a kind of cyborgs equipped with out-of-this-world arms, which in our view might be perhaps somehow a pervious option, but by people of simple belief, who in a self-annihilating rapture fight the system by its own means – technology.

NATION STATE MODERNITY

The Enlightenment explored and discovered a kind of truth that was and since then has been independent of any denomination and context. A kind of on mathematics and geometry based rational thinking was discovered on which the modern Nation State was founded and developed through the course of the whole modernity. A temporal, colour-blind State (M Lau) or Hobbes's mortal God was structured as a by-product of a bitter endeavour to find an agent, which might terminate the painful presence of unceasing religious conflict. The concept of the Nation State and the existence of laity public stood very closely to each other. The modern sovereign could no longer derive his/her authority from God. In an effort to stop the endemic, religion motivated fighting; he/she was forced to found their authority on the *vox dei* of the *vox populi*. The latest movie Gloriana (UK, 1996, S Kapur), Elizabeth, stylised herself a virgin – what absurdity – and married the (English) Nation. The offspring of this peculiar Immaculate Conception has been the modern Nation State.

The evolution of modernity and its form of supreme social organisation – The Nation State – has been reflected through the process of technological advance which depended on coal-mining energy, metal-working materials, and later towards its closing stage at end of the millennium, on the processes of electro-magnetism and chemistry largely based on energy of fossil fuels. It is now claimed that the Net of Cybercommunication is creating a new social organisation and economy paradigm. This may well be the case. Nevertheless the benefit promised by the Net cyberspace of innovative technologies can only be realised by changing the ways of educating for working in a fundamentally changed landscape of culture. Re-organisation of education as such, and engineering education par excellence are central to emerging digital economies and newly constituted social organisation.

MODERNITY IRRELEVANCY

We still tend to think of nation states as principal movers in global affairs, and the economic development as a principal grouping criterion for such states. We tend to divide world along the lines of economy of nation states. This mercantilist and nationalistic benchmarking is the legacy of the Enlightenment and the ensuing advance of modernity not older than a few centuries. It is a specifically Western point of view, which, with the end of The Cold War, has become irrelevant. "It is far more meaningful now to group countries not in terms of their political or economic systems or in terms of their level of economic development but rather in terms of their culture and civilisation", (S P Huntington). This might have been just an opinion before the 11th September 2001 but it has been since rather a plain, and painful reality. People, institutions, and even states redefine their identities, which also any institution of higher education or for that matter engineering education cannot avoid. For many universities this may well mean the return to the original state of affairs, when they identified themselves and made partner alliances rather on terms of culture identity than of allegiance to a nation state government. For many technical universities as heirs of modern progress, this phenomenon may represent a shocking novelty. That engineering education might be looked upon or in any way qualified in terms of cultural identity - this might seem absurd to many. Nevertheless a simple fact of irrelevancy of nation state or single ideology identification exists, and it should be faced and dealt with. This concerns also the basic differences and fault lines between various cultures and inherent risk of possible conflict. The fact that WTC-terrorists received their higher education in cultures they wanted to destroy cannot be ignored as collateral occurrence. The technical knowledge is no longer inert and unbiased. Knowing something and related consequences of individual action are too serious that the right of control might be waived. Bacon's identification of knowledge with power is no longer a matter for a witty scholastic dispute. It is apparent that this implies serious ramifications for engineering education.

KNOWLEDGE SOCIETY

The volume of knowledge is presently doubling every five years. We are witnessing the process of radical and speedy transformation from an industrial to knowledge society. This is of tremendous effect on the whole of social organisation structures inclusive education and primarily higher engineering education. Current social reality tends to be organised on the information we have at our disposal – our knowledge, and the progress of nano- or biotechnologies may illustrate the looming paradigm, as well as the rapid development of digital infrastructures of the Net.

Contemporary societies are characterised by self generated structures and the capacity to determine their own futures. Knowledge is not just a constitutive element of current economic structures. It is rather a fundamental organisational principle of the way we run our lives (N Stehr). Generation, reproduction, distribution and realisation of knowledge – education – represent a corner stone of contemporary social order. That, who monitors and controls knowledge generation and dissemination, represents an authority, which can have a word in the process of regulating the rapidly growing volume of new knowledge, and which might influence the course of the current social order

transformation springing from knowledge as a basic organisational principle. Living in the knowledge society means that we organise our social realities on the basis of the state-of-the-art of our knowledge.

KNOWLEDGE SOCIETY EDUCATION – MANAGEMENT OF FUTURE

Within the knowledge society, the production of information is primarily directed to those standing outside the realm of science, rather than to scientists themselves. The knowledge society is characterised by the knowledge production; not by the modern science development. The production of knowledge is governed by the principle of uncertainty (D Schwanitz). Uncertainties are posed as problems, researched, and finally conclusions for action drawn. New knowledge comes into being by demoting the current knowledge. This is made feasible by the dialectics of theory and method. The method is chosen in accordance with a certain theory. The theory is modified after the methodical scrutiny of the researched data. Such a dialectics represent the starting point for research project development that dissolves the given problem into independent data of free combination. New knowledge is produced by uncertainty and solving of self-posed problems. The production of knowledge manages and sets down future development. Research programming and hypothesis assertion operate with future. Fatality is being transformed into a calculable risk. An equal footing of knowledge with future results in a massive acceleration of knowledge production. But the flip side of this innovation rush is that the standing knowledge becomes even more rapidly obsolete. What calamity for gowned academic dignity! The positive outcome of the predicament constitutes life-long learning, and re-learning, which is of critical importance for managers of knowledge generation and propagation – universities. Education has become of supreme importance but it is no longer a luxury. It is a precious commodity for the wide global market. Concretely: the topicality of engineering education is constantly jeopardised by progress of speedy innovation. In such a situation, the engineering education can no longer rely on structures of ready data transfer but they should rather concentrate on teaching methods for new data acquisition. Education should teach learning. Not the information *per se* but abilities of choice, evaluation, and targeted data employment are key qualifications for the state-of-the-art information acquisition in the knowledge society. Technical abilities are not enough. Only contextual abilities of content are fit to manage the World Wide Web information deluge of the Net.

ENGINEERING EDUCATION SUCCESS

Social and material access to education *per se* does not guarantee that the education will be accomplished. Education is primarily a cultural problem. It is a problem of

an adequate format for data acquisition, as well as their generation. Graduate's individuality, self-direction, and self-reliance are of paramount importance. The post-modern engineering education should aim at developing such a graduate's character. Only a person who is flexible and at the same time target oriented can find his/her bearing in the chaos of the Net data flows. Only a target focused, robust individuality has courage enough to jump from one information island to another. *Hic Rhodos, hic salta* and in the process unite the variety of media, contents, and your own interests. It would be silly to rely solely on traditional canons of engineering education or any traditions for that matter. The knowledge society has no precedent and cannot rely on any tradition. Punished in Hades for their "modern" sins of modernity, the state-of-the-art engineering education should prove their relevance always anew in a Sisyphean manner, again and again laying down and constituting its authority.

IMPERATIVE

Future oriented engineering education means not only the development of rational thinking, logical analysis, and action directed conclusion making but also facilitating of understanding the functioning of complex social systems. Technological education should be brought about within the wider context of not only economic and environmental – which are usually single concessions to humanities nowadays – but also cultural realities in the widest possible sense of the term. Not *divide et impera* but unite and govern should be the imperative of the future oriented engineering education.

EXIGENCIES

Structural rigidity of higher education based on the authority and financial resources of the nation state does not correspond to dynamics of present culture development. Institutions of higher education need to be de-nationalised, as they need freedom for employment of their resources in their effort to reach goals set by regional and global standards. These standards do not depend on academic hierarchies but derive from result-oriented responsibilities. Instead of stiff hierarchies of faculties and department/insti-tutes, flexible co-operative interdisciplinary network based structures should be developed at universities that would act on current demand and customer need. That teacher is a university professor, who has got palpable result represented by research and human capital amassed. Not that one, who has been smart enough getting round all hurdles of academic career code. And a tangible result is not a verdict, which a highly learned body after V.S.O.P. deliberation has settled on, but a vivid outcome that makes for professor's, as well as his university well being – a flexible managerial organisation independent of Sate subsidies or any paternalistic support. Middle Age ceremonies and organisational principles of the Modern Nation State have no

place at future and globally oriented post-modern institutions of higher education. This concerns also performance and efficiency of university self-government. It represents a subject for hot controversy, as an inalienable academic right. Nevertheless a simple truth is that universities need no "dignified" government but an efficient management.

LINGUA FRANCA COMMUNICATION

The most important feature of the looming complexity of the digital economy and social organisation is the human individual creativity and ingenuity unleashed by education organised on principles of the Net functioning, and information technology development.

Future oriented engineering education should aim at teaching a graduate, who is able to act in a way of an independent craftsman, rather than educating somebody, who is about to join a rapidly disappearing world of assembly line shop floor or office. Future oriented engineering education should teach a graduate, who is both an engineer and entrepreneur skilled and self-reliant enough to move freely in the global communication cyberspace of the Net. Such free movement without a lingua franca is tantamount to an option of Fata Morgana, and engineering education without a foreign language component on a par with technical or any other "classical" engineering subjects would represent a major hindrance to the development of meaningful engineering curricula. A mirage of nation language autarky guaranteed by the State is a serious obstacle on the way of an academic trying to develop contemporary engineering curricula, as he/she is unable of making good use of the opportunities offered by the existence of worldwide digital infrastructures of the Net. The emergence of digital economy and social organisation rooted in the global transportation and communication of the cyberspace asks for creating a new form of higher education. The education that would spring from local community values of family and region but which would be fit to participate in the global culture of co-operative alliances.

EMANCIPATION THROUGH KNOWLEDGE

State-of-the-art engineering education should be aware of the need to teach digitally literate, innovative graduates able to operate independently in the cyberspace of global culture. To teach a traditional engineer is rather out of date. A cyberengineer – definitely not a cyborg – should be the imperative of any current engineering education.

Scientific or technical knowledge generated by engineering education is primarily the ability to act, start something going. As such it is obvious that not the reduction of our capacity for action is presently radically transforming the institutions of the standing social order but on the contrary, a tremendous expansion of the same action capacity comprises a need for change as it generates a seemingly absurd sensation of social stasis – inability to affect any sensible action in the dazzling light of too many

options. Politicians, theologians, philosophers, and social scientists often argue that people lose the capacity for action in proportion as science and technology triumph. This triumph allegedly reduces individual's capacity of participating in society and fosters isolation, invading people's privacy and generating a sense of helplessness. But actually the opposite is true. But the flip side of emancipation through knowledge is the risk posed by the emancipatory potential of knowledge. The increasing spread of knowledge in society and the concomitant growth in opportunities for action also generate social uncertainty. (N Stehr)

ENGINEERING EDUCATION RESPONSIBILITY

Technological knowledge implies material and action power - not only for super powerful states. The 11th September 2001 has taught us how fragile such super-power can be, as reflected by a technologically educated individual of different culture beliefs. "It is obvious nowadays that a single superpower – not even the untouchable military and technical superiority of the United States – is in the position to control the whole world" (E Hobsbawn).

We no longer need science & research pure or technology *per se*. What we need is a responsible scientific research and a reflected technology. Contemporary engineering education needs to reflect the changed situation of knowledge acquisition in the changed realities of the current global civilisation. Science, technology, and engineering education are no longer protected by ideology of modernity. Ideology as the "objective" description of the way leading to future paradise, which in fact very often proved to be a horror scenario, is dead. "Ideas no longer can substantiate practice but only the unyielding practice acknowledges the accuracy of ideas" (R Burger). Post-modern realities ask for redefinition of means and goals for knowledge acquisition and its proliferation. Also the engineering education should face the challenge of finding the right balance between knowing and believing, and balancing the weight of these two; the value of knowing is that of a commodity only without a dash of transcendence. Humanisation and consistent application of multidisciplinary approaches to curricula development, as well as their implementation, are needed. Parallel, unaffected existence of human and technological sciences outside transcendence in the right meaning of the term is no longer relevant. We still may tend to assert Helmut Schelsky's view: „ … in the face of technically guaranteed truth, all opposition is irrational" to be the case but we are obliged to come to terms with such irrationality. We are obliged to define our culture stance. A sustainable culture defines itself not in contrast to nature as a separate existence. Our culture is nature, as we know it.

CONCLUSION

It is obvious that post-modernly oriented action and initiative in the field of our deliberation ask for major

revisions to the current university management and organisation structure. It is not easy to expand the traditional HE dual mission of the modern society - education, research - for the third, urgently needed post-modern aspect of technological service to the immediate post-industrial environment of the knowledge driven economy and society in which universities operate. It is not easy to ask academics to be practical. A lack of practical-mindedness in a professor character is proverbial and a quality that many academics understand as their species right.

The post-modern university asks both for independence and global orientation, as well as close relationship to local condition and region that mediate realism and counterbalance the abstract character of too broad decision-making process.

The first step is to denationalise the university that means not only its transfer from public to private ownership but rather dismissing its nationality or national characteristics. University academic freedom is a must, which should be accompanied by economic independence from the nation state. The second logical step is to develop a university third dimension in technology transfer, making it dependent on the demand of knowledge and technology market. Within the knowledge driven economy and information society, the knowledge is increasingly less produced for the sake of university science alone, as the role of knowledge outside the ivory tower of academy is increasingly important and decisive for the welfare of the local community and the state in which communities function. Refusing to comply with the course of post-modern societal and state organisation change would bring university to the significance margin and degrade its impact to that of secondary education. This is valid for any university. It is twice as valid for technical universities and as a consequence for the engineering education as a whole.

We need to work for the conflation of art and sciences, humanities and technical subjects that would produce something, what the post-modern, post industrial society needs: posthumanities (J Grigely). A new HE structure, a new interdisciplinary institute of higher education, an institute for posthumanities is needed. To work for it means to fight the omnipresent anxiety of interdisciplinary approach, which is a very real anxiety, as it goes against the grain of traditional university culture based on the ancient principle of *divide et impera*.

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