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TECHNICAL DEVELOPMENT — SOCIAL MODERNIZATION*

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Ladies and Gentlemen!

Many thanks for the occasion provided by the Faculty of Natural and Social Sciences to the Rector to say some words and to have the right to outline my views as a coachsmith among social scientists. I have talked to my friend Mr. Hronszky several times about the possible subject of my lecture at this Conference. First I thought that I had held a lecture with the title 'Traffic Environment — Engineering Responsibility' on two international and on one university conference in Summer in London and Liverpool, then in September in Bucuresti. I would pursue further this line of thoughts in this Conference, too. In the meantime I attended several other conferences and participated also in the European Rectors' Conference. I know that this topic is too narrow and rather specific for this conference, and the complete lecture text is available for the participants, so I decided not to read this lecture.

I try to compile another lecture with the slogan technical development — social modernization, the slogan selected as title for this Conference, however, I add that with the eyes of a coachsmith. Would you, please forgive me in advance for possible incorrectness in terminology like which the social scientists do not, however, I think that thoughts are important rather than correct interrelations or terms.

I often say to my students that they should not focus on what I write on the blackboard and should not focus on what I say because I can make errors, my thoughts are important, they are surely right.

As to technical development and social modernization I am going to divide this lecture in six small topics.

First topic: The world as I see it.

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Second topic: How can mathematically be described the world as I see. Do not panic, I am not going to write differential equations, although I like them.

Third topic: What does this new world mean for the engineer?

As fourth topic I would describe what this implies in the content of training, as fifth in form of training and as sixth in spirit of training?

1. What is the World like with the Engineer's Eyes?

The world is small, finite and all its processes have accelerated. By this I mean also that half-life of our scientific knowledge extremely shortened making today on some scientific fields only 2 or 3 years. In some conservative scientific fields like civil engineering the half-life may be of 10 years. However, in comparison with the former half-life of 50 to 100 years these 10 years demonstrate also a huge acceleration. The acceleration is indicated by the fact that new branches of science, new disciplines arise and these fields require sooner or later new departments and faculties. It can also be seen at the Technical University of Budapest where number of faculties increased. When number of faculties does not grow then at least their name changes, e.g. Faculty of Electrical Engineering and Informatics. It incorporates the idea of separation, i.e. within a reasonable time the independent Faculty of Electrical Engineering and Faculty of Informatics will work separately.

Acceleration is indicated by the extraordinary fast flow of information transferred by fax, telex and phone at an extremely high speed. It means that a stock exchange crack in New York will be known in Tokyo in 6 hours. Technology develops very quickly, you cannot find a place in the world without consequences, plagues or benefits of technology. Both in Papua's island and in the North Pole with Eskimos you can find cans thrown away. Travel time also shortened, you can meet anybody within 24 hours wherever throughout the world in person, too.

The emergence of new management and development policies indicate also acceleration. Today, many companies declare that there is no secret in development, production and technology. Everything can be announced, published and demonstrated to all persons having interest in it. There is nothing confidential because development is so fast that by the time the competitive company learns it and is going to introduce it (because of delay slip) the factory having demonstrated it is by two steps ahead. Maybe it is not general practice yet, however, such a factory exists and I can nominate it. It is Cumins in the USA that do not hide any result in motor development and are ready to demonstrate any development laboratory,

research institute or design office at any time. This openness will sooner or later characterize the other branches of industry, too. This openness is necessary because the other side of the question is that the finite and shrunk world raises a lot of problems that should be solved for the sake of the whole mankind, and company secrecy greatly hampers it.

How does the shrinkage of the world appear? It appears in mass application of technology. We can cite shocking data: The more than 5 billion inhabitants of the Earth use at present half a billion cars. Half a billion vehicles are operated by fossil fuel and contaminating the environment, although everybody knows that fossil energy resources are finite and so are the other raw material resources, too. In these technologies, very high performances are present, and specific performances are on increase. I mean, of course, not only vehicles but also power plants demonstrating further contamination for the world. I think not only of the well-known air pollution, soil and water contamination which are, of course, rather dangerous, but also of the heat pollution. Efficiency of this huge energy hardly reaches 30 % in the case of power plants, and efficiency of vehicles, road and railway traffic makes optimistically 18 %. However, if we conceive of unloaded condition of utility vehicles in return cargo as full loss, then this efficiency seems to be rather overestimated. The real value is about 9 to 10 %, and it is extravagance.

Shrinkage of the world is shown also by trade co-operations as outlined by Minister Pungor earlier at this conference. General Motors will produce 200 000 diesel motors in Hungary. Ford are going to introduce spare part production supplying not only the European market but also meeting overseas demands up to some extent. At the beginning of the Suzuki co-operation, share of Japan spare parts was about 60 %, and in the future the Hungarian share will constitute 60 %, however, 40 % continue to be imported for a long time. These indicate that the world has become finite, industrial co-operational processes are closely interrelated.

2. Some Properties of the World's Mathematical Description

Full mathematical description of the worldwide economic — in wider sense — social processes seems to be hopeless. We do not even try to set up differential equations for the complicated phenomena, and presumably the modern economic and social science will not be able to formulate them within some centuries either.

Although setting up the characteristic equation is hopeless of it some properties can a priori be determined. On the other hand, by our knowing

some properties of the equations, some essential properties of the possible solutions can also be estimated — based on our mathematical experience.

Foreseeable properties of the hypothetical characteristic equation:

- The differential equation will be partial (space and time dependent).
- The equation system will contain a lot of variables.
- The differential equation will surely be nonlinear and retarded.
- Process of outer stimulus (including also natural effects) is stochastic, however, probably not ergodic and not stationary, Gaussian character of the process of the stimulus can surely be excluded. In the short run, the stimulus may possibly be regarded as nearly stationary and ergodic.
- Boundary conditions to be considered when solving the equation are — because of the world's shrinkage — finite instead of infinite. (There is no infinitely far point in the world.)
- We do not exactly know the initial values to be considered when solving the equation, they can only be estimated.
- Constants (actually, slightly time-dependent variables) of the differential equation are not known sufficiently. They can be taken as probability variables (unknown distribution function), or handled possibly by interval-algebraic methods or fuzzy estimation.

Based on the above characteristics, some properties of the possible solution can well be estimated:

- The describing differential equation, and thus the world's economic and social problems have no general solution valid for all boundary and initial values.
- Because of the great size of the equation, the solution is confusing and is complicated to handle. (Too many variables should be simultaneously examined in their interrelations.)
- Because of nonlinearity, small changes of the initial values (=small uncertainty) result in huge change of the result (=chaotic phenomena).
- Likewise, uncertainty of constants (parameters) can result in chaotic phenomena.
- Due to to the presence of the boundary conditions in the finite region, the solution is getting complicated and inaccuracy of approximative solutions is increasing.
- Due to retardation of the differential equation (due to delay in decisions), stability of the possible solution is threatened.
- Due the nonergodic and nonstationary stochastic stimulus, the task cannot be handled; in this case, effects of one given realization can

only be followed in function of time. The solution's stability can be lost in long term.

- Because of the nonlinearity of the equations as well as because of uncertainties in the initial values and parameters, drastic interventions should be avoided in social and economic life. For example, peace treaties after the World War I resulted in instability observable also today.

Summarizing: Economic (and social) problems of the world seem to be solvable only very carefully and by the tactics of small steps. The next step (or direction) can be chosen upon thorough analysis of the consequences of former ones. Otherwise we can always bring about chaotic situation or instability.

History presents numerous examples for such instable and transitory situations.

From this mathematical analogy, it is obvious that past events cannot serve as examples for solution of present problems because of different initial and boundary conditions (in spite of all similarities). You cannot step twice in the same river.

3. Engineering Tasks of the Rapidly Changing World

What does this accelerated and shrunk world mean from the point of view of the engineers' tasks?

Engineering solutions saving material and energy are of extreme importance. It implies that tasks should be formulated and solved with by magnitudes larger care and precision, otherwise we cannot speak of actual material and energy savings.

New tasks and new problems arise in material recycling indicating a completely new dimension in engineering thinking. We got accustomed to sharing engineers' responsibility. The first engineer is only designing, the other ones are engaged in realization or technological design. At present, engineers cannot be satisfied by this vertical division of labour, they have to think both of design, realization, utilization and also the condition after utilization. The constructor has to ponder also the question of waste materials. Let us take into consideration the half a billion vehicles a great part of which is older than 20 years and will soon end up in a junkyard in order to allow to replace them by another one billion new vehicles. (The half a billion cars increase yearly — because of the 50 million new ones — by 30 million vehicles surely.) Beside of precision, this requires a rather developed comprehensive view and moral power allowing him to enforce his conviction even against corporate, enterprise, private or state interests. A

company may not be interested in a solution saving energy or in a durable product which can be recycled. In most cases, companies interests are the opposite, they want others to buy from them other new products as soon as possible.

4. What does the Changing Task Mean in the Content of Engineering Training?

Accelerating time means rapid obsolescence of the teaching material. New disciplines and completely new educational programs appear. Necessity of permanent further training was only a marginal phenomenon earlier because the university is not able to train up-to-date specialists. The teaching staff itself is not able to keep abreast of development in science and technology. There is always a time slip between the university education and the current stage of science. Knowledge of students is always behind that of lecturers. It calls for permanent further training, which does not necessarily mean organized forms of education, it may also be self-education.

In this way, what is the task of the universities' graduate programs? It has to provide lasting fundamentals both in knowledge and approach.

In which fields? First of all, in the field of natural sciences comprising Mathematics, Physics and Chemistry and some of their subsections. I know that also natural sciences are changing, however, its speed is slower than that of the technical applications. Some time will pass until engineers will design fusion reactor either in Hungary or abroad. From engineering aspect, from the aspect of the technical application, fundamentals of natural sciences can be regarded as a stable basis, their scientific results can surely be retained and used by the engineers for a long time. (Physicists are probably of different opinion, many of them say that Physics is also accelerating.)

What can we offer in addition at the Technical University of Budapest? We have to offer students engineering and professional knowledge, like procedures, technologies, material science, computer science. All of them can be classified as elements of engineering knowledge irrespective of the fact that every field can be conceived of as an individual discipline. In the creative engineering work, however, they appear mostly as trade dodges. These fundamentals should also be learned even if we know that they also will change and will be replaced by other new techniques and methods in the engineer's activity. It is a significant part of the permanent further training, too.

Finally, as third component — as necessary and sufficient condition of stable support — economic, organizational, management and legal knowl-

edge, which are indispensable for an engineer in the future market economy. Every technical activity will have its financial consequence (and it will be a measurable dimension in a market economy), i.e., if the engineer neglects this aspect, he will perish. The Technical University of Budapest is in this aspect again exemplary. The oldest curriculum I could say dates back to the epoch of Rector József Stoczek, and already this curriculum contains the subject Economy taught in all Faculties and Sections. We have to go on with this tradition by all means, i.e. economic training should be an integral part of the engineering training like the past.

Content of the teaching material can sufficiently be realized in the training only if at the Technical University of Budapest, science is taught by scientists, profession by masters and economics by businessmen. Persons who reached internationally acknowledged results in science, who proved their professional abilities in their works, and businessmen who made a lot of good bargains.

5. Form of Engineering Training

What does it mean in the form of education? The University has to be flexible. Freedom in studies should be provided for both students and lecturers. Free choice of lecturer, however, the student's choice should also be there. The individual work should predominate over the small group exercising lectures like in the primary school. From the turn of the century, proficiency in two foreign languages will be indispensable in Europe.

These are not my own words, it was formulated in the Conference of European Rectors last year. After a long discussion, where I was present, a Dutch Rector declared that two foreign languages should be spoken. If mother tongue is a German language, then the two other languages may be chosen from the Latin or Slav languages.

Open laboratory, experience abroad for students. The best 10 % of students in the 5-year training have to spend one semester abroad by all means in order to study and pass exams in original foreign language environment.

Postgradual students without exception should be sent abroad for doing research in original foreign language environment.

6. Spirit of Engineering Training

What does this changing world imply for us in the spirit of engineering training? I think that engineers' responsibility has essentially increased and students should be made aware of this responsibility. Responsibility

has grown in terms of law and economy (both in micro and macro economy). New ideas have arisen in the engineers' responsibility, e.g. ecological responsibility which is more than environmental protection, it means active responsibility. Engineers' task is to avoid ecological problems rather than abolish present environmental problems. It implies also moral responsibility. We can discuss the question whom is the engineer accountable to: either to himself, to his company, to his environment, nation or society. It is everybody's own competence to determine the limit of responsibility, which limits are allowed by his moral. If we succeed in training students for responsibility, I hope that engineers will get also competence and right to say their opinion on world's problems. I am not sure whether this right exists at present de facto or not.

Everybody knows the Greens' philosophy: Engineers have spoiled the world. Therefore professional knowledge and environmental protection exclude each other, thus, engineers are not competent in questions of environmental protection, on the contrary, lack of all professional knowledge qualities anybody to solve environmental problems. You need not ponder the risk of a measure, realization of environmental protection should be dictated by the opinion of the public. I would not cite examples (from Budapest) where inhabitants of a street want people living in another street to breathe in pollutions of exhaust gas. I understand it, I would also prefer living in a cleaner environment, however, anger, emotions and different private interests obviously cannot decide in these questions, only the cool engineering professional knowledge can make these decisions. Engineers are competent, however, they will get also the social authorization for it only if they really have a deep sense of moral responsibility.