UDC 378.22:005

# Systemacity as a leverage point for Engineering Education Reformation

*National Research Tomsk State University*
***F. P. Tarasenko***

**The author supports the idea of Russian Engineering Education reformation and underlines the importance of systemacity in engineering education management, in particular in professional paradigm of future engineers. Possible provisions of the developed Engineering Education Doctrine are suggested. These provisions are focused on systemacity in some kinds of activities in engineering university.**

***Key words:*** *engineering education, systems thinking, design thinking, systemacity of practice.*

**F.P. Tarasenko**

More and more figures of Russian higher education are alarmed at quality of engineering training in Russia. They evaluate it to be in a crisis state [1]: challenges of social and economic environment and inner changes in higher education system have caused problems that need to be urgently solved. The Russian Association for Engineering Education put forward an initiative to start development of "National Doctrine of Engineering Education in Russia" [1, p.p. 50-65].

Basic condition of any successful guided influence on a social system (no matter if it is some corrective actions, reform or crucial system change) is the correct correlation between the level of effect design systemacity and the level of problem complexity. If the level of management systemacity is higher than the level of problem difficulty, the aim will be achieved; if the management is not systematic enough – we'll fail. (In cybernetics this condition is known as law of requisite variety). Neither inner and outer enemies nor unskilled executors (or Mother Nature's ironies) are guilty in management fail or in unsuccessful reforms. All these and many other factors should be foreseen in the process of systems intervention design. The requirement for necessary systemacity also refers to the development of the basic engineer's competence - the ability to solve engineering problems: to design and implement technical and human-machine systems.

Thus, Y. Pokholkov's opinion that systemacity should be a necessary component of the future National doctrine is quite reasonable [2]. Not only should systemacity be implemented in the intended improvements of the engineering education but also the curricula of engineering specialities should include subjects that encourage and develop engineering systems thinking ("Applied Systems Analysis", "Systems Engineering", "Methods of Engineering Creativity"). Systemacity is one of the most powerful leverage points to influence any system [3].

A multi-purpose technology of systems problem-solving in real life, which has been developed in applied

systems analysis for the last 50 years, is practically implemented in the form of interactive planning [4], or idealized design [5]. It is not a professional systems manager ("moderator", "facilitator" or "coordinator") who develops and implements a problem-solving plan: he/she doesn't have neither necessary information nor resources. The only thing he/she knows is what questions are to be asked in the process of design. The answers can be given only by all participants of the problem situation together. They will design themselves the future they want.

Engineering education doctrine is a target part of the education paradigm; it is a starting base for planning and implementing engineering education reform. The doctrine contains crucial problems of contemporary engineer training system, aims and objectives of the suggested reform and the ways to achieve them.

Completeness and accuracy of all the models constituting the Doctrine are significantly important for reform success. Mistakes in the used models cause failure of the planned reform. For example, the famous endeavors to solve such problem as alcohol addiction at the state level (in the USA – the beginning of the XX century and in the USSR – the end of the XX century) were in vain because of insystemacity of the planned interventions. These interventions were not improving ones, which is the condition of systems problem-solving. The engineering reforms can also contain mistakes in the working models. The example is a modernization program started by the ex-president and now Prime-Minister, D. Medvedev [6].

The notion of modernization according to the program is connected with planning, development and implementation of only five types of hi-tech scientific innovations. They do contribute to society progress and are necessary components of its development. Nevertheless, only these components can not ensure the desired progress, because technological modernization is not a final objective but means to achieve a target of higher level. Modernization has to be carried out in different ways for different purposes: for improving people's welfare or for improving national defense capability or for ensuring competitiveness of some national industries after WTO accession. Thus, there is a confusion of ends and means in the formulation of the modernization tasks, which can lead to failure.

However, confusion of ends and means is not the only and the worst of the possible mistakes while formulating management aims and objectives. More risks arise when not all essentially required objectives are identified. (It happens if simple solutions are suggested for complex problems.) In such cases the implementation of simple solution not only fails in solving a complex problem but also causes new problems. Quite a number of contemporary reforms don't work for that reason. The same fate is destined to the modernization reform, if the objective of technological development is not supported by other, not less important, objectives.

The key point of the program implementation became a foundation of a super powerful innovative center Skolkovo (instead of investing these considerable funds into the existing scientific, technological and production centers and their infrastructures). A famous researcher of Russian science, American professor Loren R. Graham tells about Skolkovo [7]: "I think that the Russian leaders are making the same mistake as their predecessors. They want to create new technologies and machines (equipment, techniques) in Skolkovo. But the problem is not in machines (equipment, engineering), Russian scientists and engineers are still brilliant, the problem is in society. It is the society to be reformed. This is much more important than building an isolated territory of flourishing hi-tech." Russia has always been rich in innovative creators. A lot of breakthrough ideas were born in Russia (Polzunov –steam engine, Stoletov – filament lamp, Popov – radio, Zvorykin – television, Sikorskiy – helicopter, etc.), but they were accepted in Russia

only after their implementation and use in foreign countries. Nowadays, such phenomenon as "brain drain" shows the demand for Russian specialists outside Russia.

D. Medvedev's program article "Forward, Russia!" with the enumeration of prior directions of modernization ends with an invitation for "everybody who has something to tell to take part in the discussion". He offered people to e-mail him their comments on the topics mentioned in the article. In my letter I drew his attention to the fact that the program doesn't contain humanitarian component (direction) that is not less prior especially for engineering education, because hi-tech development and implementation is impossible without highly qualified personnel. Neither did I receive the answer nor noticed any changes in the program.

A lot of philosophers and educators, including L. Tolstoy, preached the idea that a humanitarian thought should be ahead of social development. French philosopher Claude Levi-Strauss expressed the same idea in the most radical way:" the XXI century will be a century of humanitarian sciences or else (otherwise) it won't be at all." Russell Ackoff [4] underlines that the highest level of human experience and understanding of reality is wisdom that determines the sense of any activity. The human history has developed criteria for conscious human behavior expressed by ethics, esthetics and morality.

Thus, an important element of engineering education Doctrine project [2] is the requirement to increase emphasis on humanitarian component in curricula of engineering training programs. Also it's worth thinking on the ways the engineering society could increase Russian managerial society's sensitivity to innovative ideas. Soviet experience of making scientists introduce their results into production turned out to be inefficient.

The Doctrine project [2] pays special attention to development of systems thinking (world perspectives) of future engineers, design thinking (perspectives of engineering activities), systemacity of practice (systems technology of engineering activity). The related disciplines should be included in the set of the required subjects of all engineering specialities curricular. (Besides, when being a Minister of higher and special education in the 80s, F. Peregudov introduced a course of systems analysis in the engineering higher schools as a required subject. But this innovation was later rejected due to the mentioned above close-mindedness of Russian practical paradigm.

However, the phenomenon of close-mindedness has not only national but also panhuman components. Not long ago three American universities conducted large scale socio-psychological experiments with managers of different levels from different enterprises [8]. The research covered more than one and a half thousand leaders of commercial, engineering, research, educational, political and public organizations. The people under test were suggested that they should give their personal evaluation of a particular situation. For example, they were asked to guess how much money is contained in a glass filled with coins of the same denomination. The suggested sum were noted, and every participant was informed about the sum suggested by other participants (and real sum in the form of subjective evaluation). Then all the participants had the opportunity to correct their evaluation taking into account other opinions. The results were also noted. The results of every experiment participant were correlated with his/her power status (characterized by the number of subordinates, degree of influence on their behavior and power hierarchy level). It turned out that self-confidence, immunity to other people's advice and errors in decision-making are related to power level by monotonically increasing dependence (it was noted that this dependence is weaker for leaders-women). No wonder, that M. Gorbachov refused R. Ackoff's offer to work on Nagorny

Karabakh problem, and later V. Chernomyrdin rejected a meeting with a group of Nobel Prize winners in economics who suggested discussing Russia's problems in transition to the new social and economic order.

One of the Doctrine's objectives should be increasing systems level of senior executives' mentality. Most of these personnel have engineering education.

While developing the Doctrine, it should be also taken into consideration that sustainable development of any system depends on its ability to adapt to inner and environmental changes. That is why the Doctrine should provide the development of an adaptation sub-system and the possibility to learn from its own experience in the frame of organizational structure of engineering education system. A principal scheme variant of such a sub-system is suggested in [4].



## REFERENCES


1. Engineering Education, Extraordinary Issue of Journal. Association for Engineering Education of Russia. 2012. Issue 10, p. 104.
2. Meadows, D., 2011, Places to Intervene in a System// Problems of Governance, Vol. 2, issue 4, p.p. 6-21. (only in Russian)
3. Ackoff, R., 2006, Management in the 21st century. Re-Creating the Corporation. / Ackoff, Rassel L., Tomsk. p. 417. (only in Russian)
4. Ackoff, R., 2007, Idealized Design, /Ackoff R.L., Addison H., Magidson J. Dneporpetrovsk, p. 265. (only in Russian)
5. Medvedev D. Forward, Russia! [Electronic resource]//Gazeta.ru. Moscow, 1999-2012. – URL: http;//www.gazeta.ru/comments/2009/09/10_a_3258568.shtml, free. – Title from screen (reference date 10.12.2012). (only in Russian)
6. Graham, L., Technologies in Ideological Trap: [interview written by Vaganov A.]// Independent Magazine.-2011.- 28 December.- p. 10. – (Science; issue №17). (only in Russian)
7. The Detrimental Effects of Power of Confidence, Advice Taking and Accuracy / See K.E., Morrison E.W., Rothman N.B., Soll J.B. // Org. Behavior and Human Decision Processes.- 2010.- Vol. 116, №2. – pp. 272-285.