Ways of Creative Components Improvement in the Engineering Education

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Abstract - **The process of engineering design includes the three most general to the type of activity: invention, engineering analysis and acceptance of decisions. It is necessary to strengthen education in the first direction of future activity by transiting from „reproductive teaching" to „creative" one.**

Keywords – **creativity, methods of creative activity stimulation, inventiveness.**

I. INTRODUCTION

Mainly «receptive approach» lies in the basis of the modern system of the engineering education, when designing products and technologies is based on attachment and adaptation of the known technical solutions. Mainly exactly such typical engineering tasks are proposed to students in the course and diploma projects.

However in engineering practice (especially in the conditions of market economy) often there are the cases, when neither of the known technical solutions dissatisfies to all requirement specifications and it is necessary to put and decide creative engineering tasks which are related to the search of more rational and new technical solutions, that are often patented how the inventions are.

Prestige of engineer in a concrete enterprise and in society is determined, above all things, by the results of his technical creation. According to the documents of UNESCO "in the general case a worker is named an engineer, if he is able *creatively* use scientific knowledge, design and build industrial enterprises, machines, equipments, to develop either to apply production methods, using different instruments separately or in different combinations, or construct these instruments, to use them, well knowing principle of their action and foreseeing their behavior in definite terms."

Among the main tasks of the program of the considerable upgrading teaching in NTUU "KPI" there is the task of transition from „reproductive teaching" to „creative" one.

What is a creativity in general and engineering creativity, in particular? *Creativity or ingenuity* is the process of still human activity that results in creation more high-quality new material or spiritual values. Creativity presents by itself arising up in labor ability of man from material, that is delivered by reality, to create a new reality which satisfies to the various public necessities.

II. CREATIVE PERSONALITIES

Psychologists paid enormous efforts, trying to analyze in a clean kind this capacity of man for creativity and find a measure for it.

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Different tests showed absence statically meaningful dependence between ingenuity and degree of mental development of the higher defined minimum value. But definite correlation is set between ingenuity and *receptivity* of people, that expose grounded curiosity in the relation of things and that, as they operate . More receptive people quick enrich the experience, they see anymore, hear anymore, anymore know and anymore memorize. In a counterbalance to them the *sensible* men, which on any occasion decide, "as it must be", limit application of the knowledge by the judgments and, consequently, hinder to development of the capacities for the invention.

In addition, people are divided into two groups on the type of overwhelming character of perception: realized and intuitional. People with the *realized* perception in greater mayor are oriented on the real world and on the five senses, people with *intuitional* perception - are oriented in a less degree on the real world and tried to be anymore laid on the intuition in "vision" of things and phenomena. Intuition means the search of meaning

, hidden after the external displays of reality. Vividly speaking, intuition of specialist - it is a pointer strange sensible device, which constantly slides on the scale of possible and impossible, on the verge of bold dream and real fantasy.

People with intuitional receptivity turn out more inclined to the invention. In whole propensity to the invention stronger turns out at receptive people, at those, who aspires to knowledge, at those, who curious, who values theoretical and wonderful and whose sense and intuition are developed in a greater degree, than at his colleagues.

Statistical researches with application of the special tests have showed that only a few percents of population (10-15%) have the necessary level of the creative capabilities determined by genetic information. But a capacity for creative activity can be developed still at the enough considerable number of specialists (40-60%) in the process of individual developing the following qualities:

- curiosity, that is ability to look after outward things, to look on a thing attentively, to look closely how they operate, to search for the hidden elements and functions;
- ability to perform the engineering analysis, that is to apply powerful scientific knowledge for the comprehensive study of the phenomenon and object;
- technical knowledge, that is deep mastering of concrete engineering field;
- wide specialization, that is the ability competently and confidently to understand the basic problems of contiguous disciplines;
- mathematical skills, that is ability in the case of necessity to apply a mighty mathematical calculus and numerical methods;

- ability to take a decision, often in the case of vagueness, but at comprehensive consideration of all existent factors;
- knowledge of technology of production, that is understanding of possibilities and limitations of both former and new technological processes;
- ability to express information about the got results, that is expressly and convincing to express the thoughts orally, in and graphically written form:
- perception of criticism and no dread of influencing of authorities (by how quick a man makes to be sure, that he is surrounded by the same people, as he, so on greater creation he turns out capable);
- developing an ability to " rolling up "and " coupling " information, to its "transfer" on other object.

Therefore new technical solutions can be two types: heuristic and systematic. The *heuristic* solutions are created as a result of *"lighting" up*, when the most important part of creative process takes place in the brain of man and can not be logically got from his previous experience. They own to the people with natural creative capabilities. It is pity that humanity does not own the algorithms of such creative process, and even hypothesis about existence of World Data (the world informative field) Bank is existed , where new knowledge is borrowed from. The English physicist the theorist Roger Penrouze in 1991 on the base of Gedelya's theorem and Bora's principle of addition has proved, that the appearance of new knowledge explaining the structure of world is simple impossible without some Higher Force.

The *systematic* solutions are got as a result of the use of methods, which stimulate "creative activity". They are based on the realized procedure of search and achievement of solutions as a result of organization of thought. Technology of such systematic search of decision is directed on that a creative worker "thought aloud" and allowed to other will familiarize with his thinking process. Ability to trace the way of thinking is important property of creative personality.

We will illustrate possibility of organization of thinking by the example of decision of Poida's task, when it is necessary to bring from a river exactly six liters of water, having the two tub - one with a capacity in four liters, and other - nine liters (pouring water "on an eye" is not allowed).

We search the solution, moving from an end to beginning:

1) 6 liters can be in a greater tub only;

2) from a full greater tub it is needed to pour off 3 liters, that to leave necessary 6 liters;

3) second tub with by a capacity in 4 liters it is needed to transfer to a "three-liter" one by infusing into 1 liter at it ;

4) we measure one liter off, pouring off twice water from a greater tub into to smaller :9-(4+4)=1;

5) a liter, that remained, we pour in the small tub, and then from a full greater tub we pour off three liters of water in it.

First of all, university departments must to determine the possible articles of creation in the particular engineering field and to put them in course and diploma projects topics. For example, in an electronics and computing a new device or a new component can be the article of creation; a new property of old component; a new circuit; improvement of a existing circuit; a new method of computation; analysis of work and exposure of specific features of a circuit behavior; new properties of a circuit and their explanation; a new algorithm; a new program; a new construction, a new technological process; a new principle of action of device and etc

Farther during organization of educational process it is necessary to take into account factors, which affect on productivity of creative worker:

- Independence in the choice of subject (it is recommended to form the a list of themes for projects, to give students possibilities to choice a project theme and a scientific tutor);
- Motivation and infatuation of work (say, to take into account rating of student for different encouragements, enriching a self-training role due to shortening audience lessons);
- Microclimate in organizations (in the group) and type of a scientific leader;
- Influencing of colleagues (organization of constantly operating seminars is recommended with students presentations on to the chosen themes);
- Possessing the systematic methods of search of new solutions;
- Impulsive and absence of comfort (identical behavior), that shows up in independence of judgments, desire to argue, to defend the point of view, unusual for age of persistence.

III. CREATIVE PERSONALITIES TYPES

Teaching for creative specialists requires from the departments taking into account not only their scientific abilities but also their psychological types. It seems that there is psychological propensity to particular direction of research. The known classification by Gou and Wudvort subdivides creative personalities into following eight groups:

- *a fanatic* is the man taken by science or technique to self-oblivion, tireless, curious, for which scientific labor makes sense of all his life;
- *a pioneer* is an initiative type, a source of new creative ideas, a discover of new ways, beautiful organizer and teacher;
- *a diagnostician* is a beautiful, clever critic man able at once to find the strong and weak sides of scientific work;
- *an erudite* is a man with wonderful memory, who easily orients in different regions of science, but nature is not creative, he is easily tuned under other, more initiative scientists;
- *a technician* is a man, that is able to add a completeness to another's work, quite good logician and master of style;
- *an aesthete* is a man who likes the refined scientific decisions, a intellectual person, with a bit contempt looks on "thin hard workers";
- *a methodist* is a man who likes methodology, likes to make presentation and teach other scientists, although his own achievements not always are considerable;
- *an independent* is a individualist, who can not stand with administrative work, full of ideas, but not resolute in their implementation in the life; stubborn, feel legs, he possesses a sharp observation and an active mind, he most values possibility to work quietly, without another's interference.

As well as every, the given classification divides specialists into groups schematically and does not represent all variety of personality of scientists or engineers. Such distributing gives only the common picture of types of creative personalities. In the real life the psychological types of these personalities in a clean kind do not meet. Always there is an alloy few types with advantage of some from them. The any known scientist or designer always combines in itself few psychological types. That is an essence of his gift. A scientist is the most productive, if he harmonically combines together the features of fanatic, pioneer, diagnostics and independent.

IV. Developing of students creative capabilities

Methods which stimulate creativity and with are recommended for student study are based on logics. Their features:

1. The purposes of creative activity are known preliminary.
2. The criteria of quality and variables are determined in the process of designing.
3. The analysis of the formed situation precedes to the search of a new solution. This analysis is taken with the purpose of exposure of disadvantages, contradictions, clarifications of object.
4. Estimation of results of solution is built on the logical reasoning and appeared in a high-quality form.
5. Preliminary the strategy of successive receptions, cycles, and conditional branches is defined.

Before defined strategy does not forge the process of creation, it allows quickly finding banal and not very banal answers. The most known methods of stimulation of creative activity are:

- *method of brain storm* and its modification, that foresees the receipt of new ideas by creative collaboration of separate members of the organized group (a group as a sole brain storms the creative solutions of the considered problems);
- *method of control lists (convergences),* that requires answers to questions about the project, which are based on the solutions accepted earlier in one or a few similar situations;
- *the method of liquidation of deadly situations (divergences),* when essence of deadly situation is determined, all contradictions between the present solutions and design requirements are turned out, and the acknowledged receptions of resolution of such conflict by transformation of unsatisfactory solution are used;
- *the method of morphological tables by* Zvikki, which is intended for the foresight of still undone inventions or for determination of optimum selection of parameters, requirements, configurations of objects;
- *the algorithm of solution of invention tasks* (ASIT) by Altshuller G.S., which is folded in comparison of existent and desired (ideal) solutions, in determination of contradiction between them and removal of disparity between the actually existent and desired (ideal) solutions by the use of receptions of removal of typical technical contradictions.

The role the University tutors in teaching creative personalities is very important, there are some requires to them, namely, the personal examples of engineering creativity; acquaintance with foreign experience, presence of foreign partners on to disciplines which are taught; construction of the most effective form of "teacher-student" cooperation . But it is worth to take into account that teachers, as well as students, also are enough different. It is accepted to subdivide teachers as scientific leaders after psychological features on following five groups:

- *an optimist* is the defender of front-rank ideas, who embarks on any actual problems, sensitively reacts on the changes of requirements of life.
- *a neutralist* does not impose his thought to the inferiors, does not bound their initiatives, does not love alteration, but he is able to set and support the necessary business contacts.
- *a promoter* is talented, ironical, in a necessary moment he exposes the splash of life. But he does not generate his own ideas, however he can support original suggestions of inferiors.
- *a worker* is organized and disciplined, he hankers the same from employees, he goes deep in a detail, but in little things does not submerge, he is able to estimate that was done, he distributes the task between performers taking into account their professional qualities, he works intensively, but attains also much .
- *an administrator* well knows possibilities of people and is able to obtain necessary results from them. Not always understanding, that it is needed to do, he imagines expressly, what doing does not follow. He is apt for mastering of another's progressive idea, understands his value in its realization and he is convinced that without his support this idea will not implemented.

Young people do not often estimate the role of leader in forming theme or question for investigation. They do not understand that more heavier to see a problem, than to find its realization. For the first there is necessary imagination, and for the second only ability.

It is needed well to understand that a man never becomes a creative personality only as a result of the attentive listening lectures and implementation of educational laboratory works. The deciding role belongs to a man itself, his self-training and self-education on the basis of the own reasoning and personal experience. Teaching in universities had to induce him to do this and to create pre-conditions for this purpose. Such conditions for self-training can be, for example, provided by wide introduction of information technologies in an educational process:

- by creation of local department computer network and department Web server with information about a department, students, scientific achievements;
- by providing Internet access for every student for supporting the obligatory informative search in Internet during course and diploma projects;
- by placing on the educational server the library, that contains methodical materials for laboratory and course works, electronic copies of lectures, reference information, which are needed for work of students and teachers of department (for example, at the CAD Department of NTUU"KPI" such library contains near a 25 Gb information,

that is equivalent approximately to 1000 books by a volume 250-300 pages);

- by providing possibilities for students to locate own Web pages, to use of e-mail for the receipt of consultations, possibilities for the anonymous testing their intelligent indexes at their desire and other.

Creative engineering labor is many-sided, and the people of different characters and inclinations can find themselves in it. It is important for each to find that verge of future activity, that befits his individualities. The protracted attempts and errors are needed sometimes for a man to become a personality, to combine himself with a selected profession. Speaking about development of personality of future specialist, it is necessary to mean and professional, and public, and cultural aspects.

Knowledge grows into world view position of man, in his actions. Active participation of students in research conducted by departments is the necessary condition of the high-quality forming of their creative personalities.

V. Conclusion

It is a natural desire of universities, coming from a public necessity to assist in development of high technologies at the country, to multiply the percent of such talented pupils. But, in regret, there does not exist today and, presumably, never be the conveyer technology of mass production of creative specialists for engineering innovates. This is a substantially "manual technology" and it is possible only to increase *the percent* of its output due to considerable efforts. Therefore the joint concerted protracted work of university departments for conversion in the life of task of transition to the creative methods of teaching is very necessary now.

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