Tools and Methods of Innovative Engineering

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It is proposed to use non-traditional approach for engineering education, when the Sustainable Development Concept integrates with Systematic Approach to be used not only as the theoretic base, foundation and philosophy of engineering education but and as science for future experts activity strategy and tactics. The essence of our approach consists not only in that the future experts have seized the concept of sustainable development, but and in that this concept became base and system forming element of all basic disciplines and courses of lectures in system of continuous education.

Introduction

The 20th century entered the history of mankind not only as an atomic age, but also as an industrial age. In this century, thanks to scientific and technological progress, the population of the planet increased almost fourfold, but at the cost of this was the devastation of natural resources and pollution of the environment. Nevertheless, at the turn of the century, the leaders of most countries of the world decided to implement the Concept of Sustainable Development for each country. There is already a standard definition of sustainable development: "This is the process of harmonizing the productive forces, ensuring the satisfaction of the necessary needs of all members of society, provided that the integrity of the surrounding natural environment is preserved and phased-in, creating opportunities for a balance between its potential and the demands of people of all generations." As is known, the Concept of Sustainable Development includes three aspects: ecological, economic and social. Underestimation of any of these three components leads to a skew in this equilateral systemic triangle and a violation in the strategy of sustainable development. Indeed, the reassessment of the economic factor with an underestimation of the ecological and social leads to a disruption in the sustainability of development, since it is impossible to ensure an improvement in the living conditions of the next generation if the improvement in the economy is not accompanied by a reduction in man-made stresses on man and social problems in society. Similarly, the decrease in man-made workloads per person can not be an end in itself, and, therefore, the solution of environmental problems can not be an end in itself, since in the limit this would lead to a return to a primitive society, when everything was in order with the ecology of a just balanced simultaneous complex solution of all three problems of sustainable development. System analysis shows a strong interaction, direct and feedback between the three factors of sustainable development.

At the same time, most countries in the world have become convinced that the development of the country's economy is the defining task in the triangle for sustainable development. Attempts to confine monetary mechanisms of development in many countries were unsuccessful and the majority, first of all developed countries, came to the conclusion that it was necessary to transform their economy technologically. In addition, many countries have become convinced that one of the most effective ways of developing the economy is the development of not an oligarchic, more often corrupt capital, but a medium and small business with innovative content, called "technology business." It is in a number of countries that it is already providing technological transformation of the economy for the

implementation of complex tasks of sustainable development. At the same time, to provide technological business, we need specialists who know not only the traditional base of engineering knowledge, but also quite specific methods, which one of the speakers called "innovative engineering". It is he who provides the technological business, above all, with the necessary specialists, as well as the creation of the necessary equipment and infrastructure. But the main task of innovative business is the development of new efficient methods for carrying out technological processes that ensure a high level of the real economy that has undergone technological transformation.

The level of technological development is a key, critical factor that determines in the long term the level of social and economic development of the country and its industrial, agrarian and agro-industrial regions. Attempts primarily monetary transformation of the economy, even with significant investments in the production sector, are not able to ensure high rates of development and long-term competitiveness, if they are not supported by high-quality technological modernization. The experience of many countries shows that it is not possible to realize the ideas of sustainable development of the country, its technological re-equipment and accelerate the transition to an innovative way of development of the real economy, until national staff capable of realizing these tasks appear.

"Personnel who have mastered technology, decide everything!" (I. Stalin).

So, to solve the problems of sustainable development of the country and technological transformation of its economy, it is necessary for specialists not only who know the theory and methods of practical implementation of the Concept of Sustainable Development, but also by the methods of Innovative Engineering.
There is no universal model for education for sustainable development (ESD). While there will be a complete agreement on the concept, there will be nuanced differences according to local contexts, priorities and approaches. Each country has to define its own priorities and actions. The goals, emphases and processes must, therefore, be determined to meet the local environmental, social and economic conditions in culturally appropriate ways. Education for sustainable development is equally relevant and critical for both developed and developing countries. It is known that Education for Sustainable Development has four major domains, reflecting diverse goals and audiences: promoting and improving basic education, reorienting existing education at all levels to address sustainable development, developing public understanding and awareness of sustainability, and training. As key, the more important themes of ESD specialists usually provide biodiversity, fresh water management, environmental conservation and protection, rural transformation, health promotion, sustainable production and consumption, human rights, peace and international understanding, and the cross-cutting alleviation and gender equality. But as we believe it is necessary for engineering education in innovative engineering it is not enough and it is necessary to use quite another approach. The matter is that the concept of SD is integrated with the Systematic Approach, has its own theoretical foundation, foundation of all engineering education, its philosophy, and in the same time. Then it will be useful in the use of ESD.

Generally, as we consider, the technicians training in the field of sustainable development is not necessary to begin with, but in schools, predominantly in junior classes. It is necessary to begin with, to bring in, to bring from, bringing in, to, from, the generation of rational,

economical consumption of energy, raw, any material values, and making and consuming them to care of the environment, purity of class, auditorium, yard, street, city, country, to bring up feelings of decency, compulsion, respect for the colleague on study, work, business, to.

Approximately 10 years ago we have started to realize essentially new concept of the development of the experts. Essence of it is not to especially prepare for experts on sustainable development. In our opinion, it is essentially incorrect. The essence of our approach is not only in that the future, but also in the theory of sustainable development. Many successfully developing countries solved the problems of technological re-equipment and accelerated the transition to an innovative way of developing a real economy, relatively quickly and effectively if their education system, as a priority, chose to implement the triad: creative thinking -> innovation engineering -> technology business and switched to training specialists , who have a good knowledge of and skills in these areas.

Tools are, first of all, competent cadres, able to create a progressive technique (the unity of technology and equipment) or to reconstruct existing ones, which under their management are the main tools for technological transformation of the economy.
Technological transformation of the economy requires personnel capable of meeting the demand for informal, non-traditional work - energetic, initiative, offensive with other thinking - critical, creative, constructive. How to prepare them? While the list of tools and methods used for this is not very extensive. Further we will give only the names of some of our developments in the field of developmental education, tested and confirmed their effectiveness. It :
• remote online, offline and modular education,
• reorganization of the structural and logical scheme of teaching on the basis of system analysis and the concept of sustainable development as its crown
• Author's training programs,
• training not only in courses, but also in disciplines, uniting students into thematic groups, taking into account the level of their preparation. More prepared students should be grouped into groups that study more complex disciplines or their sections.
• conceptual and problem lectures, based on the results of the author's scientific works, on the works implemented in practice,
• brainstorming,
• the work of the student groups of the synectix,
• laboratory works and practical classes on the real subject of medium and small business in the style of coaching,
• replacement of the production practice with the "study-work in half" system (the system of the VTUZ Plant),
• reduction or cancellation of course projects,
• Realization of only real diploma projects on subjects related to medium and small business preferably in a student business incubator,
• Introduction of electronic professional scientific and technical libraries on disks or other media with digitized educational, technical and scientific literature,
• the creation and publication of production and technical literature adapted for the training of modern specialists without an abundance of science-like mathematical calculations and little-known terminology, extremely rarely used in engineering practice, included in the book, not for reasons of necessity, but for the purpose of "learning it". Restore the

publication of books with production themes that do not contain any mathematical dependencies that are never needed in the future,
• strengthening the system of postgraduate education with regular training of graduates by holding seminars and lectures, courses, coaching, trainings, realizing technical re-equipment projects,
• development of the practice of performing contract research on the order of enterprises where graduates of the university are working with their direct participation.

In all the rapidly developing countries, there was an acute need for specialists capable of profound knowledge of the subject of engineering business (science-intensive products and technologies), systematically analyzing domestic and foreign markets, and comprehensively addressing the issues of production management and organizations of various forms of ownership. That is, specialists of a new type were required, possessing both theoretical knowledge and practical skills of an engineer, economist and manager. In addition, the internationalization of business puts these specialists in front of additional tasks: fluency in foreign languages, the fundamentals of foreign economic activity. The study of the problems of education and training of specialists for development programs is perhaps the most important task, especially during the critical period of implementing the programs of global reform of the country.
Our experience has shown that special attention should be given to the creation and implementation in the higher education system of the means and methods of training specialists possessing creative thinking and possessing innovative engineering and methods of technological business so that they can conduct fundamental and applied research in the field of natural sciences providing rational use of natural resources and their processing, development of innovative technologies and equipment for obtaining new materials. After all, without solving scientific problems of optimization of individual industries it is impossible to ensure sustainable development of the whole country. One of the most promising areas for optimizing its economy is the use of technology to innovate the latter.

To ensure innovative development of the country's economy, it is necessary to give preference to the tactics of the technological business, which is able to divest the spheres of investment and innovation management, to use modern methods of project management. The conclusion about the existence of two interrelated, inseparable goals - innovative - engineering and educational - is logical:

Innovation and engineering purpose, for example, for chemists, involves the purpose of identifying competing processes and providing effective ways for their synergetic harmonization to conduct a systematic analysis of regime-technological and instrumental-constructive methods for conducting chemical-technological processes of diffusion and chemical reactions in heterogeneous systems. To achieve this goal, it is expected to use fundamentally new highly efficient solutions based on the use of harmonization of competing processes of molecular and turbulent diffusion. In order to obtain these solutions, the rapporteurs have already carried out a significant amount of research, it is proposed to continue industrial testing and commercialization in a number of practically important for the economies of the Republics of Kazakhstan and China previously received and new innovative solutions that have already confirmed their relevance and high efficiency.

The educational goal, inseparably linked with the first scientific goal is to assist in the organization and scientific and methodological support of the training of national cadres who have creative thinking and who own innovative engineering and methods of technological business capable of providing technological re-equipment of the real economy and accelerating its transition to an innovative development path. One of the key trends in the development of the world economy is that economic development in the world increasingly relies on the accumulation not of physical but of intellectual capital and an increase in its contribution to the growth of the knowledge economy. In this connection, the highest growth rates show the global turnover in the trade of medium and especially high-tech products. According to many experts, their joint share in world commodity exports will exceed 65-70% by 2020. The key risk for the economies of many countries is the increase in the lag in recent years from the new technological stage of development and the threat of the final displacement to the periphery of the world economy with their consolidation as a supplier of raw materials and semi-products.

The rapporteurs unsuccessfully tried in their countries to solve this problem, which psychologists tried to solve before them (in particular, to study the patterns of the creative thinking of the young man and the transition from him to innovative engineering), on his own territory and his methods, studying in higher education transition from innovative engineering to technological business and using active methods of creative learning on real objects of medium and small business, helping students already at the university to start own business. The basis of the developed and used methodology is the use of the ideology of system analysis, the possibility of synergy as an instrument, means and method of ensuring harmony and the correspondence principle not only in the real economy, but also in politics, business, in general, in our diverse life.

A new synergistic conception of creativity has been proposed, developed and comprehensively used, which is not based on accidental search for solutions by trial and error, not on plagiarism in Nature of its decisions ("Sinektics"), not on revealing and then destroying, overcoming, eliminating, eliminating contradictions (TRIZ approach), but on the concept of unification, interaction, creation and strengthening of the harmony of technical systems. This approach allowed the speakers to create a fundamentally new technology of invention and develop a new concept and effective technology of creative education. This method of developing creative consciousness and thinking is based on system analysis, revealing the limiting hierarchical levels in the system, determining the kinetic characteristics of the subsystems at these levels, matching the parameters found with the characteristics of the impact on the system, harmonizing the competing subsystems with each other and with external parameters of the impact, (usually using the methodology of mathematical planning of extreme experiments), the transition to commercialization based on media and methods of innovative engineering. The new methodology can be useful not only for students, but also for scientists, specialists of engineering profile, entrepreneurs, youth, gravitating to technological innovative technological business.

It should be noted that until recently, another practice was widespread: concentration of efforts in the technology business, and on technology transfer, which was recently recognized in most countries as inexpedient due to the fact that the transfer of technology is not oriented towards the use of market forms of management, is fully based on the authorities, on its command methods and limited possibilities for financing. Fortunately, this

system has almost supplanted the technology business. Among many tools and methods for implementing the technology business, special attention should be paid to the use of industrial and industrial - agrarian symbioses, the formation and support of microclusters of technology businesses focused on innovative filling of medium and small businesses.

Cluster policy.

The prerequisite for creating an innovative economy is the formation and support of clusters of technology business, while clustering should be viewed not as an end in itself, but as one of the methods of project management. In a market economy, the role of power in creating a technology business sector using clustering mechanisms is limited and reduces to: formulating the task and initiating the emergence of clusters, creating incentives and mechanisms for clustering, promoting the creation of infrastructure - a nutrient medium (networks of private entrepreneurs - business angels, technology businesses - incubators, service centers), legislative support of the technology business, incentives for receiving positive results. The cluster approach can get a rapid development if theoretical developments and positive practical experience in the field of technology can be transferred to the field of economics and technology business.

It is advisable to take into account that international experience demonstrates four variants of cluster policy depending on the role of the state: catalytic cluster policy, supporting cluster policy, policy cluster policy, interventionist cluster policy. In the implementation of clusterization, the authorities should not reduce everything to their regular regulatory functions, but rather contribute to the verified decisions of whom, with whom and why to integrate into clusters, how, with whom and why then to cooperate with the clusters formed, and, most importantly, what are the motives and mechanisms of these processes .

Implementing a progressive cluster approach to local and central authorities can help create service networks of technology business centers as structures that promote the development of medium and small businesses and turn it into a technology business in order to accelerate the country's exit from the global crisis and ensure its sustainable development. Their main task is to contribute to the solution of the main strategic task in crisis conditions - the implementation of the principles of sustainable development with the solution of economic, social and environmental problems. The main tactical methods for implementing these strategic tasks are the initiation of the formation and maintenance of microclusters of the technological business. It is expedient to conduct this work on the basis of scientific and educational centers and start working with the formation of an industry center for technology business. The experience of creating such a center before the deep economic crisis, in which the real economy is now, had one of the speakers who created such a center, the electronic version (portal) of which is still working. Prior to the stagnation, the Technological Business Incubator, now operating in a virtual mode, was actively operating in this center, there was a cluster base with web pages and sites for each project, a database of investors, a fair for technology business projects and other units. It is advisable to put the principles of the system approach and project management (using such tools and methods as clustering, diversification, symbiosis), as well as market mechanisms of management with the formation of a technology business based on medium and small business with innovative content, into the basis of innovation policy. It is necessary to promote the formation of

microclusters of technology business on a tender basis, provide legislative support for the establishment of business angel institutions and private investors.

The logical sequence of innovative engineering and technology business.

The content of the course of innovative engineering, which should be introduced for the current students, can be considered on the example of the Training - coaching for future subjects of innovative engineering "Modern means and methods of innovative management" offered by us with the following program:
• Fundamentals of system analysis and methods for optimizing systems.
• Cluster methods of management.
• Fundamentals of project management. Innovation and investment management.
• Synergetics of management.
• Algorithms for finding optimal solutions (Brainstorm, ARIZ, synectics, author's algorithms).
• Express training - coaching (or round table, at the choice of listeners) "The principle of democracy, means and methods of its implementation."

The unpreparedness of the authorities to solve these problems is very hindering the transition to the technological development of the real economy. It would be good to not allow power to this power at all until the subjects of power, before the others, are trained in these questions of theory and practice, will not be tested on this or similar program and will not prove their professional preparedness for the performance of their power functions. And the higher school can be involved in the organization of trainings, seminars, coaching, consulting on this or similar programs.

Many years of fairly positive experience in the creation and reading of the author's course of lectures on the "Engineering and Technology Business" by one of the speakers allows us today to recommend the introduction of an engineering profile in engineering universities, this course is well combined with the implementation of the author's method of developing creative abilities among young people, Innovative engineering, of course, should also become one of the main courses in the preparation of modern masters, at least technical Of course, the course should not only justify the concept and general tasks of innovative engineering, but, most importantly, students should study specific methods and means of using it as a way to technological transformation of the economy by the implementation of original ideas and breakthrough technologies. pp.) at this course includes the following sections:
• The concept of sustainable development (CSD) is an imperative of innovative engineering.
• System analysis - the beginning of the beginning.
• Innovation, innovation process and innovative engineering.
• General information about synergy in creativity.
• Foundations of invention in the search for innovative solutions in engineering.
• Methods of developing critical and creative thinking in inventing and technology business.
• Information technology in innovative engineering and business.
• Industrial - agrarian symbiosis is the basis of innovative technological business in the economy.
• Improvement of technological processes at the molecular level and the level of supramolecular structures.

• Perfection of technology for gas-liquid systems.
• Innovative nanotechnology.
• Development of capillary technologies. Innovative solutions for the processing of capillary-porous materials.
• Innovative management of energy conservation.
• Innovative management and innovative marketing.

Technological student business incubators are another effective way of realizing the synergistic unity of both of the above mentioned tasks. Such student business incubators have proved themselves in many countries when developing their business. In the Ukrainian university this works and now in the form of an on-line virtual technological business incubator. For contacts with the external business environment, approbation of its achievements, the student investment business technology fair has also proved itself.

Constructivism is usually the result of education and experience.

Unfortunately, the appearance in many countries of the next "strategies for reforming higher education" does not change much. And it's not the individual details and local changes in the systems. The point is that the initial prerequisites of the strategy adopted in many countries, which have much in common in approaches to the problem, need serious rethinking.

Unfortunately, in most strategies you will not find:
1. Clear formulation of requirements for a modern specialist who could become an innovator, capable of becoming the main driving force of sometimes resuscitation, and in most cases of technological development of a real economy. Moreover, in most cases we did not find even a mention of the means and methods that should be used for this.
2. Recognition of the fact that the whole world has accepted that higher education, like science, is not a wasteful budget item, but a productive force that actively participates in the country's sustainable development.
3. There are also no constructive proposals for implementing the concept of the unity of education, science, production and business in universities. And in many leading countries of the world, universities have long become the flagships for the development of both theoretical and applied science, providing, with the help of their business units (business incubators, self-supporting university technological centers, etc.) the development of a real economy.
4. The ideology of integration, synergetic unification of all these directions of activity of a modern university in specific means and methods adopted in many countries of the world (for example, in the form of a cluster approach developed in our country at the time) has not been reflected.
5. There are also no concrete proposals on the development of science in universities, and the sciences do not have long-term plans for fundamental research at the expense of the long-suffering budget, but with the solution of short-term tasks of technological transformation of the country's real economy.

It is not laid down in the strategies for the higher education of higher education than the Mauhlianism and dogmatism of the stages of development of consciousness, such as criticism, creativity, constructivism, without which it is impossible for the generations of the reformers of the country that have come to them to come and come for the next few years.

What is needed today, tomorrow and in the coming decades is creative engineers and specialists capable of critically analyzing everything that relates to their field of activity and finding effective, creative, constructive, competitive solutions, the implementation of which will transform the real economy of the country. And the preparation of faceless bachelors and masters will remain the lot of the higher school of the most developed countries, where the branch science that can solve the problems of production development remains in the sphere of production. Where there is practically no branch science, the only hope is that higher education will return to the training of highly qualified engineers capable of accomplishing the forthcoming miracle of rapid revival and rapid development of the country's economy due to the development of innovative engineering and the main way of its implementation - the technological business, first of all , medium and small ..

The problem of higher education is also that traditionally there is a huge set of specialties, for which bachelors and masters in universities are preparing. For example, only chemistry specialties in the universities of the countries of the former Soviet Union are not less than a hundred. They say that we train specialists with profound professional training. It is difficult to object, but it is not necessary. Narrow specialists today simply do not correspond to the market conditions of enterprises regardless of their forms of ownership. We have to turn around - depending on the requirements of the market, to change raw materials, products, technologies, equipment. For example, if in the past there was an orientation in one-nomenclature production in the chemistry and the country, for example, bought in the USA, Japan, Czechoslovakia and built a million-ammonium production, the world has long taken an orientation to multi-nomenclature flexible lightly transformed production, in accordance with the requirements of the market, to produce other products from other raw materials.

Can a narrow specialist very quickly provide such a transformation? No, of course, he was not taught this. Creation of new production always, even if it was bought abroad, took several years, and the market considers for days, well, for months. And for this we need easily reconfigurable flexible automated production systems, which today there is simply no one to create and exploit. If we talk about chemists, it is completely unclear why this in the respective universities is such a love for the training of specialists - technologists and specialists - mechanics. Can a technologist be a professional if he does not know the equipment, where his technological process is realized. Conversely, can a specialist be a professional if he is poorly versed in the processes that occur in his equipment, if he can not develop a model of the apparatus and implement an algorithm for optimizing the process? The answer is clear. In general, is it possible to solve complex complex issues of optimization of technology (if we understand the synergistic unity of technology and equipment) discrete methods by specialists who do not understand each other and often speak different technical languages? Believe me, this is impossible. Maybe that's why many leading foreign universities refused to split up specializations, and in chemistry they often switched to the training of chemical engineering specialists, and not separately for equipment or technology. Everything written has a direct relation to the issue of creativity of specialists, because without any universality, a broad outlook, mastery of system methods, modern information technologies, optimization methods, decision theory, no creativity can be said.

As in the old days, today in the technical universities read a huge course of lectures on mathematics from Lobachevsky times, which will never find application in engineering

practice, but do not teach the use of modern software products for computer technology in practical activities. They teach physics, not unlike school courses, but do not teach the use of the laws of physics in modern technologies, and especially in the practice of their optimization. It is not necessary to prove that a modern specialist needs serious basic theoretical training, but at the same time, one can not substitute the fundamental knowledge necessary for a modern specialist with a set of disconnected scientific information that will never be claimed and will be immediately forgotten after the exam. Apparently, serious reorientation of theoretical courses is necessary, overcoming their isolation from practice. This can be done if, leaving theoretical lectures to rest, pay special attention to the content of laboratory workshops, linking the theoretical conclusions to demonstrating the possibilities of using it in solving practical problems that are close to the profile of the future specialty of the student. You can continue to tour the theoretical courses, but it is much more interesting to consider the problems of setting profiling courses in modern high school.

Recall that not so long ago in the former USSR was realized in our universities the concept of familiarizing the future specialist with production at the university bench. The issuing departments paid much attention to the organization and conduct of numerous practices and, especially, pre-diploma, laboratory practical work on real equipment and technological schemes or on its enlarged models.

Today, most of the enterprises that used to be practice bases were stopped long ago, and those that work moved into private ownership. The organization of the practice of students do not want to be engaged in the latter - there is time - money, and there is no money for paying for practice at universities. That often turns practice into its imitation. There are also no means for updating the laboratories of graduating departments in universities. Teaching modern technologies and mastering modern equipment in installations of the middle of the last century is impossible. In these conditions, the qualitative preparation of creative and non-creative specialists too becomes very problematic. Some profiling chairs had to switch from practical practice and practical work on real objects to simulation simulations on computers, which, of course, is far from being equal. Working in the scientific programs of NATO, one of the authors visited relatives of his department at the universities of Denmark, Spain, Germany, Britain, Italy, USA, Norway. I saw fine modern laboratories, pilot production plants. I wanted to howl with jealousy ... And now let's think about whether it's worth hypocritical to declare the "bolonization" of higher education without having an elementary material base for this. What kind of comparability of the quality of education and the application to the diploma can be said! And why should we "mobility of teachers and students" in this situation. I imagine a Western professor who got into the modern chair of almost any Ukrainian university. Apparently, all the talk about cooperation, the exchange of students and teachers, participation in the next EU Framework Program, etc. will be very quickly curtailed. Perhaps, it is the impossibility to organize in the realities the required practical training of a specialist, due to the increased attention of the profiling chairs to the inclusion in the curricula and work programs of the implementation of numerous projects and all kinds of homework assignments. Their huge, far from always comprehensible and justified quantity, sometimes simply depresses. The monotonous theme, the complete absence of solutions to creative tasks in the task makes it simply pointless to implement them. Students, often in the use of information technologies, are more "advanced" than their teachers (remember computer games, films, social networks, which are so keen on modern youth), not without malice and pleasure, they find ready-made solutions to any problems

and any projects on the Internet before graduation. And in recent years even drawings that are ready in electronic form are being procured in the same place, and they can be printed out quickly and inexpensively.

Those whose parents are richer come even easier, ordering ready-made projects and assignments from "specialists" who do everything dearly, but quickly. Who among us has not seen many suggestions of these questionable services to students, graduate students, applicants even doctoral degrees on the Internet, on message boards, on tablets that are on the torsos of living dummies - the same students. Recently, such an announcement appeared even in the lobby of one of our esteemed universities, with quotations for services. And they say that the most effective is such a service, when projects in service firms are performed by orders of students exactly those teachers who gave them the assignment. Especially it is pleasant to extramural students. That's great, and you will not blame anyone for corruption - market relations work. Maybe that explains the abundance of projects and similar assignments in programs and curricula, that this is a kind of corrupt transaction between service offices and individuals with universities.

Summing up, you can consider the advice of psychologists on the development of creativity from the angle of entrepreneurship. We spoke about childhood and adolescence above. And, here, how to learn to think more creatively in adulthood? Let's listen again to the psychologists. Many psychologists advise writing down all ideas that come to mind, both good and bad. If you put forward only good ideas, this can lead, on the one hand, to the "deterioration" of potentially fruitful thoughts, and on the other - to a constant feeling of dissatisfaction. When you are engaged in creative work, you should not practice critical thinking development (evaluation of the stated judgments and creation of an informed conclusion). Give yourself more time to think. Some psychologists advise you to play the problem to be solved in person or draw a diagram of it in order to create a more vivid picture of it. They recommend talking out loud with yourself and, playing the task in the faces, go through all of its decisions. It is always useful to follow in the footsteps of famous creative people and show perseverance:
- Consciously make an effort to show originality and put forward new ideas.
"Do not worry about what people might think of you."
- Try to think broadly, while not paying attention to the prohibitions imposed by cultural traditions.
- If you made a mistake at the first attempt, consider other options and try to find new ways.
- Be always open for discussion and check your assumptions.
- Look for explanations for strange and incomprehensible things.
- Overcome the functional fixity and look for unusual ways of using ordinary things.
- Give up the usual methods of activity and try to look for new approaches.
- To give out as many ideas as possible, use the method of brainstorming.
- When evaluating ideas, try to be objective. Imagine that they belong not to you, but to another person.
- Do not have authorities and idols (any person, as if clever and remarkable was not, can be mistaken, and "authorities" often also relax and begin to carry crap.) And fans continue to listen to the speeches of authority as divine revelation)
- Do not be afraid to be "not like everyone else" (although the question is not right there, in the ideal, there should not even be a thought in the spirit of "do I look like others or not?" There was no sense in such reasonings. measure yourself best with your ruler).

- We need some boldness of thinking and a lack of stereotypes. In order not to have stereotypes and other filth that prevents creative thinking, you must first of all think INDEPENDENTLY.

All this helps the main thing - to see things closer to reality (not "such as they are" - not the fact that it is generally available to a person). And, therefore, and find new ideas, where others - constrained by stereotypes and "truths" will not notice them for a million years.

Summarizing the psychological aspects of creativity, we note:
1. One of the foundations of creative thinking is the ability to see the world undistorted by other people's opinions, stereotypes, attitudes, and sayings of authorities.
2. To see the world close to reality, one must be able to treat everything critically and have independent thinking.
3. Impressions and experience - fuel for creativity, independent thinking - cleaning plant, subconscious mind - engine.
4 . System approach - theoretical base, project management - tactics of realization of creative projects

What's next?

The role of creativity is constantly growing in the modern rapidly changing economy, which is connected with several factors (dynamism of modern business, hypercompetition, increasing level of consumer demands, increasing the role of intellectual resources in the production system, increasing the cost of labor and its quality in production and business, small business and the transition from mass reproductive production to small-scale and individualized, etc.). Today, those organizations that actively develop the creative potential of their employees win on the market.

In this regard, it is proposed to master new methods of creative learning based on the use of system approaches. What is the essence of the methods of creative education developed and tested by the authors? First of all, the entire methodology is based on the knowledge and practical use of the systems approach, system analysis. Students do not just study the structure of complex systems, but also learn how to decompose vertically and horizontally, build network structures. It is also important to teach the student to take into account the relationship, direct and reverse influence of various hierarchical levels of the system (interectality) and the resulting new qualitative and quantitative result (emergence). However, it is most important for the creative teaching of a student to achieve not only theoretical, but also practical mastering of the properties of complex systems. It is on these properties that the search for creative solutions is based. For example, the most difficult for understanding and mastering by students of the principle of harmony or consistency, formulated as the need to ensure that the parameters of the impact on the system correspond to the defining characteristics of this system at a limiting level (most often, these are amplitude-frequency characteristics).

Let's consider the main provisions of the new method of searching for non-standard creative solutions in various areas of human activity developed by us (the method can be used not only to solve technical problems or scientific problems, but also to solve economic, political and even social problems).

The method is based on, as noted above, system analysis and its laws. The properties of hierarchy of systems, their decomposition, interconnection, as well as direct and feedback of different levels of hierarchy are used, the hierarchical level of the system is defined, the principle of the correspondence of methods of influence to the amplitude - frequency characteristics of the system at a limiting level is used. In addition, our bases of regime-technological and hardware-constructive methods of influence on the system's limiting level will be thoroughly discussed. And, finally, the unity of instrumental - constructive and regime - technological methods of optimization, in particular, for chemical and technological systems. Particular attention will be paid to teaching methods of using our technology when searching for creative solutions, the so-called synergy and dissynergy. Synergy or synergism (from the Greek Synergos - (syn) - together (ergos) - acting, action) is the interaction of two or more factors, characterized by the fact that their action significantly exceeds the effect of each individual component in the form of a simple sum. In technology, close concepts are "emergence", "interactivity." It is easier to understand these concepts from simple arguments - illustrations: what can a person do with "one right" or "one left"? And what can he do with both hands? For example, how many times will it be released from one floor to the other? In many cases, this is not just much more than doubly, it's a radically new quality: for example, a violinist or a guitarist "one right" or "one left" can either clamp the chords without making a sound, or sound, but not music. the musician creates music, even to just hammer a nail, you need two hands, and our sense organs - vision, hearing, speech, smell and touch? They work separately, but only synergistically joining together, they give us the full picture And when he joined himself with the brain, his understanding.

In conclusion, we only give an algorithm for searching for creative solutions, the optimization algorithm has not yet been explained:
1. DECOMPOSITION of the system (for example, production) at typical hierarchy levels (for example, production - workshop - installation - apparatus - contact stage - molecular level) vertically and horizontally.
2. IDENTIFICATION of the reference level.
3. Identify the limiting level of the hierarchy.
4. Determination of the kinetic characteristics of the process at a limiting level.
5. Selection of creative tools and optimization methods from the database of methods, taking into account the combined approach, alignment, conformity principles, use of synergy, etc.

Acceleration of the innovation and technological transformation of the economy can provide not only the development and implementation of modern technologies for creative development of students, their training in innovative engineering and technological business at the university base, but also postgraduate education of entrepreneurs and other small and medium-sized businesses through training, coaching, thematic schools, Internet - schools, etc. Development of medium and small business, first of all, on the basis of its innovative filling and transformation into those business can help to implement the transition from a survival strategy to a sustainable development strategy of the country, technological transformation of its economy through a comprehensive solution of environmental, economic and social problems by focusing on the development of medium and small businesses, the use of high innovative potential and market-based management mechanisms based on the systemic analysis, synergetics, project management and modern information technologies.

Abstracts

It is proposed to be used in the non-traditional approach to engineering education, when the Sustainable Development is a concept based on the principles of the theory of economics. The essence of our approach lies in the formation of a system of continuous education.

Attempts to confine monetary mechanisms of development in many countries were unsuccessful and the majority, first of all developed countries, came to the conclusion that it was necessary to transform their economy technologically. In addition, many countries have become convinced that one of the most effective ways of developing the economy is the development of not an oligarchic, more often corrupt capital, but a medium and small business with innovative content, called "technology business."

Many successfully developing countries solved the problems of technological re-equipment and accelerated the transition to an innovative way of developing a real economy, relatively quickly and effectively if their education system, as a priority, chose to implement the triad: creative thinking -> innovation engineering -> technology business and switched to training specialists , who have a good knowledge of and skills in these areas. In all the rapidly developing countries, there was an acute need for specialists capable of profound knowledge of the subject of engineering business (science-intensive products and technologies), systematically analyzing domestic and foreign markets, and comprehensively addressing the issues of production management and organizations of various forms of ownership. That is, specialists of a new type were required, possessing both theoretical knowledge and practical skills of an engineer, economist and manager.

The conclusion is drawn about the existence of two interrelated, inseparable goals - innovation - engineering and education. A new synergistic conception of creativity has been proposed, developed and comprehensively used, which is not based on accidental search for solutions by trial and error, not on plagiarism in Nature of its decisions ("Sinektics"), not on revealing and then destroying, overcoming, eliminating, eliminating contradictions (TRIZ approach), but on the concept of unification, interaction, creation and strengthening of the harmony of technical systems. This approach allowed the speakers to create a fundamentally new technology of invention and develop a new concept and effective technology of creative education. This method of developing creative consciousness and thinking is based on system analysis, revealing the limiting hierarchical levels in the system, determining the kinetic characteristics of the subsystems at these levels, matching the parameters found with the characteristics of the impact on the system, harmonizing the competing subsystems with each other and with external parameters of the impact, (usually using the methodology of mathematical planning of extreme experiments), the transition to commercialization based on media and methods of innovative engineering. The new methodology can be useful not only for students, but also for scientists, specialists of engineering profile, entrepreneurs, youth, gravitating to technological innovative technological business.

The prerequisite for creating an innovative economy is the formation and support of clusters of technology business, while clustering should be viewed not as an end in itself, but as one of the methods of project management. In a market economy, the role of power in creating a technology business sector using clustering mechanisms is limited and reduces to: formulating the task and initiating the emergence of clusters, creating incentives and

mechanisms for clustering, promoting the creation of infrastructure - a nutrient medium (networks of private entrepreneurs - business angels, technology businesses - incubators, service centers), legislative support of the technology business, incentives for receiving positive results. The cluster approach can get a rapid development if theoretical developments and positive practical experience in the field of technology can be transferred to the field of economics and technology business.

Many years of fairly positive experience in the creation and reading of the author's course of lectures on the "Engineering and Technology Business" by one of the speakers allows us today to recommend the introduction of an engineering profile in engineering universities, this course is well combined with the implementation of the author's method of developing creative abilities among young people, Innovative engineering, of course, should also become one of the main courses in the preparation of modern masters, at least technical about the direction.

It is not laid down in the strategies for the higher education of higher education than the Mauhlianism and dogmatism of the stages of development of consciousness, such as criticism, creativity, constructivism, without which it is impossible for the generations of the reformers of the country that have come to them to come and come for the next few years. What is needed today, tomorrow and in the coming decades is creative engineers and specialists capable of critically analyzing everything that relates to their field of activity and finding effective, creative, constructive, competitive solutions, the implementation of which will transform the real economy of the country.
The role of creativity is constantly growing in the modern rapidly changing economy, which is connected with several factors (dynamism of modern business, hypercompetition, increasing level of consumer demands, increasing the role of intellectual resources in the production system, increasing the cost of labor and its quality in production and business, small business and the transition from mass reproductive production to small-scale and individualized, etc.). Today, those organizations that actively develop the creative potential of their employees win on the market.

It is proposed to master the new methods of creative training, developed by the presenters, based on the use of system approaches.
The development of medium and small business, first of all, on the basis of its innovative filling and turning into a technological business, can help to implement the transition from a survival strategy to a sustainable development strategy of the country, technological transformation of its economy through a comprehensive solution of environmental, economic and social problems by focusing on development of medium and small business, the use of high innovative potential and market-based management mechanisms based on system analysis, synergetics, project management and modern information technologies.