THE DATABASE OF ECONOMIC PHENOMENA AND EFFECTS RESULTING FROM THE ESTABLISHMENT OF MODULAR INVENTIVE STRUCTURES IN RESEARCH AND EDUCATION INSTITUTIONS

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Abstract

Starting from basic ideas in the study of invention and creativity:
- "Every school is a living organism, born out of certain human needs, which lives and develops continuously" (Delia Perju)
- "Great inventions arise during times of economic crisis" (GN Althsuller)
- "Universities train young inventors with exciting ideas" (V. Belousov),

and based on the experience acquired during 20 years at the National Institute of Invention in Iasi, we have designed a new modular invention structure which reflects the current transformations in higher education under the Bologna Process. The new modular structure connects MA and PhD students from any field of activity, in order to facilitate knowledge of the unique set of interdisciplinary effects (technical, economic, psychological and overlapping effects), in an education environment tailored to the third millennium.

Nowadays the following facts are widely known: the Earth's material resources are limited; the resourcefulness of human creation is inexhaustible; the performance ratio of the human brain is higher than 1. To improve human performance it is necessary to establish the target modular creative groups, comprised of MA and PhD students in all fields (education, research, design), with the aim of increasing the efficiency of specialized technical and economic creation.

Keywords: invention / creativity, modules, technical and economic effects, transfer

The progress of mankind would not be possible without *people's theoretical or practical creative and inventive activity***.** For this reason, it is natural that it should be viewed as the highest form of human activity.

The stimulation of creativity and inventiveness is a major focus area not only for psychological research, as creativity and inventiveness represent the highest level in the development of personality on the scale of learning behaviours.

On the outside or behind any creative or inventive product one can always distinguish its creator. Each piece of work is preceded by the creative and inventive personality, with many different profiles.

A person's inventive profile may be understood as a set of skills and intellectual and motivational features interacting in his personality when that person engages in problem-solving. Each inventive profile may be described as a 'mosaic' of distinct creative and inventive aptitudes and personality traits.

Inventics is conceived of as the science and art of technical creation. It is a science to the extent that the creative process relies on convergent thinking, on algorithm and logic, and an art when it is expressed in the sphere of divergent thinking, of heuristics and the cooperation of the conscious and the subconscious.

Inventiveness is dependent on a number of elements: *experience* (including knowledge and technical skills), *talent, the ability to think outside the box and to discard inadequate ideas.*

The establishment of new modular structures focused on inventive research, bringing together MA and PhD students in any field (education, research, design), to facilitate knowledge of the database of effects (technical, economic, psychological, social, environmental and super-effects), amid the broadening of education and research tailored to the requirements of the third millennium, would lead, first of all, to enhanced performance of inventologists / creatologists, to inventors working in research and development and in education, hence to greater efficiency of human capital.

Secondly, the building of the economic effects and phenomena database, according to the selected subject, will enable the rapid selection by each group member of the field-specific effects

and will boost the efficiency of technical-economic activities, directly and through heuristic methods.

The specific contribution of this research consists in the identification of opportunities to implement new effective forms of research, analysis and leadership in the economic field, to integrate the specific inventive phenomena and effects and to disseminate information among specialists.

MATERIAL AND METHOD

The analysis of inventions, of the foundations of the creative synthesis of inventics has enabled the design of approaches, procedures, techniques and methods of technical creation, built as means of boosting the efficiency of creative processes.

The creative and the inventive processes respectively do not unfold as a straight line, rather they involve four successive stages, i.e.: instinctive search, intuition, materialization and logical definition of the new idea.

At the ***instinctive search*** stage, the process of searching new ideas occurs in the subconscious, lacking the outlines of a definite goal.

The second stage, ***intuition***, marks the point of contact between the conscious and the subconscious. At this stage the exchanges between the various environmental forces emerge, alongside the connections that determine such exchanges. Over time, intuition will develop into an innovative idea, if it is consistent with the focus of the research or education body in question.

Materialization is the third stage in the third phase in the creation and invention process, dealing with the sorting of ideas, the disposal of ideas which are not applicable, and the retention of those which are deemed useful for the design of a new product.

The spirit of competitiveness may be stimulated by resorting to the following families of applicability of creativity and inventiveness: a) creation, invention, innovation; b) problem-solving; c) problem optimization (*In the modern era, inventive problem-solving has been transferred to the field of psychology, when the focus is on the connection between the brain and understanding and innovation respectively. Methods such as process and error brainstorming are commonly suggested. The number of processes involved will vary depending on how complex a problem is.*).

The structuring of intuitive and logical-intuitive techniques and methods is based on **heuristic approaches** (quantitative changes, changes of shape, in space, in time, of motion, of materials; changes by elimination, addition or substitution, the use of replacements, reserves or analogical transformations; changes through complex combination and synthesis). Thus, creative techniques emerge as directories of heuristic approaches (*Used since the Antiquity as a means to discover the truth, the **heuristic** approach currently sees increasing applications, both in research and in the teaching and learning process. In the modern understanding, heuristcs in education is not confined to heuristic conversation; rather it represents a leading idea, a guiding principle for the overall teaching methodology*).

Inventics, according to the inventologists and creatologists of Iaşi, has emerged as a discipline with a strong practical focus, constantly addressing the issue of the extent to which the newly introduced knowledge help the technical creator and the degree to which invention can become a matter of praxis for the creator.

Taking advantage of the opportunity to investigate the invention process from the inside, using the post-introspective method, with a prevailing natural-engineering logic, and contributing to and benefiting from the results of Romanian inventics and technical creation practice, it is now possible to structure, develop and design a database of illustrated information for inventors comprised of:

- An illustrated database (data sheets and tables) of heuristic approaches;
- An illustrated database of effects and inventive phenomena and principles.

The existence of bodies of knowledge nowadays facilitates:

- the more effective use of basic procedures in applying the generalised logical method of exploring new technical solutions and conducting specialised particular heuristic searches;
- a considerable increase in the productivity of the creative intellect;
- access to creativity and invention, respectively, to less creative engineers and technicians, even in interdisciplinary areas, such as physics, chemistry, environmental biology.

Increasing the creative and inventive performance and especially the value of the technical solutions proposed by inventors in research and development, in industry or operating privately, and enhancing the efficiency of human capital are top priorities for scientific research overall and prove the important role of this field.

The organisation, classification, creative approaches and procedures, the heuristic methods, the structuring and development of inventive effects databases, and the proposal of new approaches and effects to contribute to the development of the generalised search method, will ensure the efficiency of group and individual creation and inventiveness, in research and education institutions.

Both in Romania and abroad, research in this field is still at an early stage, and is confined to general classification and listing heuristic approaches, inventive effects and principles, often incompletely and using formats that do not

facilitate algorithmisation or the introduction into automatic search and selection systems.

Thus, researchers and education professionals are faced with a shortage of data required to provide them with new solutions, in areas such as:

- cost-cutting;
- preventing technical and economic failures;
- avoiding crisis situations.

The structuring and development of the logical-heuristic method, of heuristic approaches based on arrangement, reorganisation, and detection of new methods, and their graphical illustration guarantee the creation of a valuable support material for scientific knowledge, enables the multiplication of results in the technical creation and inventiveness activities of researchers, education professionals, designers, students and pupils.

RESULTS AND DISCUSSIONS

The study of creative solutions has revealed four features shared by all, viewed as **inventive principles**:

- similarity principle,
- uniqueness principle,
- ideality principle,
- "problem is the solution" principle.

The similarity principle: in terms of their basic logic, creative and inventive solutions can be similar to the most conventional solutions.

Most of us perceive the creativity or inventiveness of a solution as being directly proportional to the change level the solution would create in the analysed system. However, the more we distance ourselves from the original state, the more difficult it is to think, due to the increasing number of new elements and relations which emerge in the system and to the high degree of uncertainty.

The uniqueness principle: we can use to our advantage the circumstances of the problem we face. The principle presupposes that we establish how the current problem differs from similar problems we have faced or know about.

The ideality principle: exactly what is needed, at the exact moment, in the exact place. We would create unwanted complications if we were to seek to achieve more than it is actually required. We must look for simple and effective solutions, rather than sophisticated ones.

The "problem is the solution" principle: the meaning reflected by its name. In conventional thinking, we tend to focus our efforts on diverting problems.

The above-mentioned inventive principles can be operationalised using four sets of questions, which help focus our thinking effectively:

1. Am I looking too far away from the most obvious solution? What is it? What is its basic principle?

2. Which are the objects/elements I try to get rid of? What are their features/characteristics? What unwanted effects am I looking to ward off? What would happen if I tried to use the objects/elements rather than dismiss them? Which are the aggravating factors? How could I use the aggravating factors to solve the problem?

3. How do I define the problem? Which unique circumstances differentiate this situation from similar situations I know? Am I using them to arrive at a solution? How (else) could I use them to arrive at the most effective solution?

4. Am I perhaps trying to find a too complex or sophisticated solution? What must I do/find to solve the problem? What would be enough to do/find to solve it? How do I redefine the problem?

The approach of **inventive-systematic** thinking may be summarised by enunciating two mandatory requirements which are met by genuinely creative solutions only: **the closed-world condition** and **the qualitative change condition.**

The closed-world condition. The field of the problem includes the elements/objects of the problem and the elements/objects in its environment (in its proximity). To observe the closed-system condition, the solution must not bring into the system (the problem field) any new types of objects. The solution must be limited to the already existing objects/elements.

The qualitative change condition. The condition forces us to focus on the relationship between the field of the problem and the solution. In the field, one or several factors generate unwanted effects. We must first identify such aspects. In conventional thinking, we seek to minimise the negative impact of such factors or even to eliminate them.

In inventics, a key factor is that fundamental and technical training prevent the specialist inventor from psychological inertia and give him a certain flexibility of thought, whereas specialist training, if subordinated to closed systems, can aggravate psychological inertia, leading to rigidity of thought.

CONCLUSIONS

The establishment of modular inventive structures in research and education institutes would have a major economic and social impact, by providing higher standards of work and living, including health standards, opportunities to education and training, job creation, environmental

protection and resource conservation, technology transfer opportunities, particularly in less developed areas and will promote regional development.

Creative and inventive performance will also boost the efficiency of the human capital, a top priority for scientific research overall.

A specialist information database will be created to be used by students, education professionals, and especially young future inventors engaged in MA and PhD programs.

Furthermore, new opportunities for involvement in national and international scientific events will arise, contributing to improving Romania's image abroad and familiarising young researchers with the requirements of international competitions.

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