THE PROBLEM OF SCIENTIFIC RESEARCH EFFECTIVENESS

Alexander F. Kurgaev, Alexander V. Palagin

Abstract: *The paper enlightens the following aspects of the problem of scientific research effectiveness: it formulates the main problem of growth of the scientific research efficiency; reveals the most essential attributes of scientific knowledge limiting the area of optimum existence for professional scientists' work efficiency; reveals the hierarchy of problem situations on a way to growth of scientists' work efficiency; defines and grounds the solution of the above-mentioned problem situations. As well the given paper investigates efficiency of the chosen way.*

Keywords*: scientific researches, the canonical form of knowledge, integral knowledge, cognition, knowledge processing system.*

ACM Classification Keywords*: A.0 General Literature; J.4 Social and Behavioral Sciences; M.4 Intelligence Metasynthesis and Knowledge Processing in Intelligent Systems*

Introduction

Development of the world community, a society of each state and all their components is constantly accompanied by uncountable set of problems, the solution of which is unknown, is inadmissibly difficult or poorly effective for practical embodiment. Only the part of problems of civilization's evolution receives social recognition, is formulated in the obvious form and consolidates scientific, organizational, material and financial effort of society to their solution in the form of scientific and technical program (STP).

The program-target method of problems' solution is generally accepted for the world community, the separate states and their components. Numerous generally positive experience of STP formation and performance for solution of many problems is saved up, (Kuhn 1962). However together with significant positive experience of STP formation and performance the certain lacks in *organization*, as well as in actual *carrying out* of scientific research take place.

Lacks of working *organizational* processes consist in some subjectivity when defining priority for scientific research problems and interrelation between them, as well as when managing each STP. These lacks are consequences of absence of the objective control mechanism for essence coordination in different documents (and coordination of their components among themselves) of each STP and, finally, conformity of essence of the received results with the planned ones. The main of the existing lacks of working processes for *carrying out* the research in STP framework is impossibility to use directly already extracted knowledge for statement and solution of the current and new problems in scientific and social evolution.

The specified lacks are inherent in all researches, but they acquire special acuteness for solving problems of society development practice necessarily demanding interdisciplinary research. This research is complicating work of scientists up to almost insuperable barrier in connection with ultrahigh complexity of their specific content. Consequence of these lacks is loss of a part of economic effect from performance of each STP and all their set.

Research tasks of the paper are revealing attributes of the scientific knowledge limiting area of existence for an efficiency optimum of the scientists' professional work; revealing problem situations on a way of scientific research progress and the most essential attributes of information technologies adequate to natural processes of problem solving.

2 The characteristic of an essence for interdisciplinary research

Extracted knowledge of the set of scientific disciplines is represented in the form of corresponding set of hierarchical scientific theories' networks (theories with different level of development, formality, content-richness and reality coverage), elements of which are probably connected through common objects of validity.

Theoretical knowledge functions and develops as a complex system inside disciplinary and interdisciplinary interactions, directed at the solution of actual problems in social science and practice's evolution. It is well known, that evolutionary development of science is periodically interrupted by revolutionary changes in the scheme *(paradigm)* of cognition's activity embodying a progressive system of ideals and norms of research (Kuhn 1962).

Any cognitive process of problem solving has a bidirectional nature – from less to more substantial and from less to more general knowledge. Aspiration to the unity of knowledge at the maximal breadth of reality coverage is caused by the unity of the world, to the display of which in science the given knowledge is directed. Growth of content-richness is caused by incessant penetration of science into more and more deep essence of the reality, defining its more and more adequate model (Popper 1984).

In the most general view disciplinary genesis of science includes two components: from particular theories solving specific problems concerning a part of the discipline's objects – to the fundamental theory fixing the most general knowledge concerning all the area of a discipline, and from the fundamental theory – to particular theories deepening knowledge of the fundamental theory.

Any interdisciplinary research includes: reveal of new relations between terms of original disciplines, establishment of the new system of laws connecting them, and synthesis of the solution pragmatists for new and more complicated tasks. Thus the knowledge of original disciplines may remain constant (an elementary, *linear* case of interdisciplinary interaction) and included entirely (or selectively) in a new hierarchical structure. The knowledge may as well undergo modification, or development due to the processes of exchange in paradigm installations, concepts and methods between different sciences (*nonlinear* interdisciplinary interaction) dictated by interdisciplinary character of a problem. But in all the cases there is a deepening of scientific knowledge and expansion or specification of the area of reality objects studied by initial disciplines.

Nonlinear interdisciplinary interaction combined with problem orientation has already become a conventional norm of global evolution in modern science (Stiopin 2003).

As a result of this process a new discipline, de facto, is formed and the iterative sequence of events repeats infinitely (from some disciplines through interdisciplinary research – to new disciplines with a new object of research) towards the approach to the integral scientific picture of the world.

The real state of affairs in science is characterized by the following: problem situations arising during the infinite process of cognition continuously become complicated and include the increasing area of reality phenomena. Thus the greater number of the problem situations demand interdisciplinary research for their solution.

On the basis of the stated above, it is possible to consider the following as the most essential attributes of interdisciplinary research:

- *Active possession* of the wide range of knowledge;
- *Unification of the form* of knowledge representation for different scientific disciplines with regard to the actual problem's solution;
- *Non-deterministic* creative process of substantial connection of insufficiently constructive scientific knowledge accumulated by diverse scientific disciplines into conceptually unified new knowledge (being the decision of some problem), creation of which is exactly the purpose of the corresponding STP.

3 Statement and general characteristic of the efficiency problem in scientific research

The current state of affairs cannot exist for a long time as it continuously complicates the scientific activity, which leads to constant decrease in efficiency of scientists work and which in its turn causes the reduce of new knowledge importance .Finally, the contribution of science into solution of urgent problems of social evolution decreases, threatening with the contribution's full loss.

On the basis of the stated, the essence of the problem of scientific research efficiency is finally reduced to the following problem of 0 levels:

Achievement of socially significant growth of the scientists' working efficiency by improvement of information technologies, directed at overcoming barriers on the way of scientific progress.

The solution of this problem is exactly the key that opens a door to acceleration of scientific development rates and progress of society as we will not exaggerate excessively by asserting that "*all components of a modern civilization are initially created in scientific laboratories*" and that is why the we consider the given problem as the most important and most actual for development of science and a society.

4 Necessity of problem solving in the form of **STP**

4.1 The characteristic of the problem's complexity

The formulated **0-level** problem is fundamental, its solution depends on the whole complex of conditions (scientific, organizational, material, financial and personnel), among which specific knowledge's creativity of many scientific disciplines is determining.

In the world science there is no standard constructive scientific theory of statement and effective solution of any scientific problems not only concerning interdisciplinary research, but also research within the framework of the any separate unit of science. Moreover, even the obvious statement of this problem is absent. Main causes for such state of affairs consist in its ultrahigh complication and complex character. Remaining the basic subject of the methodology of science, cognition processes and their components are investigated when solving the specific problems in cybernetics and mathematics, the theory of complex systems, linguistics, logic and in all a spectrum of computer sciences: from computer engineering up to the systems of knowledge processing and an artificial intellect.

4.2 An unproductive component of the scientists' work

Still Aristotle was confident, that any doctrine and training are based on some earlier existed knowledge. The appeared or extracted knowledge is necessary for scientists and their professional work just as a pivot was necessary for Archimed to raise the Earth. Presence of volume of the extracted knowledge, sufficient to be a basis for some problem's solution, is the only (except for necessary and sufficient attributes of a learning subject and conditions of its work) and objectively necessary condition of success. In the most abstract form scientific activity is carried out according to the iterative structure (fig. 1), where 1 – extracted knowledge, 2 - the plural subject of science, in particular in structure of pairs: 3 - scientists, 4 - information technologies (IT), 5 - the reality.

This implies a direct dependence of the professional work efficiency of scientists on labor expenditures on *search, reveal and comprehension* of actually necessary fragment of extracted knowledge and *operating* it in the course of research. In its turn, the volume of all these four components of labor expenditures is determined by perfection of the form of representation of the becoming knowledge circulating in society, i.e. by the level of its most essential attributes:

- *Popularity* (a range: from well-known, professional up to indeterminate knowledge);
- *Openness* (a range: from obvious up to the implicit form);
- *Commonality* (it is measured by a variety of forms);

- *Constructivity* (a range: from suitability up to ineligibility for direct use in problem solving). According to a standard conception about duality of the world, knowledge acquires constructivity in two displays: *information* (algorithms, knowledge bases, databases etc.) and *material* (patents, projects of designs etc.).

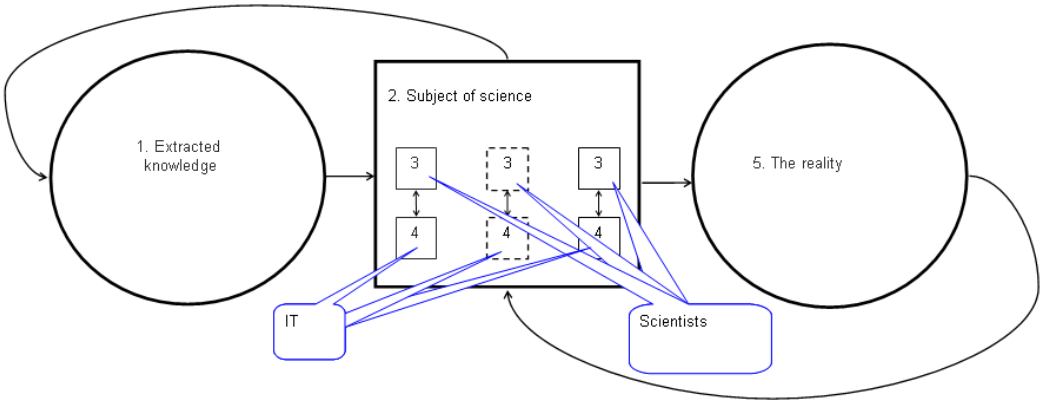

Fig. 1 Iterative structure of scientific activity

Obviously, the global minimum of labor expenditures or the maximum of the scientists' professional work efficiency exists only in a very small discrete subset (concerning cumulative extracted knowledge of all the area of science) of knowledge. It is represented in the single unified form, obvious, constructive and well-known concerning all the science (or well-known regarding disciplines to which the researched problem belongs). The form of knowledge meeting these conditions we shall name *canonical* (fig. 2).

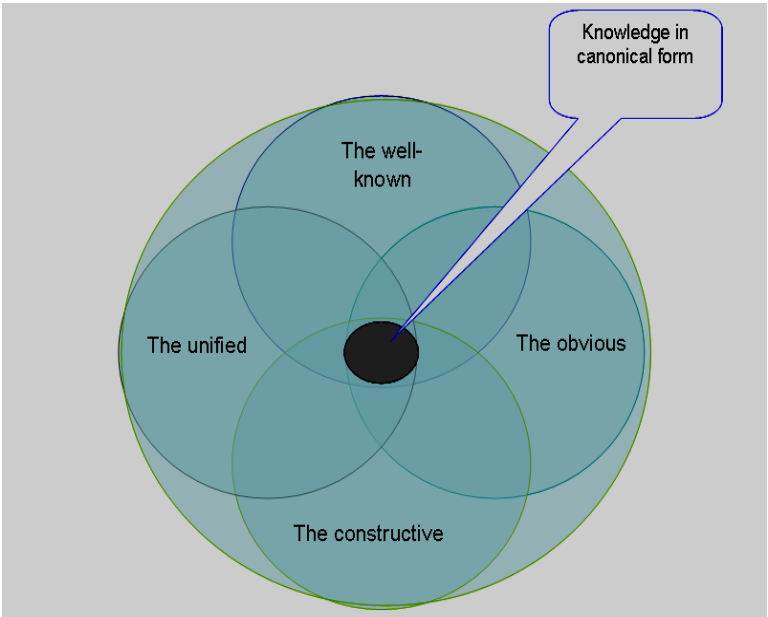

Fig. 2 Area of the maximum of scientists' professional work efficiency (the general area of five rings) - only a small part of extracted knowledge of the general area of science

Usually, *optimum conditions are absent* owing to many reasons and mainly some combination of negative attributes of knowledge takes place: *non-openness*, *uncertainty* (general or concerning some discipline), *non-constructivity* and *non-commonality*. In all these cases, instead of direct research of a current problem scientists apply efforts to *search* (with full or partial absence of guarantees of existence), *comprehension* and

transformation of the extracted knowledge from implicit into obvious, from unconstructive into constructive and from different forms into a singe unified form with reference to conditions of the current problem.

All labor expenditures on *search*, *comprehension* and *transformation* of extracted knowledge, i.e. on its multiple reprocessing, are unproductive concerning the solution of each of many current problems; their volume reaches the lion's share of cumulative labor expenditures on separate problems' solution, and in general may considerably exceed labor expenditures on primary creativity of extracted knowledge. Moreover, this part of professional work of scientists is not only socially useless, but it even harms, as in each concrete research is carried out ad hoc (i.e. concerning specific conditions of the current problem), continuously increasing entropy of extracted knowledge in the general area of science.

4.3 Alternative ways of problem solving

In all the set of probable solutions of a 0-level problem there are two alternatives: evolutionary - gradual accumulation of positive effects and revolutionary - at the expense of paradigmatic innovations' introduction into the development of information technologies of processing and distributing scientific knowledge in society.

A number of lacks is inherent in the evolutionary way, namely:

- As the cognitive process *is not determined*, and *suitability* of the scientific results' content (in the modern form) *to the control is too low*, each research brings to the common coin box two parts of knowledge – the part that reduces entropy of awareness about reality, and another part that increases it, according to the two components of the scientists' work (productive and unproductive). At the same time the real state of development of a modern civilization does not add optimism for confidence in reduction of the common entropy of scientific knowledge while using available information technologies. Even if reduction takes place, it is quite obvious, that its *rates do not correspond to requirements of time*;
- Now, as a result of an informational "explosion" and continuous expansion of scientific space, *the volume* of extracted scientific *knowledge has already achieved critical point* in ability of scientists to receive actually necessary part of knowledge, its mastering and active use;
- *Indemnification* of an unproductive component of scientist's work at the expense of *extensive development* of science *is unacceptable in essence*;
- It is allowable to assert, that the present *state of development* of science is close to *crisis*.

Thus the problem situation is obvious and it is unsolvable at the current state of affairs. As the acuteness of a problem situation induces to resolute actions for its solution, the specified lacks and difficulties of evolutionary succession of events compel to concentrate effort on development and realizations of an alternative way, especially as according to the general belief *about no time for delay in science*!

As a whole, the way of paradigmatic innovations is quite natural, it is certified by the indisputable facts of development of both separate scientific disciplines and all science, and it repeatedly justified itself. Its efficiency (even at presence of risk) is generally accepted, provided that a new paradigm has ripened enough within the current one, i.e. its suitability for solving available problems (unsolvable or difficult within the limits of a current paradigm) and an opportunity for realization of its constructive embodiment are grounded (Kuhn 1962).

4.4 The basic idea of the problem solving

It is offered to change cardinally the methods of extraction, representation and use of scientific knowledge, and as consequence - the attitude to knowledge on the part of a society, scientists themselves and finally to science as a whole (Palagin and Kurgaev 2009).

In a modern society there is a conventional belief, that *the scientific knowledge* (irrespective of its structure, level and place, time of creation and the subject-creator) is *a version of raw material* use of which is impossible without spending additional resource for its processing during new knowledge's creativity and/or creation of more or less

useful material or information product. There are quite enough bases for it, which can be proved by world scientific practice, and all scientists submissively accept it as inevitable evil or, on the contrary, as a public permission for imperfection of personal working results.

Obviously, such state of affairs does not satisfy anyone. In interaction of society and science everyone is interested in receiving the greatest contribution to one's development: society from science, and science from society. The exit of this problem situation is only one – meet each other instead of opposition, filling with the constructive contents and accepting for joint realization the well-known thesis: "*Science is a direct productive force of social progress!*". It is offered to make a fundamental statement as a new paradigm's foundation.

The statement. *Extracted knowledge in a canonical form – is the most perfect version of a fixed capital of society which is providing development of science and progress of the civilization*.

It has own bases even now, as the common attributes (suitability for duplication, modification, development, improvement of safety and comfort of life and labor, growth of social progress rates, profit formation etc.) are inherent in its components. Regarding the quality of the listed attributes, there is no doubt that knowledge's attributes are essentially better, than attributes of material versions of a fixed capital, and only scientific knowledge may determine and continuously correct civilization's development towards its harmony with nature. In spite of this, it is obvious, that in relation to modernity the suggested statement is false, as the scientific knowledge still does not possess the following most essential attributes of the final commodity and condition for its existence in society:

- Suitability for *direct use*;
- *Measurability* of parameters of quantity and quality;
- *A market price* and *cost*;
- *Effective norms for the rights and duties* of the manufacturer and consumers.

The essence of the 0-level problem's solution consists in an embodiment of necessary and sufficient conditions for effective functioning of the extracted knowledge as a commodity and also in stimulation of this process. The main means for achievement of these conditions should be the solution of the scientific problems' set concerning creation of a system of new computer information technologies which are adequate to natural problem solving processes in science.

4.5 Hierarchy of problem situations

On a way of solving the 0-level problem appears a group of the 1-level problems the presence of which is proved by the 1-level problem situations confirmed by the facts of a modern state of science:

- *Inadequacy* of modern computer knowledge processing to natural process of scientific research;
- *Difference of the form* of the scientific knowledge used for the constructive problem solving and the form that circulates in an infrastructure of the knowledge distribution in society.

Each of the specified problem situations of the 1st level is complex in its turn and demands carrying out the research of different scientific disciplines for solving the problems of the 2nd level, the presence of which is proved by the problem situations, in particular:

- *Insufficient* constructivity of scientific knowledge, its *ineligibility* for direct use in solving the current and new problems and for practical implementation;
- *Variety* of the existing forms of extracted knowledge (i.e. structures and languages of theories), inherent in different scientific disciplines, in comparison with *the unified* form of conceptually single new knowledge, for creativity of which a corresponding STP is generated;
- *Complexity, variety and uncertainty* of natural creative processes for statement and solution of scientific problems, their versions and components;

- *Inadequacy* of computer information technologies, models and languages of knowledge representation to natural creative processes of statement and solution of scientific problems;
- *Inadequacy* of the working Internet-technology to needs of scientists concerning accuracy and relevance of search of actually necessary scientific knowledge;
- *Production* of new scientific knowledge is carried out by intensive work of creative persons who pay *the expensive price* for it , and *it is sold too cheaply*, almost at the price of the carrier spent for fixing this knowledge;
- *The level* of educational methods and technologies, preparation of experts in the higher school *does not correspond* to the modern state of science.

The stated items prove quite sufficiently the complexity, interdisciplinary character of research of the formulated **0-level** problem.

5 The characteristic of problem solving results

5.1 Expected results

As a result of research directed at the solution of the problem situations listed above, the following should be determined: a conceptually uniform area of extracted knowledge in canonical form and the totality of adequate and mutually coordinated information technologies for effective support of all components of scientific professional work in the sphere of any scientific problems' constructive solution and direct practical implementation of new scientific knowledge.

Analyzing the essence of causes and effects of paradigm innovations' introduction into computer systems' development, it is possible to make certain, based on many facts, that the whole evolution of computer science is connected with reception of precisely these results. At the time of computers' emergence the primary attention was concentrated on questions of practicability of constructive calculations and achievement of record values of quantity indicators. Eventually among the foreground questions appeared issues of adequacy of information-analytical support for all components of natural problem solving process in relation to scientific and practical problems. Nowadays the primary attention is focused on realizations of knowledge processing systems represented by various formal models with use of modern mathematical methods and architectural decisions, in particular, with hardware support of these methods.

5.2 The characteristic of the results' efficiency

Due to lending a combination of the most essential creative attributes to the extracted knowledge, under conditions of their overall effective support by means of information technologies and rules of law, scientific knowledge will acquire the abovementioned but absent now attributes of a final commodity:

- Suitability for *direct use*;
- *Measurability* of parameters of quantity and quality;
- *A market price* and *cost*.

Efficiency of the solution for the abovementioned problem situations is defined by the sum of effects (different quality as a whole) from purchase of these and other attributes.

5.2.1 The effect from direct use of the extracted knowledge

This effect is formed due to the change in structure (fig. 3) of the scientists' professional work in new (II) information technology in comparison with traditional (I), where labor inputs on: 1 - search, 2 - comprehension and transformation of the extracted knowledge in an canonical form; 3 - creativity of new knowledge (operation

with knowledge, theoretical and empirical knowledge, examination of hypotheses and test of results); 4 - embodiment in the final information product.

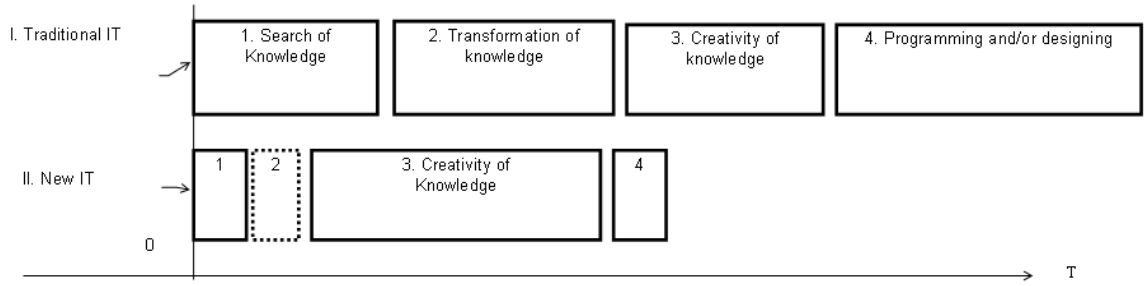

Fig. 3 Comparison of structure of scientists' professional labor inputs in two information technologies, where T – time

In new information technology:

- Labor inputs 1 for search of actually necessary knowledge are essentially smaller than in traditional informational technology, due to restriction of search space by knowledge in a canonical form;
- Labor inputs 2 are optional (any benefit is possible only from their part connected to the knowledge comprehension, though, mainly we are not interested in some artifact's functioning, if only it is known which problem it solves and also norms of its use);
- Labor inputs 4 are essentially reduced due to the use of technology opportunities in operating information in the form of knowledge.

Granting scientists an opportunity to use knowledge directly in a canonical form creates the *base* that will allow scientists either to find time for the new problem solving, or to concentrate all their creative abilities and efforts on improvement (validity, deepening and generalization) of the new knowledge being the constructive solution of certain actual problem. That is, the new opportunity creates necessary and sufficient conditions for essential *growth of the* scientists' *professional work efficiency*, *rates and quality* of scientific development.

5.2.2 Effects of the knowledge parameters' measurability – such as quantity and quality

Quality of the extracted knowledge acquired as a result of any scientific research, is exhaustively determined in four-dimensional space of the most essential attributes:

- *A problem,* solution of which is a new knowledge;
- *The content* of knowledge;
- *The form* of knowledge;
- *A fragment of the reality* to which the knowledge is distributed.

Specific characteristics are inherent in each of these attributes:

- *The problem* is determined by a closed logic formula (or its natural language equivalent) validity of which is a consequence of scientific research, and also by a place among other problems of science (or its separate discipline) in the form of structure of connections between them;
- *The contents of knowledge* is determined by a cortege of <*A*, *KB*, *K*, *X*, *C* > sets (where *A* - axioms, *KB* - basic concepts, *K* - derivative concepts, *X* - variables, *C* - constants) and *structure S* built on their generators;
- *The form of knowledge* is determined by volume (e.g. in quantity of definitions, formulas, text's or code's lines etc.) and some set of quality indicators (in particular, productivity of task solution, volume of testing, tasks' examples etc.);

- *The fragment of the reality* – is a cortege of sets of objects or phenomena, to which knowledge is distributed, i.e. domains of *X* – variables, and *C* – constants .

For example, on the basis of the logic formulas being the statement for different problems, it is possible to define some set of relations between them, in particular, the relation of following, and on the basis of structure of some problem's connections with other problems – their affinity to *the base* or *periphery* (to a special, individual branch) of corresponding discipline and other problems' dependence on it.

Only for the canonical form of extracted knowledge there is an opportunity to measure indicators of quantity and quality of scientific results and, accordingly, *assess objectively, compare and supervise* scientific research results. In particular, due to this it becomes possible to measure *the* certain researches' *level of fundamentality*, completely *exclude* attempts of bureaucratic *dichotomy of science* (for example, its division into the fundamental and applied) and criteria of research *results' dichotomy into* obvious or implicit, constructive or unconstructive acquire an obvious form.

5.2.3 Effects of adequacy

Effects of *adequacy* of information technology to natural problem solving processes consist in comfort improvement in the scientists' professional work at the expense of granting qualitatively new opportunities for individual use:

- Direct operating with knowledge;
- Supports of intellectually difficult processes of theoretical and empirical cognition, transformation of implicit knowledge into obvious, etc.;
- Establishments of mutual understanding, partner interaction with a computer directed at problem solving.

In its turn, a new quality of comfort comes back to scientific development as an additional (related to fig.3) decrease in the scientists' labor inputs exactly into the creative component, as a more complete display of the deepest components of scientists' personality intelligence concerning *quality perfection* of problem solving results, and also as a growth *of appeal* and *prestige* of scientific work in society.

Due to structural change in the creative component of scientists' work, in new (II) information technology we will obtain essential *social effect* (Kurgaev 2008), in comparison with traditional (I) technology (fig. 4), where 1 - programming and/or designing; 2 - task solving; 3 - knowledge in a canonical form (accumulated at the beginning of the current problem's solution), 4 - the new knowledge acquired during the current problem' solution.

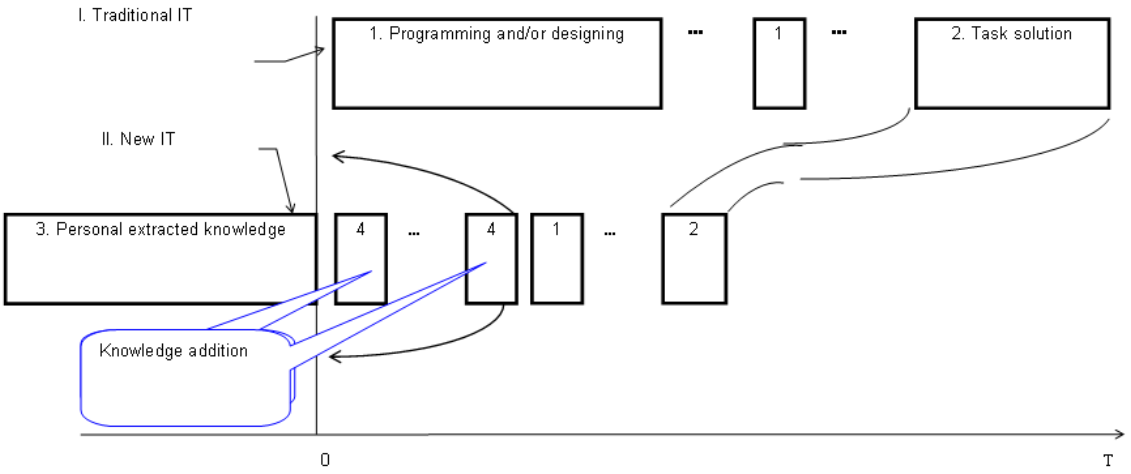

Fig. 4 Comparison of structure of individual professional scientists' work in two information technologies, where T – time

Social effect is generated from two components; the first one consists in change of attitude to evaluation of the researchers' work:

- Information products created by using traditional technologies, do not accept secondary use for task solving, and the tasks' statement differs from the primary one. Therefore these informational products are valued as quickly worn means of labor, and accordingly the labor applied to them is qualified as not valuable and quickly losing its utility;
- The new information technology is based on accumulation of knowledge in a canonical form – knowledge entered and verified is suitable for multiple reuses, irrespective of the specific tasks' statement up to moment of change of reality or our idea about it. The labor applied for knowledge extraction, accumulates and acquires the quality of an intellectual capital, and the character of labor update coincides with the character of update of capital's means.

This component is estimated as the difference between total cost of the past labor applied to the extracted knowledge which is a basis for the current problem's solution, and the cost of the labor applied to the knowledge adjustment and update.

The second component of social effect is defined by saving social labor for problem solving by new technology application.

5.2.4 Effects of attaching a market price and cost to the knowledge

The knowledge received as a result of any of scientific research, acquires the objective price and cost only within market relations between manufacturers and consumers of knowledge and with strict observance of legal relations between them.

Primary cost *of the C-knowledge* in a canonical form can be defined on the basis of different fact sheets. In particular, the assessment will be quite objective in the following range:

$$C_0 \cdot (1 + k) \le C \le k \cdot P,$$

where C_0 – the cost price of knowledge, k – average profit rate for information branch, P – the average consumers' profit on the use of knowledge, cost of which is assessed. Market cost is determined by conditions of supply and demands.

Obviously, that *the main effect* from adding *a market price* and *cost* to knowledge consists in involving science in *direct participation* in economic activity of society with all its positive attributes and consequences, the essence of which leads to more effective (in comparison with modern) use of powerful regulating mechanisms of market relations as *additional stimulus* for scientific development.

5.2.5 Effects of assistance to positive tendencies of social development

The abovementioned effects prove the expediency of the considered way for the specified problem situations' solution and prove it more than sufficiently.

However *the main effects* are seen in realization of the optimum new conditions for evolution of the positive civilization phenomena observed at present. These positive phenomena consist in *development* (in structure of type fig. 1) *population* of individual man-machine intellectual systems (IMMIS) where information technologies play the role of a catalyst, an amplifier of individual intelligence. Due to the possibility of continuous knowledge accumulation (according to fig. 4) new information technologies are means of encouragement for development of human creative abilities, realization of personal ambitions concerning the intellectual capital's accumulation for social status improvement at the expense of it, and also are the guarantor of rights and freedoms for each scientist.

In its turn, the development of IMMIS population capable of knowledge creativity in the form of end product is optimum for existence and development *of creative* IMMIS *groups* in which necessity of administration is

completely eliminated (bureaucracy is out of the question) and a basis for trust and cooperation is displaced from moral to professional qualities of colleagues. Due to this there appear *new opportunities* for socially significant growth of scientists' professional work efficiency in problem solving, because owing to *creative interaction* in a working team total result of work of each creative team (measured by collective volume of knowledge) is essentially higher than the sum of those results for team members, which they are capable of outside of the team. This additional effect, under condition of efficient protection of the employees' rights for its part, serves as a cementing stimulus for a creative working team, and its existence – as competitiveness in *the creative society*, which is determined by the total effect of realization for the created non-material product.

The structure of effective knowledge and problems' functioning in society (fig. 5) includes: 1 – extracted knowledge; 2, 3 – an information and material embodiment of knowledge in a canonical form; 4 – current problems of science and society; 5 – problems in the obvious form; 6 – set of structures built of creative IMMIS groups; 7 – creative IMMIS groups; 8 – administrational structure for the managing subjects of society; 9 – managing subjects; 10 – educational structures; 11 – examination of the produced knowledge in novelty, perfection, utility; certification of knowledge, their distribution according to these features and allocation of knowledge in a canonical form; 12 – realization of market relations concerning knowledge; 13 – examination of problems in novelty, importance, urgency, and certification of problems.

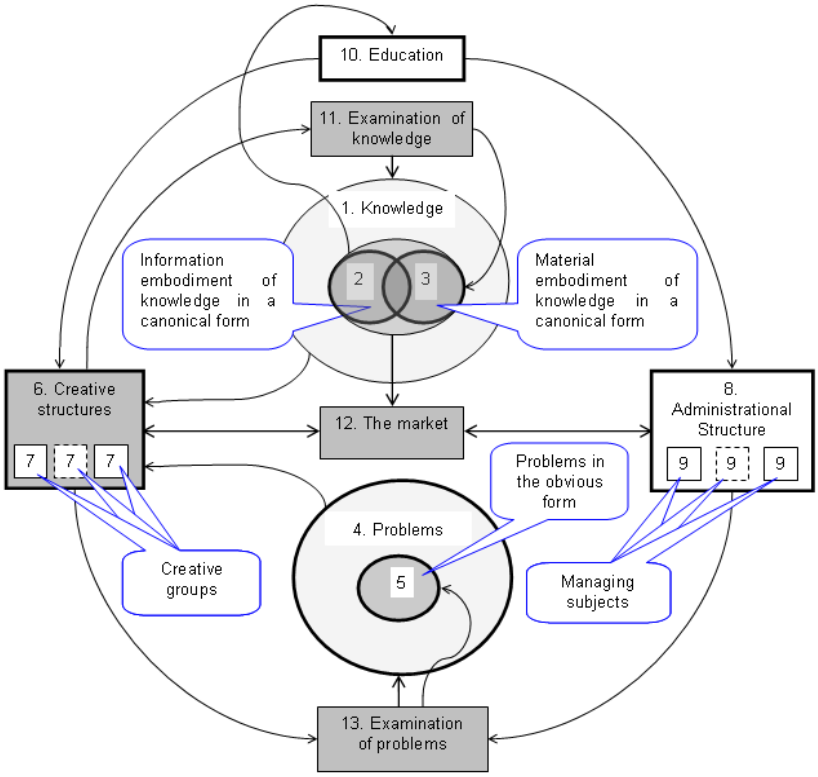

Fig. 5 Structure of information space of the effective process of the knowledge and problems' functioning in society

At fig. 5 new or essentially updated components of a (modern) information infrastructure for spread of knowledge are selected with blackout. The presented structure shows the interaction of its components which due to mutually coordinated combination of positive effects of several feedback contours creates optimum conditions for stimulating informational development of all society's components – science, education and manufacture (Palagin and Kurgaev 2009).

6 Summary and Concluding Remarks

It is proved, that:

- The area of a maximum of scientists work efficiency is limited by extracted knowledge in a canonical form, i.e. obvious, constructive and presented in the unified form;
- Paradigm innovations are expedient for development of information technologies of processing and distribution of scientific knowledge in society.

It is offered to accept for implementation the new attitude to scientific knowledge (as to *the most perfect version of a fixed capital of society*) by providing the knowledge with the most essential attributes of the final commodity which are absent at present and creating the most favorable conditions for its existence and development in scientific and public practice.

It is proved, that efficiency of results for creation of new information technologies' system is defined by the sum of effects, in particular:

- *Unproductive labor expenditures* of scientists are extremely reduced due to *the direct use* of extracted knowledge in a canonical form;
- Only the canonical form of knowledge enables objective *assessment* (in particular, in money equivalent), *comparison and supervision of* scientific research results;
- *Comfort* of scientists' work essentially improves due to use of the information technologies *adequate* to natural creative processes in problem solving;
- *Quality* of problem solving results *will be improved* and *appeal and prestige* of scientific job in society grows;
- The extracted knowledge acquires attributes *of the intellectual capital* owing to the realization of functions *of knowledge accumulation* in a canonnical form;
- With the receipt *of a market price* and *cost* by knowledge, science becomes *a direct participant* of the economic activities of society, which serves as an additional stimulus for scientific development;
- The updated information infrastructure of knowledge functioning in society technologically provides productive interaction of all its components, which create the most favorable conditions for progress of both the science and a creative society.

Bibliography

Kuhn T.S (1962) The Structure of Scientific Revolutions, Chicago

Kurgaev A (2008) Problem orientation of computer systems architecture. Stal, Kiev

Palagin A. and Kurgaev A (2009) Interdisciplinary scientific research: optimization of system-information support. Visnik. *National Academy of Sciences of Ukraine*. 3, pp. 14-25.

Popper K. R (1984) Evolutionary Epistemology. In: Pollard J. W (ed) Evolutionary Theory: Paths into the Future, John Wiley &. Sons, Chichester and New York, ch. 10, pp. 239-255.

Stiopin V. S (2003) Theoretical knowledge. Progress-Tradiciya, Moscow

Authors' Information

Alexander F. Kurgaev *- Leading Researcher, Doctor of Technical Science, Ukraine, Kiev, 03187, Akademika Glushkova ave., 40, Institute of Cybernetics V.M. Glushkov National Academy of Sciences of Ukraine, E-mail: afkurgaev@ukr.net*

Alexander V. Palagin *– Prof., Member of National Academy of Science of Ukraine, Deputy Director Ukraine, Kiev, 03187, Akademika Glushkova ave., 40, Institute of Cybernetics V.M. Glushkov National Academy of Sciences of Ukraine, E-mail: palagin_a@ukr.net*