European Research Studies,
Volume XVIII, Issue 4, Special Issue, 2015 *pp. 47 - 56*

Generic Heurorithm of Innovation Management from Generating Ideas to Commercialization

A.I. Bashmakov[1], V.V. Popov[2], D.N. Zhedyaevskii[3], D.N. Chikichev[4], E.A. Voyakin[5]

Abstract:
The problem of providing an integrated scientific, methodological and information support of the innovation process, covering all its stages including the creative phase, at which novelties are created (solving the problem of conceptual design), is considered. The generic heurorithm (heuristic algorithm) of the innovation management serves as the methodological basis for the implementation of the information support and management innovation system. It is a standard program tool for corporative innovation infrastructure for use in universities, and is intended for describing, accounting and management of ideas at different stages of the innovation cycle.
Heurorithm has a modular structure and is represented by a graphical notation systems working schemes. Its schemes reflect a variety of means to support innovation: scientific and methodological support, methods, instructional materials, information resources and a program toolkit (including components of information support and innovation management system). These means correspond to the heuristic components of activities and heuristic information facilities: weakly formalized creative processes and experience gained during their realization. Availability and detailing of heuristics generated and used at different stages of the innovation process for its intensification, is one of the main differences between the developed heurorithm and known organizational charts of innovative activity. On the basis of the generic heurorithm in the system of information support and innovation management an interactive navigator on the stages of the innovation process and means of its support is developed.
The research was conducted at the financial support of the state e represented by the Ministry of Education and Science of the Russian Federation (the unique identifier of the research work RFMEFI57314X0007).

Key Words: *Invention, innovation, innovation management, innovation cycle, conceptual design, scientific methods and information support of innovation, scientific and technological creativity, software tools support innovation, heuristic facilities, heurorithm.*

---

[1] PhD (Technical Sciences), Research & Manufacturing Association "Inform-Systema", info@informsystema.ru
[2] PhD (Technical Sciences), Research & Manufacturing Association "Inform-Systema", info@informsystema.ru
[3] PhD (Technical Sciences), Russian State University of Oil and Gas named after I.M. Gubkin, info@informsystema.ru
[4] Russian State University of Oil and Gas named after I.M. Gubkin, info@informsystema.ru
[5] IBS Group, Director of Education Department, evoyakin@ibs.ru

Introduction

In today's economy the competitiveness level of the country is mainly determined by the efficiency of the national innovation system – the amount of innovation and volume of competitive high-tech products produced. In recent decades, Russia is working on the creation of such system, forming various kinds of support for innovation, intensively developing infrastructure – technology parks, innovation and technology centers, innovative-industrial complexes and clusters, centers of technology transfer and commercialization, coaching centers, business incubators, and even science cities.

However, efforts to create a national innovation system yet have a little impact on the growth of the quantity and quality of innovations. In the world rankings of competitiveness Russia does not rise above 50s positions.

One of the reasons for this situation lies in the fact that many innovators practically don't have the effective tools (methods, techniques and means) for knowledge management of the creative process at all stages of innovative activity - from generating competitive ideas to their commercialization.

1. Disadvantages of the traditional approach to innovation support

The dominating approach to the construction of national innovation system focuses on the process of commercialization of scientific and technical activities results, i.e. bringing innovations to the market. It is assumed that the very innovations (concept technical solutions of varying degrees of maturity) either already exist, or successfully created within processes, the support of which is not a priority of the innovation system.

As a result, the most important inalienable stages of the innovation cycle, providing the formation of innovation (the definition and specification of technically implementable needs, formulation of the problem of creating a novelty, consistent solution of this problem by the methods of scientific and technical creativity), are on the periphery of the innovation management [1–3]. The support of these stages by the current innovation infrastructure is minimal and is reduced only to formal issues (for example, planning and accounting of jobs by means of the project management technology). All intentional problems of conceptual design are solved without the use of system-wide resources of scientific and methodological support, provided by the innovation infrastructure.

Several researchers justify this distribution of priorities between the areas of responsibility of the innovation system by the creative nature of designing a novelties, complicating their formalization. Also, there is a point of view that the problem of creating novelties is not actual (there is a "sea of ideas"), and the effectiveness of the innovation process is determined by the marketing of the results of scientific and technical activities and the search for sources of funding for their commercialization.

In our opinion these arguments cannot be accepted, because it is not about formalizing the process of scientific and technical creativity and knowledge of the subject areas in which it is under way, but about ensuring their advanced scientific, methodical and information support. Research of engineering creativity process, cognitive technologies and heuristic methods of conceptual design indicate the existence of objective laws and regularities of the technology and engineering development, and invariant to the domain methods of the directed search and synthesis of new technical solutions [4–6].

Ideally, every specialist involved in the innovation process should possess the appropriate methodology and have access to the cross-industry facilities of heuristics that support it [7]. Creating such environment for innovation is the task of the national innovation infrastructure, which should include scientific, methodical and information support means, covering all stages of the innovation cycle, including creative ones. The availability of these facilities for a wide range of users is achieved through their implementation on the basis of modern web-technologies.

2. Generic heuristic algorithm as a methodological basis of software tools to support and innovation management at all stages of the innovation cycle

One component of this program toolkit class is the *information support and innovation management system (ISIMS).* It is an element of the corporative innovation infrastructure, oriented on use in universities, and is intended for describing, accounting and management of ideas at different stages of the innovation cycle. The methodological basis of ISIMS is a generic heurorithm of innovation management from idea generation to commercialization.

Heurorithm is a heuristic algorithm which describes the system of actions to solve a problem. In contrast to the algorithm that determines the formal process leading to the goal with a guaranteed in a finite number of steps, heurorithm includes unformalized steps performed on the basis of experience and the creative efforts of a human. Thus, despite the similarity of purpose with an algorithm as a process specification mean, heurorithm essentially cannot be fully realized as a computer program because it includes sections that require creative interaction.

Heurorithm specifies scientifically based rational method of activity. Following it contributes to the effective solution of the problem, but in general, due to the creative nature of activity the goal is not guaranteed.

Another difference between heurorithm and algorithm is changing while it is performed and the number of "passes" increases, reflecting the accumulation of human experience. This improvement of the activity scheme can be described as accumulation of information assets used in heuristic blocks (weakly formalized processes).

As part of the ISIMS an interactive navigator on the innovation process stages and means of its support is realized based on generic heurorithm.

To describe the generic heurorithm a notation of the system work schemes is used. For the correct interpretation of the heurorithm the presence of unformalized components should be taken into consideration.

3. Structure of the heurorithm

The heurorithm has a modular structure. On the upper level there is a generalized diagram of the innovation process which covers 6 stages:

1) identification of the need;
2) formulation of the problem (the formation of technical specifications);
3) solving of the problem (product development);
4) commercialization;
5) identifying and realization of the additional needs increasing the value of the product;
6) clustering and diversification, as well as an overall assessment of the innovation effectiveness.

Each of these steps is represented by a relatively compact diagram, containing connectors linking it with the diagrams of adjacent steps. Key processes of each stage are detailed on individual diagrams.

In the diagrams of the heurorithm the means to support the innovative activity are presented. These means are implemented in various forms: scientific and methodological support, methods, guidance materials, information facilities and program toolkit (including the ISIMS components). They correspond to the heuristic component of activity: weakly formalized creative process and experience gained during their implementation.

Availability and detailing of heuristics formed and used at different stages of the innovation process for its intensification, is one of the main differences between the developed heurorithm and known organizational charts of innovative activity [1, 2].

In the top level heurorithm diagrams describing the six stages of the innovation process, heuristic means of its support are presented as a data blocks used in key procedures. The development of these resources and the formation of an innovative culture (competencies required for effective implementation of innovative projects) is carried out at each passage of appropriate procedures as well as through special processes performed when receiving unsatisfactory results at a stage.

In the diagrams describing key procedures of the heurorithm, heuristic support means are detailed more particularly. They are presented as processes related to supported process. At the same time application of the support tools, the volume and character of its use are situational and depend on the decisions of specialists involved in the project.

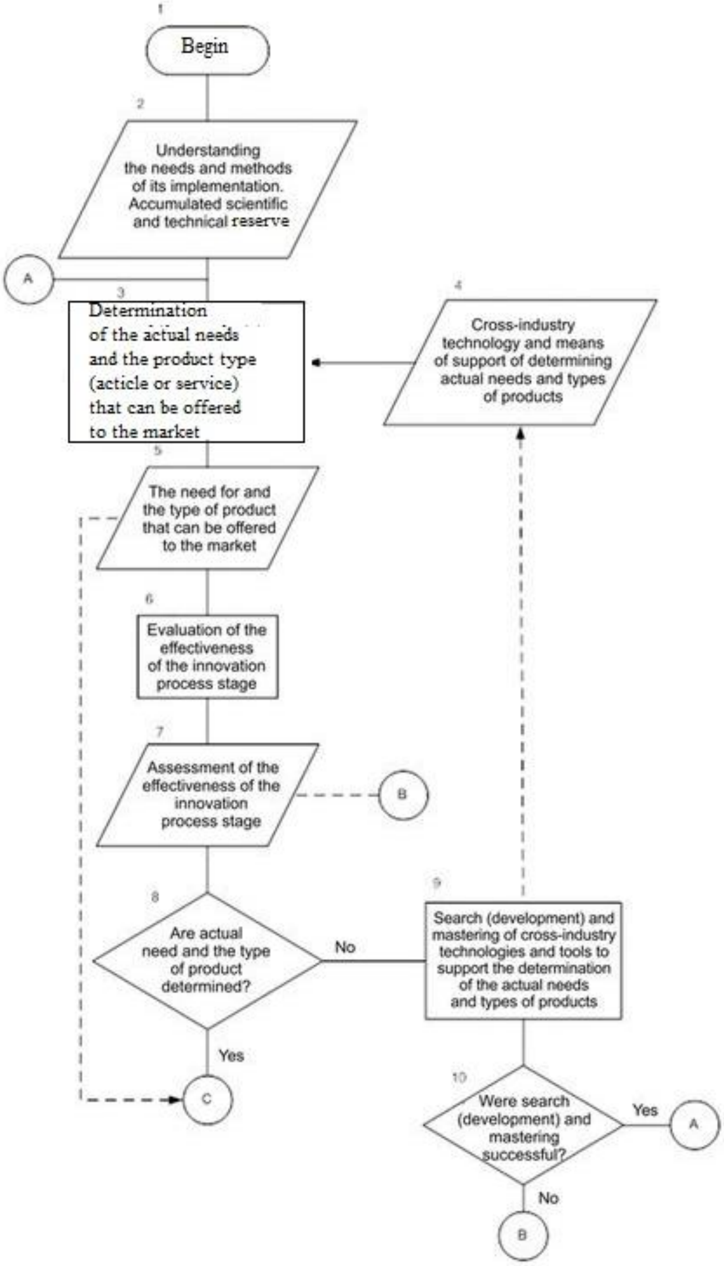
The portal implementation of the ISIMS includes an interactive graphical representation of the heurorithm:

- top level – diagrams for the 6 stages of the innovation process with the implementation of the transitions between them (stages navigation);
- the key processes of each stage presented by individual diagrams starting by activation of the respective blocks in the top-level diagrams;
- navigation on diagrams of key processes;
- visual selection of heuristic means of innovative activity support included in the ISIMS (subsystems representing the systematization of human needs, laws and regularities of the development of technology, technics and products, heuristics methods, directions of diversification of innovative activities as well as integrated into the ISIMS program tools for the intensification of innovative activity) with realization of the transition to these facilities via hyperlinks.

The upper level of the heurorithm describes it in general and does not contain detailed specifications of the processes. The purpose of generic heurorithm representation at the top level is to show the fundamental logic of action at key stages of the innovation cycle, as well as the relationship between the stages.

To provide a convenient representation of heurorithm the upper level diagram is divided into six parts corresponding to the stages of the innovation process. As an example, Figure 1 shows a top-level diagram describing stage 1. At this stage the needs and the product type (article or service) that can be offered to the market are identified.

Figure 1 – The upper level diagram of the generic heurorithm at stage 1 (identification of the need)



The analysis and identification of needs serve as a fundamental principle and a driving force behind any innovative activity. The initial information for this stage is a general idea about needs and the ways of its realization, which are available for the subject of innovative activity (designer, entrepreneur), and existing scientific and technological reserve (block 2). This information is determined beyond heurorithm so it acts as an input data.

The key process of the stage is 3 – Determination of the actual needs and the product type (article or service) that can be offered to the market, is detailed on the separate diagram. For its support the heuristic tools described by block 4 are used. They are replenished and adjusted during each performance of the process 3.

After the exit from the block 3 the effectiveness evaluation of the innovation process stage is carried out. This evaluation may be performed using techniques developed within the ISIMS project. The resulting evaluation of the block 6 is used for forming an integrated effectiveness evaluation of the innovation process (data transfer from the block 7 to the connector B).

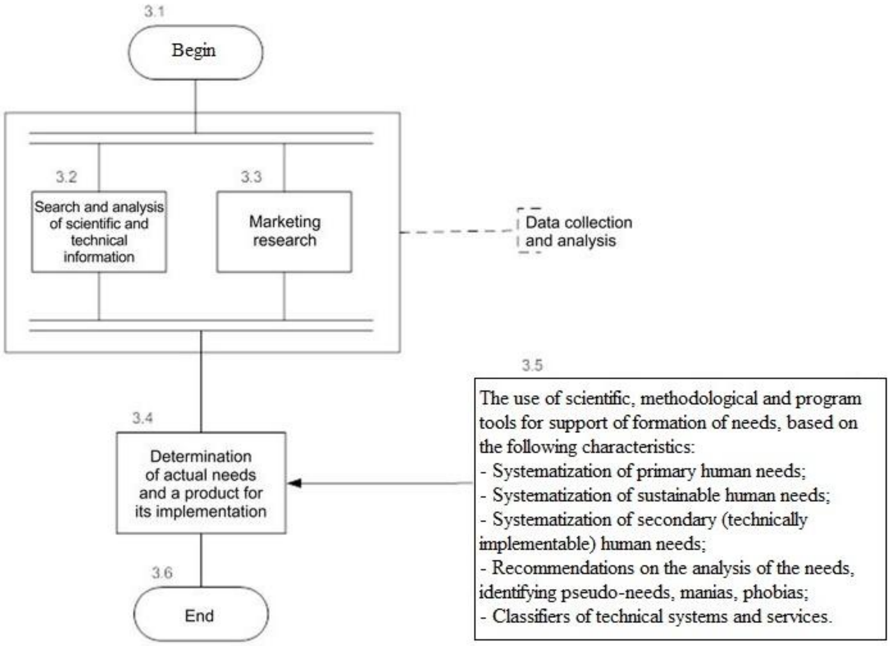
Unsuccessful completion of the process 3 does not mean that innovation process is finished. The cause of the failure may be the absence of effective cross-industry technologies and support tools for problem solving on the stage, or weak abilities to use of these heuristic tools. The process 9 provides the elimination of these problems by finding a suitable tool, its development and exploration. Upon successful completion of block 9 we should return to the process 3 (via connector A) to repeat it using replenished heuristic support tools and competences acquired. The negative outcome of the block 9 involves the transition to the final phase of the heurorithm (via connector B).

Achieving the goal of stage 1 (output "yes" from the block 8) causes a transition to the next stage of the heurorithm (exit to the connector C).

Similar in form top-level diagrams are developed for each of the six stages of the innovation process.

The example of diagram detailing key process is shown on Figure 2. This chart describes decomposition of process 3 of stage 1 (determination of the actual needs and the product type that can be offered to the market).

Figure 2 – The diagram of the process 3 – Determination of the actual needs and the product type (article or service) that can be offered to the market



The content of the first phase of the process 3 (processes 3.2 and 3.3) is collection and analysis of information specifying the original idea of the needs and the available scientific and technological reserve. The second phase (block 3.4) is search and formulation of the needs on the basis of the analysis results. Heuristic support toolkit presented by the block 3.5 is used.

Similar diagrams describe each key process in all stages of the innovation cycle.

4. The constitution of heuristic facilities for scientific, methodical and informational support of innovation

Generic heurorithm involves the use of scientific and methodological support of innovation, based on a variety of heuristics [4-8]. In addition to the heuristic facilities referred to in the section 3.5, such tools include:

- rules of identification and formulation of technical systems (TS) functions;
- interdisciplinary thesaurus of the TS functions;
- description of TS functional structures by R. Koller operations;
- ideal final result, its examples;
- modeling, synthesis and improvement of TS functional structures;
- the law of the TS stage development;
- the law of TS progressive evolution;

- the law of correspondence between the functions and the structure of TS;
- regularities of TS qualitative improvement;
- value analysis;
- functional and physical analysis;
- technical and physical contradictions in TS and the standards of their solution;
- technique of TS predecessors analysis and heuristic methods, inter-sectoral information fund of heuristic methods;
- modeling, synthesis and improvement of TS operating principles, databases of natural-scientific and technical effects;
- morphological analysis and synthesis;
- recommendations on the use of "good" and "bad" verbs;
- the focal objects and associations garlands methods;
- recommendations and examples on the use of metaphors;
- methods for analysis and searching of materials with unusual properties;
- methods of qualitative improvement of TS based on the resources containing in TS and natural and technical environments.

Conclusion

The validity of the developed generic heurorithm is determined by its comprehensive coverage of stages, phases and tasks of innovation activity, as well as conformity of heurorithm elements to the innovation cycle stages. The novelty of the heurorithm lies in:

- integral presentation of the innovation activity methodology in the technosphere with the laws and regularities of technology and engineering development;
- reflecting of heuristic tools and associated information and methodological facilities intended to support the innovation process;
- procedures of the development and exploration of heuristic tools and information and methodological support facilities for the innovation process, providing the formation of a new innovation culture.

Further development and use of the generic heurorithm in the ISIMS creation project is associated with the following tasks:

- implementation of the interactive navigator on stages of innovation process and its support facilities as part of ISIMS;
- development of program toolkit for innovation activity support as ISIMS subsystems under heurorithm.

References

Altshuller G.S. (1984), “Creativity As an Exact Science”, New York: CRC Press, p. 320, ISBN 0-677-21230-5.

Bashmakov A.I., Zhedyaevsky D.N., Popov V.V. (2011), “Creative pedagogics. Methodology, theory, practice”, edited by Popov V.V., Kruglov Y.G., The 2nd ed. Moscow: BINOM. Laboratoriya znaniy, p. 319.

Christiansen J.A. (2000), “Building the innovative organization: Management systems that encourage innovation”, New York: St. Martin’s Press, p. 357.

Cooke I., Mayers P. (1996), “Introduction to Innovation and Technology Transfer”, Boston: Artech House Publishers, Inc., p. 256.

Fey V., Rivin E.I. (2005), “Innovation on Demand: New Product Development Using TRIZ”, New York: Cambridge University Press, p. 242, ISBN 0-521-82620-9.

Hargadon A. (2003), “How breakthroughs happen: the surprising truth about how companies innovate”, Boston: Harvard Business School Press, p. 25.

Koller R. (1976), “Konstruktionsmethode für den Maschinen-, Geräte- und Apparatebau”, Berlin: Springer-Verlag, p. 184.

Polovinkin A.I., Popov V.V. (1995), “Technical creativity: the theory, methodology, practice: Encyclopedic reference book”, Moscow: NPO "Inform-Systema", p. 408, ISBN 5-88439-006-8.