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Three Main Issues of Understanding the World

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A ll animated objects in the World actively react on external impacts. This reaction permits them to forecast the changes in the environment. Humans set more challenging goals. Each person, and humanity in whole wants to increase their knowledge. To study a situation human brains create three main questions. They are: What? How? Why? The answers to all questions in this sequence create new knowledge. After this the sequence of the same answers repeats again. The sequence of these three questions is the simplest step in the cognition process or SSC. As a result the infinite way of cognition can be represented as spiral of knowledge. There are two possible ways to choose the first question in this sequence. Two possible directions are known also in the sequence of these questions. The choice between these two sequences of study the Nature depends on so-called Tacit Knowledge of an individual. Achievements in studying of transformation processes allows us to formulate some new problems for further investigations of production of new knowledge and investigations of some fundamental laws of human cognition.

Introduction: Three Main Questions of Human Knowledge

Nature at its core is heterogeneous. Each independent structure part of the Universe can be treated as an object. They are very different. All objects interact with each other. All known types of interactions between objects are very complex. Nevertheless it is possible to detect and discuss some general laws of interaction process (Romanenko & Nikitina, 2014). Animated Objects have active reaction on these external impacts. This is due to the fact that a living body needs to forecast the changes in its environment. One denotes such search for forecasting as *Probabilistic Prognosis* (Feigenberg, 2014). Animal forecasting is based on previous experience. Unlike animals, people set more challenging goals. Over the time the human behavior, i.e. a sequence of actions, began to be tied up with these specific goals (Vygotsky, 1978; Vygotsky, 1986). Just the presence of a goal of actions differs humans from other animals. Therefore, we can speak about the specific human property denoted as the mind. Solutions of human goals form, stage by stage, all human knowledge. Each person and humanity in whole wants to increase their knowledge. Human activity in this field distinguishes people from other animals.

Faced with a new situation human brains create some questions. Their diversity can be reduced to three main questions. The first question asked by a human being when he or she meets a new object or phenomenon is *What is it?* The primary response to this question enables us to generate a first perception of a new object or phenomenon. This perception makes it possible to differ the object (phenomenon) from others. We can say the answer to this question leads to separation or identification of the object. After one learns to identify the new object, his or her interest grows to find an answer to the question: *Where did this Object come from?* or *How does the sequence of actions enable its creation?* If one is interested in understanding the new phenomenon he (she) asks: *Where did this phenomenon come from?* The answer to this question gives a general idea about the actions on how the new object comes up. Learning this, one finally asks *Why was this Object created?* Learning the phenomenon one asks *Why does it consist of a given set of actions?* In brief, the way of human knowledge runs the sequence of three main questions (Romanenko & Nikitina, 2015a):

$$WHAT \rightarrow HOW \rightarrow WHY$$

This sequence has a form of triad. After all the answers to the sequence of these questions are received one can say: *A new*

step in creating new knowledge was completed. Human knowledge usually tried to find answers to these questions in a sequential order. There are two ways to run through this sequence. The first is from simple to complex (from left to right on the sketch above). This way is traditionally denoted as synthesis. The second runs in the opposite direction. This way is denoted as analysis or reduction. Historically, the first way was closely connected with human practice. One can rather treat the second way as theoretical or philosophical. These both ways of learning Nature always influenced each other. Moreover it is known that at long term development of knowledge the synthesis may be changed to analysis. This effect is known as *The Arch of Knowledge* (Oldroyd, 1986; Nevin, 2010). However, this change does not affect the sequence of three basic questions mentioned above. Therefore, all these three questions were frequently discussed simultaneously. However, the emphasis in their study has changed over the time and places.

The Spiral and the Circle of Knowledge

Human actions in the field of knowledge never stop. It develops unevenly over time, and in different areas. If one understands a new object or phenomenon he (she) immediately is faced with some new ones. As a result, the triad of new sequence of questions runs again. This new set of questions acts at the next level of knowledge hierarchy. At each new sequence the human curiosity returns back from the last question to the starting one. The system of human knowledge is hierarchical (Turchin, 1997; Rand, 1990; Ding, 2007). At the same time the knowledge moves up or down to a certain level of its hierarchy. One can say human cognition moves spiraling. In many cases one can simplify this way to a circle in the plane. The way up a hierarchical ladder corresponds to the synthesis of knowledge. The way down corresponds to the analysis.

Let us illustrate this with simple examples. Let's suppose that an archaeologist found a strange subject that looked like a horse stirrup. It is known at that period this object was not yet known. Moreover, its form was a little different from the common stirrup. The archaeologist asked himself what it was. After some studies he understood it was a part of weapon. Step by step the archaeologist reproduced the design of this weapon and began to search for its missing parts. After some time he rebuilt a Roman crossbow. This set of actions is the way up in a knowledge spiral. As it was already mentioned, this is the process of synthesis. The second example is historical. In 1901 Greek divers studied a sunken ship. They found a strange device which was built in 150-100 BC. After many decades X-ray investigations allowed them to establish it was a mechanical computing device. Now it is known as *Antikythera Mechanism* (Chrisian & James, 2014). In the process of its learning all parts of this design were established. At the same time, the purpose of each part was understood. This set of actions is the way down in a knowledge spiral. This is the typical process of analysis. We want to point out that in both knowledge ways the first question in the process of study is WHAT.

Two Ways of Cognition

Each thoughtful researcher knows that solution of any problem immediately creates a new one. This situation repeats constantly. This change consists of standard cycles. That is why one can say a human brain processes an infinite stream of new concepts. As a result our knowledge is constantly changing. The concept of knowledge was at first explored in ancient times (Gerson, 2009). The infinity changes of human knowledge were active studied from the period of the middle ages. Probably one of the authors which at first clearly formulated connection of infinity and development of knowledge was John Duns Scotus (Cross, 1999). He wrote that infinity is that which is not bound by something else. A lot of works which were devoted to study infinity were published after this time.

Our goal is to emphasize the infinity of the process in which each new explanation of any concept at the same moment creates a new problem which is necessary to study. Attention to the problem of standard cognition cycles began in the economy (Hayek, 1945; Reilly, 2009). Some additional sources about cyclic thinking one can find in (Farell, 2014). Each cycle of cognition consists of the three questions mentioned above. Let us enumerate them: WHAT – 1; HOW – 2 and WHY – 3. In many cases one can see the end of one cycle creates some new unknown objects or phenomena. As it was told earlier each new cycle replicates the same sequence of questions. So we can say this sequence of three questions is the *Simplest step in the cognition process* or *SSC.* This infinite way of cognitions can be represented as:

$$.... \rightrightarrows 1 \rightarrow 2 \rightarrow 3 \rightrightarrows 1 \rightarrow 2 \rightarrow 3 \rightrightarrows 1 \rightarrow 2 \rightarrow 3 \rightrightarrows .....$$

Double arrows $\rightrightarrows$ correspond to a transition from one step of cognition to the next one. It is the transition of $3 \rightrightarrows 1$ type. It means each step of cognition starts with the question WHAT. After the answer is found a human being begins to study the process of creating the studied object. After the answer to question HOW is received the cognition stage is over. Then one can say he (she) studied a new object, understood what it was for, and knows how to make it. Frequently it is sufficient and further

examinations are not needed. Nevertheless, a more inquisitive explorer usually tries to understand some general matters connected with the object under learning. For instance, one can learn how a new transportation device operates. After he understands all its properties and the ways of its operation he (she) can ask (his-) herself why the engine on this vehicle and on most of the other ones is located in the front part of a vehicle. It is the typical question WHY. At the different levels of knowledge hierarchy the generality of these questions varies a lot. At a certain level these questions become rather philosophical.

The authors described above the most widely spread sequence of the questions on the way of knowledge. Here it is interesting to note that one of the first basic questions which asked Socrates when he at first denoted the term knowledge was: *What is knowledge?* (Benson, 1990; Firey, 1999). Yet, sometimes, a human being used the reverse sequence of the same three questions:

$$.... \rightleftarrows 3 \rightarrow 2 \rightarrow 1 \rightleftarrows 3 \rightarrow 2 \rightarrow 1 \rightleftarrows 3 \rightarrow 2 \rightarrow 1 \rightleftarrows .....$$

This is the transition of $1 \rightleftarrows 3$ type. It is a rare situation indeed. For example, let us mentally move back to the end of the XIX century. Let's suppose, for the first time an inventor decided to create the system of electric lighting. In the standard way he (she) would ask him- or herself WHAT is the source of light. After this he (she) would concentrate all his (her) efforts on the development of the electric bulb. A more experienced inventor would ask WHY many invented devices were not used in real life. The answer is evident. The bulb is only an anchor part of the lighting system. This system consists of switchers, generators and many other units. Such system is operational only if all bulbs can be switched on independently from one another. It is possible if the bulbs are switched on in parallel rather than in series. Only after this it is possible to ask WHAT design of electric bulb is needed. The answer is to invent a bulb with great electrical filament resistance. All these studies were made by Thomas Alva Edison. Therefore, he won the competitions of electric bulb inventors. This example is clear enough but not general. More general situations will be discussed further.

The authors draw your attention to the fact that both types of knowledge way steps did not start from question 2 – HOW. It is not a coincidence. The steps of such type are so rare that the authors do not take them into account further. Nowadays, the answer to the question HOW can be found in the analysis of transformation actions or General Technologies (Romanenko & Nikitina, 2015a; Romanenko & Nikitina, 2015c). It means the end of the study of transformations enables us to stop the concrete analysis and begin to investigate general matters tied with the studied objects or phenomena in this field of knowledge.

Some General Issues Related to the Study of Transformation Processes at Modern Time

It is well known that understanding of processes in any field of knowledge is uneven. In the field of description and understanding of transformation processes there has been substantial progress in recent decades. This progress enabled the authors to formulate a number of general issues related to the understanding of these processes. Some of them are related to the general problems of cognition (Romanenko & Nikitina, 2015c). The first of these issues are connected with the unexpected, related to the fact that many independently derived results have a form of a triad. We can describe the Technology as a triad:

INPUT OBJECT → PRODUCTION TECHNOLOGY →OUTPUT OBJECT

All transformation processes may be divided into three groups depending on the degree of uncertainty of their results (Romanenko & Nikitina, 2015a):

RECEIPT → RECOMMENDATION → PRODUCTION

Let us consider ways of introducing and spreading a new product, which is a result of some invention. One usually speaks of three successive stages of this process (Rogers, 2003):

INVENTION → INNOVATION → DIFFUSION

One can detect three main stages in the modern instructional strategies at the tertiary level at PC-assisted training. Their sequence is written as (Romanenko & Nikitina, 2015b):

TUTORIAL STAGE → COMPETENCE CREATING STAGE→ ADVISORY STAGE

It is not difficult to continue this listing. This list in particular will include triads which are studied in the Theory of Design,

triads of Professional skills which are created in the period of education and many others. It is not difficult to detect the similarity of all these triads with a so-called logical triad of Hegel (Mueller, 1996):

THESIS → ANTITHESIS → SYNTHESIS

If one takes into account all these observations he (she) will ask *Why is it so?* It is necessary to understand if it is connected with behaviour of the human mind or it is something tied with the unknown *Law of Nature*. One can try to find an answer if the triad is a representation of the results of different actions widespread. It is the first general problem which came up in the general studies as a result of the development of the Transformations theory.

It is known the second WHY is asked after he (she) studied all achievements in the field of Production Transformations or Technologies. This question is connected with the S-shape of developing a new technological idea (Rogers, 2003; Martin, 2001). One usually asks if this is connected with the Law of Resource depletion (Romanenko & Nikitina, 2009). It is interesting to find an answer why some new production transformations can be tied with only one new idea. The third example of the question WHY is connected with the problem of Technological diversity. It is well known that the diversity of different products grows depending on their complexity (Chaikovsky, 1990). Yet, the detectable diversity is usually detected only at the upper levels of the details hierarchy. At the higher levels of hierarchy the diversity is built as a combination of a few similar units. Each of them uses very few elements of a certain type. Contrary to this, at the lower levels of hierarchy the number of elements of each type rapidly grows. One has to find an answer to the question: *Why hasn't anyone still detected the numerical laws in the field of study of these two diversities?*

The investigation of different transformations allows us to describe some general laws of these processes. Many of them are intuitively clear. Nevertheless, they are never systematically described. Thanks to the last achievements in the theory of transformations, one can examine these laws more carefully and describe them in detail.

The Lack of Symmetry in Matters of Cognition

The way of cognition is infinite in principle. In each period, plenty of people planned their investigations. These plans may be based on transitions of $3 \rightrightarrows 1$ or $1 \rightrightarrows 3$ type. In a formal approach, both types of research are equally possible. Nevertheless, it is well known the way $3 \rightrightarrows 1$ is more common. The choice between two possible ways of study depends on so-called *Tacit Knowledge of Individual* (Polanyi, 1966). It is natural to assume this choice is connected with asymmetric functioning of two halves of human brains. However, the fact of asymmetric choice is evident.

In each historical moment there are many problems which cannot be intelligently explained. In such cases the researchers try to offer an acceptable explanation. They are rarely willing to admit that there is an objective need to wait for some time before new investigations can clarify a problem. This is typically asymmetry in mental activity, too. In most cases an investigator prefers to explain obtained results or observations on the basis available for understanding. Possible explanations based on the reliance on religious beliefs are known, too. In different historical periods the preference of one of these two positions was very different and frequently their choice was asymmetrical.

Conclusions

This brief overview suggests the way of cognition is infinite and built on the base of standard repeated steps, which can be denoted as the *Simplest steps of Cognition*. Each step is the sequence of the three main questions: WHAT → HOW → WHY. The development of knowledge is built on these steps and has the spiral form. The way of knowledge may be oriented from the lower level of knowledge hierarchy to the upper one and in opposite direction. These two ways describe synthesis and analysis. Most cycles of cognition started from the question WHAT. There are also excellent known situations started from the question WHY. Yet, nobody knows any example in which the process of cognition started from the question HOW. This question is closely tied with transformation processes. Modern achievements in the General theory of transformations and their history give excellent facts to study different interesting situations. Some of them are connected with the asymmetry of the ways of cognition. An additional field of facts for further study is a discussion of different forecasts about the development of technologies. The positive forecasts are usually justified in one form or another. Opposite to this, most negative forecasts usually do not come true (Romanenko & Nikitina, 2015d). This asymmetry is principal. The real awareness of this has come recently. There is no doubt it will be investigated more carefully in the near future. ∎

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References

[1]   Benson, H. (1990). *Misunderstanding the "What-is-F-ness'Question."* Archiv für Geschichte der Philosophie 72. 125-142.

[2]   Chaikovsky, Yu. V. (1990) *Elements of evolutionary varieties* (2-nd ed) (In Russian) Moscow: Nauka, 272 pp.

[3]   Christian, C. C., James, E. (2014) *On the Epoch of the Antikithera Mechanism and its Eclipse Prediction* Archive for History of Exact Sciences 68(6) 693-774.

[4]   Cross, Richard, (1999). Duns Scotus, Oxford: Oxford University Press. 250 pp.

[5]   Ding, L. (2007) *A Model of Hierarchical Knowledge Representation – Toward Knowwere for Intelligent Systems* Jour. of advanced Computational Intelligence and Intelligent Information 11(10) 1232-1240.

[6]   Farell, T.J. *One for Everybody: II. Selected works about cyclic thought and linear* (2014) Univ. of Minnesota Duluth Library Press. pp 66-68.

[7]   Feigenberg, J. M (2014) *Memory, Probabilistic Prognosis, and Presetting for Action* Retrieved April 21, 2015 from: http://www.nadin.ws/ante-study/wp-content/uploads/2014/05/ Feigenberg-Memory-Probabilistic-Prognosis-and-Presetting-for-Action-ed.pdf

[8]   Firey, T. A. (2009). *Socrates' Conception of Knowledge and the Priority of Definition* Thesis submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Master of Arts in Philosophy, 57 pp. Retrieved August 2, 2015 from http://scholar.lib.vt.edu/theses/.../etd-100499- 091648/

[9]   Gerson, L. P. (2009) *Ancient Epistemology* Cambridge UK: Cambridge Univ. press, 179 pp.

[10] Martin, L. A. (2001) *Exploring S-Shaped Growth* Massachusetts Institute of Technology, MA: 67 pp.

[11] Mueller, G. E. (1996) *Gegel legend of "Thesis-Antithesis-Synthesis"* in: *The Hegel Myth and Legends* Stewart, J -editor) North-Western Univ. Press, Evanston Illinois. pp 301-305.

[12] Nevin, Creig (2010) *Initiation on Model of the Foot on and Control of Gait from First Principles: A Mathemtically Animated Model of the Foot* Boca Raton, Florida: 190 pp.

[13] Oldroyd, D. R. (1986) *The Arch of Knowledge*: *An Introductory Study of the History of the Philosophy and Methodology of Science* NY: Methuen. 432 pp.

[14] Polanyi, M. (1966) *The Tacit Dimension* University of Chicago Press. Chicago.

[15] Rand, A. (1990) *Introduction to Objectivist Epistemology*, expand. 2-nd., NY: Meridian, 315 pp.

[16] Reilly, C. *The Concept of Knowledge in KM: a Relational Model* (2009) The Electronic Journal of Knowledge Management 7(1), pp. 145 - 154, Retrieved August 1, 2015 from http://www.ejkm.com

[17] Rogers, E. M. (2003) *Diffusion of Innovations (*5-ed.) Simon & Schuster, Inc. NY:. 550 pp. Romanenko, V., Nikitina, G. (2009) *Comparison of the global models in natural and humanity sciences* (In Russian). In: Collection of works edited by "Norma" SPb. pp. 62-71.

[18] Romanenko, V. N., Nikitina, G.V. (2014) *How the Physical World Impacts Different Objects* Studies in Sociology of Science, 5(3) pp40-43.

[19] Romanenko, V. N., Nikitina, G.V. (2015a) *Computer Assisted Instructional Technologies: New Demands for Teachers' Staff 4-th International Scientific Conference* Proc. of 14 Conference Engineering for Rural Development 14, pp 648-655.

[20] Romanenko V. N., Nikitina, G.V. (2015b) *Learning of Technologies: Road from Non-Formal Empirical Descriptions to Formal mathematical Study* Proc. of 14 Conference Engineering for Rural Development 14, pp 636-647.

[21] Romanenko, V. N., Nikitina, G.V. (2015c) *Instructional Technologies of the XXI Century: Theoretical Approach* Handbook of Applied Learning Theory and Design in Modern Education (in print).

[22] Romanenko, V. N., Nikitina G.V. (2015d) *Predtechi (Precursors)* (In Russian) Spb: Publ. House "NORMA" 214 pp.

[23] Turchin, V. F. (1997) *The Phenomenon of Science: A Cybernetic Approach to Human Evolution* NY: Columbia Univ. Press. 348 p.

[24] Vygotsky, L. S. Mind in Society. Cambridge, MA: Harvard University Press. 1978. 176 p. Vygotsky, L. S. Thought and Language. Cambridge, MA: MIT Press. 1986. 392 p.