Theoretical Framework and Denotatum-Based Models of Knowledge Creation for Monitoring and Evaluating R&D Program Implementation

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ABSTRACT

The paper presents two semiotic models for a description of development stages of indicators, including generation processes of expert knowledge about developed indicators. For the description of stages of these processes, a new notion of “Frege’s space” is introduced. The authors described two applied semiotic models of knowledge acquisition. Those processes were studied in the context of forming an expert knowledge base named proactive dictionary, which represents a component of an evaluation system. This dictionary enables experts to fix stages of indicators development, to present the results of developing different variants of indicators in graphic form, to compare and evaluate these variants.

Keywords: Cognitive Informatics, Knowledge Acquisition, Knowledge Based Systems, Knowledge Representation, Research And Development Management, Semiotics

INTRODUCTION

The paper presents a semiotic approach to the study of knowledge creation processes. These processes are aimed at generating expert knowledge bases in various subject areas. Now we are studying this generation in scientometric and linguistic researches. Our prime application aim is to create an expert knowledge base containing new developed indicators for monitoring and evaluating implementation of R&D programs (Zatsman & Kozhunova, 2009; Zatsman & Durnovo, 2010; 2011; 2012).

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The indicator development was carried out under the First Russian Academic (FRA) Program, which was approved by the Government of the Russian Federation in February 2008 as a tool of public intervention in the area of science. The Russian Academy of Sciences (RAS) has decided to create an evaluation system for providing assessment of the FRA Program as a whole and of its thematic subprograms.

In order to develop new program-oriented indicators, we are designing the proactive dictionary as a tool for indicator development (Zatsman & Durnovo, 2010; 2011; 2012). The dictionary is a part of the evaluation system for monitoring and evaluating implementation of the FRA Program. Our dictionary design is based on two semiotic models for a description of indicators development stages, including generation processes of expert knowledge about developed indicators:

- The model describing a frozen state of the indicator development process, named the frozen-state model (Zatsman, 2009b).
- The model for identifying a dynamics of the indicator development process, named the time-dependent model (Zatsman, 2009a).

These frozen-state and time-dependent models are based on two pillars, namely:

- Examination and categorization of Human Computer Interaction (HCI); and
- Definition of a digital semiotic triangle.

These two pillars used for model creation are traditionally related to different knowledge areas: informatics and semiotics. Each of these areas has its particular term system and corresponding notions. In these two pillars further description we use a term system developed for modelling new knowledge creation processes. Such system by itself represents a new theoretical approach to the modelling of the new knowledge formation processes.

This approach concept is closer to Cognitive Informatics (CI) because it focuses on new knowledge creation and knowledge presentation in computer systems while they are being dynamically formed. Wang and Kinsner (2006) state about the CI gist:

*The fundamental methodology of CI is bidirectional and comparative. In one direction, CI uses informatics and computing techniques to investigate cognitive science problems, such as memory, learning, and reasoning. In the other direction, CI uses cognitive theories to investigate problems in informatics, computing, and software engineering. CI focuses on the nature of information processing in the brain, such as information acquisition, representation, memory, retrieval, generation, and communication (p. 121).*

The theoretical framework of CI (Wang, 2007) encompasses five main areas of basic and applied research on: a) Abstract intelligence: fundamental theories of natural intelligence; b) Denotational mathematics for modeling abstract intelligence; c) Cognitive models of the brain; d) Neural informatics; and e) Cognitive computing. These areas of CI are elaborated in (Wang et al., 2011).

The main difference CI and our theoretical framework for the new knowledge creation process modelling, which we call Conceptual Informatics (ConI), is following: CI focuses on the nature of information processing in the brain and brain cognitive models. Fundamental theories developed in CI include the Object-Attribute-Relation (OAR) model of information/knowledge
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