Models and Systems for Knowledge Integration and Creation

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Abstract

Many approaches to knowledge and technology creation have appeared for these 20 years. Their specific feature is that they try to utilize the irrational or a-rational creative abilities of the human mind, such as tacit knowledge, emotions and instincts, and intuition (Wierzbicki and Nakamori, 2006). In management science a novel approach was developed by Nonaka in 1992, with an international publication: *Knowledge Creating Company* (Nonaka and Takeuchi 1995). This is the now-renowned *SECI Spiral,* with its process- and algorithmic-like principle of organizational knowledge creation. This principle is revolutionary because it stresses steps leading to knowledge increase surely, based on the collaboration of a group in knowledge creation and on the rational use of irrational mind capabilities, namely tacit knowledge, which consists of emotions and intuition.

Historically, the first of such approaches is *Shinayakana Systems Approach* by Sawaragi, with first publications in Sawaragi and Nakamori (1990), in the field of decision and systems science. Being systemic and influenced by the soft and critical systems tradition, it did not specify a process-like, algorithmic recipe for knowledge and technology creation, only a set of principles for systemic problem-solving. To these principles belong: using intuition, keeping an open mind, trying diverse approaches and perspectives, being adaptive and ready to learn from mistakes, and being elastic like a willow but sharp as a sword - in short, *Shinayakana*.

Further development of the *Shinayakana Systems Approach* was given in Nakamori (2000), in a systemic and process-like approach to knowledge creation called *Knowledge Pentagram System or i-System.* The five ontological elements (or subsystems) of this system are *Intervention* (and the will to solve problems), *Intelligence* (and existing scientific knowledge), *Involvement* (and social motivation), *Imagination* (and other aspects of creativity), and *Integration* (using systemic knowledge). True to the *Shinayakana* tradition, there is no algorithmic recipe for how to move between these ontological nodes: all transitions are equally advisable, according to individual needs. Thus, *i*-System stresses the need to move freely between diverse dimensions of creative space.

- *Intervention*: Taking action on a problem situation. First we ask: what kind of knowledge is necessary to solve the new problem? Then the following three subsystems are called on to collect that knowledge.

- *Intelligence*: Raises our capability to understand and learn things. The necessary data and information are collected, scientifically analyzed, and then a model is built to achieve simulation and optimization.

- *Involvement*: Raising the interest and passion of ourselves and other people.

Sponsoring conferences and gathering people's opinions using techniques like interview surveys.

- *Imagination*: Creating our own ideas on new or existing things. Complex phenomena are simulated based on partial information, by exploiting information technology.

- *Integration*: Integrating heterogeneous types of knowledge so that they are tightly related. Validating the reliability and correctness of the output from the above three subsystems.

From a viewpoint of social science, Zhu (2004) explored the *i*-System as a (re-)structurationist model for knowledge management. Viewed through *i*-System, knowledge is (re-)constructed by actors, who are constrained and enabled by structures that consist of a scientific-actual, a cognitive-mental and a social-relational front, mobilize and realize the agency of themselves and of others that can be differentiated as intelligence, imagination and involvement clusters, engage in rational-inertial, postrational-projective and arational-evaluative actions in pursuing sectional interests.

The *i*-System has several applications such as a guideline to develop a knowledge archive system, a guideline to develop technology roadmaps, or a guideline to develop an evaluation system of research activities and environments in academia.

In this presentation, we first consider the emergence of knowledge sciences and introduce the school of knowledge science at Japan Advanced Institute of Science and Technology, and knowledge creation models in academia. Then, we introduce the *i*-System (or the knowledge pentagram system) with some applications. For further details, see the books by A. P. Wierzbicki and Y. Nakamori (2005, 2007)

References

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