Chapter 1
Systems Approach to Knowledge Synthesis

Yoshiteru Nakamori
Japan Advanced Institute of Science and Technology, Japan

Andrzej P. Wierzbicki
National Institute of Telecommunications, Poland

ABSTRACT
This article presents a systems approach to knowledge synthesis or construction, starting with a new systems thinking named the informed systems thinking, which should serve as the basic tool of knowledge integration and support creativity. Based on this new systems thinking, a new systems approach to knowledge synthesis or construction has been developed as a systems methodology that consists of three fundamental parts: how to collect and synthesize knowledge, how to use our abilities in collecting knowledge, and how to justify the synthesized knowledge. This article first describes the informed systems thinking and then introduces a new systems approach to knowledge synthesis and the features of this new approach from a viewpoint of knowledge creation.

INTRODUCTION
An important concept in the theory of organizational knowledge creation (Nonaka, 1991, 1994; Nonaka & Takeuchi, 1995) is ‘Ba’ which is a Japanese word meaning ‘place’. Nonaka uses it as ‘creative environment’; actually Nonaka (Nonaka & Konno, 1998; Nonaka et al., 2000) called the dynamic context which is shared and redefined in the knowledge creation process ‘Ba’ which does not refer just to a physical space, but includes virtual spaces based on the Internet, for instance, and more mental spaces which involve sharing experiences and ideas. They stated that knowledge is not something which can exist independently; it can only exist in a form embedded in ‘Ba’, which acts as a context that is constantly shared by people.

Similar ideas exist in systems theory: for instance, Churchman (1970) states that all knowl-
edge is dependent on boundary judgments. This article follows this idea in such a way that our theory chooses three important dimensions (or subsystems) from the high-dimensional Creative Space (Wierzbicki & Nakamori, 2006) and require actors to work well in each dimension (or subsystem) in collecting and organizing distributed, tacit knowledge. These are Intelligence (a subsystem or a scientific dimension), Involvement (a subsystem or a social dimension) and Imagination (a subsystem or a creative dimension). When the theory is interpreted from a viewpoint of sociology, the Creative Space is considered as Social Structure which constrains and enables human action, and consists of a scientific-actual front, a social-relational front and a cognitive-mental front corresponding respectively to the three dimensions or subsystems.

Our theory introduces two more dimensions or subsystems: Intervention and Integration, which correspond to ‘social action’ and ‘knowledge’ from a sociological point of view. This article follows the definition of ‘systemic intervention’ in Midgley (2000, 2004) that systemic intervention is purposeful action by an agent to create change in relation to reflection upon boundaries. Our actors collect knowledge on all three structural dimensions or fronts, with a certain purpose, and synthesize those distributed knowledge to construct new knowledge. In this sense, the subsystem Intervention together with Integration corresponds to Midgley’s ‘systemic intervention’. As Wang Yang-Ming the 14th-century Confucianist contends that knowledge and action are one, for purpose, and with consequences (Zhu, 2000).

The theory to be presented in this article aims at integrating ‘systematic approach’ and ‘systemic (holistic) thinking’; the former is mainly used in the dimensions or subsystems Intelligence, Involvement and Imagination, and the latter is required in the dimensions or subsystems Intervention and Integration. Leading systems thinkers today often emphasize ‘holistic thinking’ (Jackson, 2003; Mulej, 2007), or ‘meta-synthesis’ (Gu & Tang, 2005). They recommend and require ‘systems thinking’ for a holistic understanding of the emergent characteristic of a complex system, and for creating a new systemic knowledge about a difficult problem confronted. Our theory aims at synthesizing objective knowledge and subjective knowledge, which inevitably requires intuitive, holistic integration.

With a similar idea, Wierzbicki, et al. (2006) proposed an informed, creative systemic approach, named Informed Systems Thinking, which should serve as the basic tool of knowledge integration and should support creativity. This systems thinking emphasizes three basic principles: the principle of cultural sovereignty, the principle of informed responsibility, and the principle of systemic integration. If the first is a thesis, then the second is an antithesis and the third is a synthesis. The problem here is: how are we to fulfill a systemic integration in the context of knowledge synthesis? One of the answers to this is Theory of Knowledge Construction Systems, the topic of this article, which consists of three fundamental parts: a knowledge construction system (Nakamori, 2000, 2003), a structure-agency-action paradigm (Nakamori & Zhu, 2004), and evolutionally constructive objectivism (Wierzbicki & Nakamori, 2007). The main features of this theory are fusion of the purposiveness paradigm and purposefulness paradigm, interaction of explicit knowledge and tacit knowledge, and requisition for knowledge coordinators.

The article is organized as follows: First, our basic systems approach is introduced briefly, which is called Informed Systems Thinking. Then a summary of the theory of knowledge construction systems is given. Second, the main model for knowledge synthesis, called i-System, is introduced, with a special emphasis on the types of integration: specialized, interdisciplinarity and intercultural. Third, a sociological interpretation of the i-System is presented, which refers to the ability of actors in collecting and synthesizing knowledge. Fourth, a new episteme to justify col-