Systems thinking on knowledge and its management: systems methodology for knowledge management

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Keywords

Systems management, Methodology, Information, Management

Abstract

KM is increasingly imperative as it is regarded as the key determinant of a firm, industry or country for survival and growth in knowledge era. Varieties of disciplines have made contributions to knowledge and knowledge management. Research focuses on one or more specific fields, but to understand which levels of knowledge processes knowledge management should concentrate on, should be more fundamental than advocacy of knowledge management. Knowledge-related matters were examined from the viewpoint of systems science. Using critical systems thinking, soft systems thinking etc., a new systematic perspective on knowledge was proposed, aiming to provide a new way of thinking and a useful toolbox on different levels and phases of knowledge management for practical knowledge users.

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http://www.emeraldinsight.com/1367-3270.htm

Journal of Knowledge Management
Volume 6 · Number 1 · 2002 · pp. 7–17
 · ISSN 1367-3270
DOI 10.1108/13673270210417646

Introduction

With the research advancement in knowledge (business knowledge instead of whole knowledge) itself and knowledge management, more and complex elements, systems and methodologies were emergent from a variety of disciplines, which constitutes a continuum of a knowledge system. Researches in different fields enrich the system and add important insights into one or more aspects of knowledge management; but standing alone, none provides an integrating framework (Teece, 1998). Knowledge researchers also diverge from knowledge as object and process that makes knowledge management rich and multifaceted but more complex to be mastered. Naturally, their approaches and solutions provided are inevitably varied. Before we put each part together, we have to trace back to major researches in knowledge and use them as a basic context for our synthesis in a methodology base for knowledge management.

Focus of main knowledge theories

Scholars defined knowledge from their distinctive angles and then explored various methods of knowledge management. It is widely acknowledged that it is Drucker's post-capitalist society that makes knowledge the most frequent word used in business management by scholars and practitioners. Drucker (1993) outlined the grandiose landscape of knowledge society in a socio-economic perspective and pointed out the structural shift toward knowledge-based society. In parallel, management needs to respond to the transition from traditional control and command (aimed at optimization based on prediction) to lead and support (aimed at flexibility and adaptation based on precognition) to fit the characters of knowledge work. Nonaka and Takeuchi (1995) created the influential concept of a knowledge-creating company and later formed the widely cited knowledge-creation theory.

Nonaka (2000) defines knowledge as:

> justified true and skill, a dynamic human process of justifying personal belief and skill towards the truth.

Human communication and knowledge conversion processes here were emphasized in organizational and interorganizational

Journal of Knowledge Management
Volume 6 · Number 1 · 2002 · 7–17

context. Through repeatedly interactive processes between explicit knowledge and tacit knowledge among cooperative participants over time, new business knowledge was generated within groups and further extended spirally in broader scope. Both resulting knowledge and concomitant processes are extremely valuable for companies to enhance innovation as well as competitive advantage. As for the process function, knowledge managers can lead and facilitate knowledge creation, accumulation and sharing of tacit knowledge activities by socially nurturing a "good" *Ba* (physical and nonphysical environment) for converting individual knowledge into organizational knowledge (Nonaka and Konno, 1998), contrasting re-use and distribution of explicit knowledge in the Western tradition.

Leonard-Barton (1992, 1995) stressed the importance of knowledge with successful innovations in view of innovation activities in firms. In her studies, knowledge creation and diffusion become the critical sources for innovation. The empathic design and ideation she identified strongly linked with certain social courses of tacit knowledge. The core capability and creativity of companies are strengthened with improvement of innovations that stem from building of organizational knowledge. The significance of these special capabilities is that they are not easily imitated (at least it takes time to imitate), which makes up for unique competitive advantages for companies that initiate and experiment with these practices.

In his intensive writings on knowledge topics, Wiig (1994, 1995, 1997) emphasized knowledge management as management of knowledge-related activities. He defined that knowledge management is broad, multi-dimensional and covers most aspects of the enterprise's activities. The enterprises, through systematic and comprehensive knowledge management, acquire desired economic ideas, knowledge and experiences to sustain competitive and successful capacities on the long haul. He also pointed out that oversimplifying problem setting and scope in knowledge management can only result in weakness.

Several authors (Edvinsson and Malone, 1997; Sveiby, 1997; Petrash, 1996) saw the true value of knowledge in understanding the difference between visible and invisible intellectual capital and maximized the five success factors:

(1) financial;
(2) customer;
(3) process;
(4) renewal and development; and
(5) human.

Knowledge management became part of visualizing and cultivating knowledge (intellectual capital) and found ways to leverage an organization's intangible intellectual assets for more value. Along with knowledge management, organizations can create and utilize the best possible capital hidden in people's brain via tools for measuring and presenting intangible assets.

Knowledge, as the key intellectual asset of an organization, was also emphasized by Boisot (1998) in information perspective (knowledge as a capacity that is built on information extracted from data), but organizational activities and environmental challenge culturally affect the generation and storage of the asset. Technology, competence and capabilities are the representations of the knowledge asset operated at different levels of an organization, but it is specialized individuals and interpersonal social relationships that reinforce the importance of the assets. Knowledge management in his view is to manage knowledge assets as a social learning process.

Practical features of knowledge were addressed by Davenport and Prusak (1998). They insisted that knowledge derives from information as information derives from data. Knowledge is refined information added value (Davenport, 1997). Knowledge contains subjective judgment. Values and beliefs are integral to knowledge, determining in large part what the knower sees, absorbs, and concludes from his observations. They put emphasis on knowledge generation, codification, coordination, and transfer through knowledge management projects. Invariably their approach in knowledge management first goes for "hard tools" – tech-knowledge (such as Web, expert systems, knowledge component etc.), but without extensive behavioral, cultural, and organizational change, knowledge management cannot take place (Davenport and Prusak, 1998).

The concept of cultural knowledge was inserted into the existing explicit and tacit

Journal of Knowledge Management
Volume 6 · Number 1 · 2002 · 7–17

knowledge classification by Choo (1998). The knowledge framework he developed underlines organizational culture, purpose and identity based on "shared assumptions and beliefs", and determines the value and significance of new information and knowledge. It is frequently helpful to clients to tap into and draw on organizational memory, to its history and past records in perspective of information.

To summarise the above review, each researcher is addicted to one or more specific interests in knowledge management, which enriches the whole picture of knowledge and knowledge management. The trend prefers to use softer treatments (for example, fostering *Ba*, changing culture, or mobilizing invisible assets) plus new technology (such as Web, information technology, expert systems, etc.) in management process. Information communication technology, globalization and competition enhance the complexity of knowledge management as well as providing accessible interactions and incisive means. However, any hard technology is not an answer but a tool.

Substance of knowledge management

Business knowledge and knowledge management finally will be mastered and utilized by users in economic organizations. To make knowledge efficiently translated into value or profit for a company and strategically used by varieties of users, relevant knowledge management is self-explanatory. What is the substance of knowledge management, or to what kind of level do managers become involved in knowledge activities? The prime work is to separate the knowledge management of knowledge processes from knowledge management of knowledge workers. Knowledge managers' work is to "manage" the favorable environment for knowledge workers to be engaged in knowledge processes and "manage" these knowledge workers.

To make it clear, we first classify knowledge management into two dimensions: one dimension is to manage existing knowledge, which includes developing of knowledge repositories, knowledge compilation, arrangement and categorization; another is to manage knowledge-specific activities, that is, knowledge acquisition, creation, distribution, communication, sharing and application. For sustaining these processes, both "hard" conditions and "soft" environments have to be created and nurtured. Hard side means technological platforms including facilities and necessary devices. Soft side consists in trust, team spirit and learning climate for improving contributors' productivity. At organizational level, distinctive organizational visions and strategies are formulated to guide and regulate knowledge management; relevant evaluation and reward institutions are to be created to define responsibility and liability of individual and organization.

For knowledge activities in economic organizations, we treat knowledge as both an object and a process. The view of knowledge as an object comes from the fact that knowledge, as an impersonal being, exists by itself over time; it forms a complex knowledge system in hierarchy of data, fact, information, experience, learning, patent and copyright, as well as expertise. From this point of view, knowledge can be communicated, exchanged, and shared, such as those things we learnt from school. For the knowledge in form of data, information or expertise, they have already existed in some special disciplines that cope with them like database, data warehouse, statistics, data mining, information systems, information science, information theory, management information systems, expert systems, decision support system, and knowledge discovery in database. The knowledge is used as the concrete element and tools during humans' theoretical and practical work. Knowledge managers have to possess basic understanding and foresight but unnecessarily own the ability to be engrossed in detailed knowledge processes that are the very work of specialized knowledge workers, unless they are among them.

For an organization as an economic entity to create and accumulate business knowledge, it is not its true end; knowledge for it is only served as a useful or important means to fulfill organizational objectives. Nonaka and Leonard look at social processes of knowledge creation and innovation within and between groups of people, rather than at individual creativity or the manipulation of knowledge objects (Cohen, 1998). The one and only aim of knowledge management for an organization is to utilize fully available knowledge and embody knowledge into products and service to enhance its core

Journal of Knowledge Management
Volume 6 · Number 1 · 2002 · 7–17

competences and competitive advantages. As for this functional meaning, knowledge management is also viewed as a process, which closely relates to practice. The latter point is of significance in knowledge management. To realize this instrumental function, a series of purposeful activities needs to be initiated.

In the above knowledge theories, most of the researchers seem to favor knowledge acquisition, transfer, and creation in organizations as process or activity among people. Actually, the detail work is knowledge workers' task rather than chief knowledge officers or knowledge managers' job. That manifests that knowledge management's potential task is on how to mobilize all the positive factors in this process by knowledge managers. Therefore, for the two groups, we have to provide two sets of systems methodologies.

Systems methodology for knowledge management

Organizational knowledge system

Knowledge as an object accumulating over time forms massive and complex systems in each independent discipline; knowledge as organizational means to realize each organization's end shapes the organization-specific knowledge system (explicit and cultural knowledge); a human being as part of an organization owns personal knowledge (explicit and tacit knowledge). It is worth noting that personal knowledge cannot be naturally included in organizational knowledge if knowledge is viewed as an important asset that can generate fortune.

As for organizational knowledge (see Table I), it is composed of four levels of knowledge subsystems: data; information; the main three parts of the same level organizational knowledge subsystem: scientific aspect of knowledge, technical aspect of knowledge, and managerial aspect of knowledge; and value and culture aspect of knowledge.

Each part of the knowledge plays a different role and has different criteria for evaluation in the organization. Data and information are the fundamental parts of organizational knowledge. Without sufficient data and information, it would be difficult for enterprise to operate normally. They are also the basic materials of organizational decision making. As to a company's three main parts of a knowledge subsystem, scientific knowledge determines which industry/industries the company can enter; its technical knowledge determines its status of long-term standing in the industry/industries; managerial knowledge is at the core of organizational effectiveness and efficiency. Scientific knowledge can be justified or falsified. It is embedded in words or electronic medium like patents and copyrights. Technical knowledge is evaluated by advancement, new, and applicability and they are usually applied scientific knowledge. They are embodied in product and working procedures, words, electronic medium like manuals, patents, or copyright. Managerial knowledge has no unified and fixed standard. It is value dependent and context related. The criteria of evaluating managerial knowledge are its practicing efficiency and effectiveness. They are reflected in corporate regulations, rules, structure, procedure, and organizational daily management activities. The three parts of the same level organizational knowledge can be synthesized in an organization's expert system and decision-support system. Corresponding individual ability's influence on the amount and quality of his/her knowledge owned, organizational culture, ethics and moral are also viewed as organizational knowledge, because they directly relate to the quality of organizational knowledge creation, sharing, and application. They are also viewed as the highest level of the organizational knowledge. Due to the different characteristics of organizational knowledge subsystems, their managerial points are also different, as shown in Table I.

While an organization is to effectively and efficiently utilize the existing knowledge base, mobilize potential knowledge resources and create new knowledge, empty talk about knowledge management without methodology will make people lose interest in it. Faced with innumerable and complicated issues or "messes" of interacting knowledge and knowledge related activities, organizations need the aid of diverse systems methods in realistic practice of knowledge management.

In the discipline of systems sciences, actually there exist varieties of systems-based methodologies developed for various applications. According to the characteristics

Table I Knowledge system, its function, criteria and management points

Knowledge subsystem	Embodied in	Function	Criteria	Management in action
Value	Corporate vision strategy	Ability to apply and create knowledge	Humanity	Cultivate and nurture:
Culture	Regulation		Fairness	Trust
Ethics	Discipline rule		Honesty	Team spirit
Moral	Evaluation and reward system			Learning and share knowledge
Main subsystems of organizational knowledge				
Scientific aspect	Words or electronic medium like reports, papers, patents and copyright	Industrial fields	Justification Falsification	Identify Precognition Direction Protect Support Promotion Motivation
Technical aspect	Producing or working procedures Words or electronic medium like reports, papers, patents, copyright, and manuals	Status in Industry	Advancement New Applicability	Identify Precognition Direction Protect Support Promotion Motivation
Managerial aspect	Corporate regulations Rules Structure Procedures Daily management activities Expert systems Decision-support system	Effectiveness Efficiency	Performance Applicability	Identify Codify Share Dissemination Promotion Motivation
Information	Information systems Management information system Organizational memory Knowledge repository	One of the main foundations of knowledge	Reliability Simplicity	Direction Support Motivation
Data	Database Data warehouse	Foundation of information	Objectivity Accuracy Reliability	Direction Support Motivation

of knowledge management we analyzed previously, the focus of it should be on the creation and sustenance of organizational environment rather than direct intervention on knowledge processes *per se*. Among varieties of methodologies, the soft systems methodologies are valuable tools to support the process (see Table II).

Summary of soft systems methods

Churchman (1979), pioneer of modern systems thinking, stated that the systems approach begins when first you see the world through the eyes of another. He encouraged looking at a system from as many perspectives as possible rather than only one view of the whole systems (Churchman, 1970, 1971). Based on this presumption, social systems design (SSD) was developed to carry out the task of finding out more perspectives and arriving a holistic perspective. A three-step dialectical process (thesis, antithesis and synthesis) was used to reach a better understanding of the situation. Later researchers were inspired by his thought and methodology.

Ackoff (1974) viewed objectivity in social systems sciences as the social product of the open interaction of a wide variety of individual subjectivities. As a result, companies are purposeful systems (meeting multi-purposes of individual, organization, and society). The interactive planning (IP) was developed as a method to realize the insight of "plan or be planned for" (Ackoff, 1981) by endorsing it in its philosophy and providing a set of practical procedures

Table II Summaries of soft system methodologies

Author	Methodology and key point
Churchman (1970)	Social systems design (SSD) Holistic perspective drawn from dialectic debate Thesis Antithesis Synthesis
Beer (1972)	Viable systems diagnosis (VSD) Identification, diagnosis, adaptation, and information flows Implementation Coordination Control Development Policy
Ackoff (1979)	Interactive planning (IP) Objectivity, participative principle, principle of continuity, and holistic principle Formulate the mess Ends planning Means planning Resource planning Design of implementation and control
Checkland (1981)	Soft system methodology (SSM) Learning, culture, participation, two modes of thought, and CATWOE analysis Enter situation Express the problem situation Formulate root definitions Build conceptual models Compare models with real-world action Define possible changes Take action to improve the problem situation
Mason and Mitroff (1981)	Strategy assumption surfacing and testing (SAST) Adversarial, participative, integrative, managerial mind supporting Group formation Assumption surfacing Dialectical debate Synthesis
Ulrich (1983)	Critical systems heuristics (CSH) Dialectical solution on what ought to be done 12 critically heuristic categories Polemical employment of boundary judgments
Flood and Jackson (1991)	Total systems intervention (TSI) Complementarism, sociological awareness, and human well-being and emancipation, system of systems methodologies Creativity Choice Implementation
Linstone (1994)	Technical, organizational and personal perspectives (TOP) Multiple perspectives Technical perspective (scientific and technological) Organizational perspectives (unique group or institutional view) Personal perspectives (individual, the self view)

through which the philosophical message is empowered. IP facilitates the participation of all stakeholders, allows incorporation of aesthetic value into planning, generates consensus and commitment and mobilizes participants, releases suppressed creativity and harnesses it to individual and organizational development, expands the participants' concept of feasibility, and eases implementation (Ackoff, 1979). Those are what the knowledge processes have need for. The participative principle of IP aiming at all stakeholders ideally participating in the various stages of the planning process, and by being involved in the planning process members of the organization come to understand the organization, and their roles also match the prerequisite of the main task of knowledge management.

Beer's (1972, 1979, 1985, 2000) viable system design (VSD) or viable system model (VSM) was based on the belief that a system is viable if it is capable of responding to environmental changes by achieving requisite variety. VSD or VSM consisted of five subsystems labeled as:
(1) implementation;
(2) coordination;
(3) control;
(4) development; and
(5) policy.

It was a thorough working out of ideas from the science of cybernetics to organization. Information flows and organizational structure played a very important role in VSD. It is on this point that the systematic analysis and idea of Beer on organizational structure and information channels offer managers and practitioners deep understanding of them.

Checkland (1981) emphasizes social systems as a never-ending process of learning. His systems-based methodology – soft systems methodology (SSM) – is for tackling real-world problems and incidentally exploring social reality as the latter is not a "given", but is a process in which an ever-changing social world is continuously re-created by its members. The seven stages he proposed are to:
(1) to enter a situation considered problematical (unstructured);
(2) express the problem situation;
(3) formulate root definitions of relevant systems of purposeful activity;
(4) build conceptual models of the systems named in the root definition;
(5) compare models with real-world actions;
(6) define possible changes that are both desirable and feasible; and
(7) take action to improve the problem situation.

Knowledge management, no doubt, is a cyclic learning process in which SSM's value is to offer inspiration on how to learn continuously and effectively.

Mason and Mitroff's (1981) strategy assumption surfacing and testing (SAST) was designed for ill-structured problem contexts where differences of opinion over which strategy to pursue prevent decisive action being taken. The basic assumption in SAST is that once issues of pluralism have been overcome, the traditional methods of management science will be sufficient to finish the task. It is designed for use with complex systems of highly interdependent problems, where problem formulation and structuring assume greater importance than problem solving using conventional techniques. The authors try to focus managers' attention on the relationship between the participants involved in a problem situation and on the human and political aspects of organizations. They expect to overcome the bias of some assumption that may be held by some powerful persons through formation, assumption surfacing, dialectical debate, and synthesis of SAST. Ulrich's (1983) critical systems heuristics (CSH) was an effort to link the systems idea with the practical reasons of a problem. CSH encourages pursuing a heuristic rather than a theoretical route in order to satisfy the requirement through free and open debate in terms of the practical importance.

Flood and Jackson's critical systems thinking (CST) and total systems intervention (TSI) was supported by the five pillars:
(1) critical awareness;
(2) social awareness;
(3) dedication to human emancipation;
(4) complementarism at the theoretical level; and
(5) complementarism at the methodological level (Flood and Jackson, 1991; Jackson, 1991, 2000; Midgley, 2000).

Both emphasized being critically and socially aware and encouraged free and open debate to examine the existing assumptions and

Table III Systems methodology and knowledge system

Knowledge system	Criteria	Management in action	Methods
Value	Humanity	Cultivate	SSD
Culture ethics	Fairness	Nurture	IP
Moral	Honesty	Share	SSM
			SAST
			VSD
			CSH
			TSI
			TOP
Main subsystems of organizational knowledge			
Scientific aspect	Justification	Identifying	SSD
	Falsification	Precognition	IP
		Direction	SSM
		Protect	SAST
		Support	VSD
		Promotion	CSH
		Motivation	TSI
			TOP
Technical aspect	Advancement	Identifying	SSD
	New	Precognition	IP
	Applicability	Direction	SSM
		Protect	SAST
		Support	VSD
		Promotion	CSH
		Motivation	TSI
			TOP
Managerial aspect	Performance	Identify	SSD
	Applicability	Codify	IP
		Share	SSM
		Dissemination	SAST
		Promotion	VSD
		Motivation	CSH
			TSI
			TOP
Information	Reliability	Direction	Information science
	Simplicity	Support	Information theory
		Motivation	
Data	Objectivity	Direction	Information science and theory
	Accuracy	Support	Data mining
	Reliability	Motivation	Knowledge discovery in database

values of the systems designs and to find the strengths and weaknesses of available methods and techniques. TSI combines systems methods that promotes creativity, guides the choice of appropriate methodologies, and ensures effective implementation. It represents a new approach to planning, designing, problem solving, and evaluation and uses a range of systems metaphors to encourage creative thinking about organizations and their problems. Combining the information gained about the problem context during the creativity phase and the knowledge provided by the system of systems methodologies about the assumptions underlying different systems approaches, it is possible to move toward an appropriate choice of systems intervention methodology.

From what has been described above, it can be known that the purpose of those systems methodologies is to help social systems serve their client (e.g. customers, employees, stockholders, and interested sections of the public and other beneficiaries of the system)

Table IV Methods for managing the process of knowledge conversion

Mode	Process	From–to	Approaches
Socialization	Tacit to tacit	Person to person	Delphi
			Brainstorming
			Contingency theory
			IP
			SSM
			Problem structure method
			SAST
			Trial and error
			Learning by doing
			Comparison analysis
			Analogical analysis
			Simulation
			Trial and error
			Coaching
			Apprenticing
Externalization	Tacit to explicit	Person to person	Delphi
		Person to medium	Brainstorming
			Contingency theory
			IP
			SSM
			Problem structure method
			SAST
			Trial and error
			Learning by doing
			Analogical analysis
			Comparison analysis
			Simulation
			IT
Combination	Explicit to explicit	Person to person	Systems analysis
		Person to medium	Systems engineering
		Medium to medium	Knowledge discovery in database
		Medium to person	Data mining
			Meta-synthesis from quality to quantity approach
			Systems comparison
Internalization	Explicit to tacit	Person to person	Simulation
		Medium to person	Learning by doing
			Trial and error
			Deep thinking
			Analogy analysis
			Logic analysis
			Coaching
			Apprenticing

and hold a holistic perspective. They provide ways to debate, to identify the assumption and interests of the clients and to realize some changes that benefit the clients of the system. There are other approaches like Delphi approach, brainstorming method, and Linstone's (1994, 1999) technical, organizational and personal perspectives (TOP), which can help people see reality in a whole perspective.

Methodology for knowledge management

There is no an all-purpose super-method for all the situations. In some cases, TSI, as a system of systems methodologies, provides an approach to creative "problem-solving" by logic group of methodologies, but for a detailed case, it turns the role to each constituent method. For the proposed methods of knowledge management in this paper, what we need to do first is to group

knowledge contexts according to the above analysis on knowledge construct into different parts and then match the methodology groupings based on types of systems methodology. It is to provide managers, decision makers or other practitioners a convenient set of tools in managing knowledge activity efficiently. At the same time, it serves as unique systems perspectives to examine and evaluate knowledge processes and phenomena. Equipped with the knowledge of methodologies, users can focus attention on more basic problems.

A useful and convenient toolkit in systematically identifying and analyzing the complex situations out of an intertwined jungle of information and data as well as knowledge itself is seen in Table III.

For more detailed knowledge processes, a methodology base is shown in Table IV.

Conclusion

Knowledge displays its meaningful utility to the economic community only when knowledge is properly utilized by knowledgeable people. Actionable knowledge is pursued by knowledge-creating companies as process means rather than end. Knowledge managers first have to distinguish between management of specific knowledge processes and management of knowledge worker. Knowledge management is to manage knowledge workers in a fostered favorable environment to be engaged in knowledge activities.

In managing a variety of knowledge activities, great difficulties lie in handling the "softest" part of knowledge processes that are closely linked with idiosyncratic ethical values, managerial philosophy, personal subjectivity or cultural behavior embedded in certain organizational contexts. For the "hard" or "softer" part of knowledge management, that is, far away from more subjective evaluation, the methodology base provides robust intellectual apparatuses in shaping thinking, modeling concept, exploring situations and taking actions in knowledge activities as well as a "solid grasp" on some abstruse and complex matters, or sometimes overabundance of information.

Appropriate systems methodologies without a doubt help make the utilization process efficient and synergize the functionality of separate knowledge in both practical application and thinking. The systems methodologies enable knowledge systematically and purposefully to be applied to knowledge itself by employing the methodologies as a whole or lens. It is also feasible to inspire users consciously to leverage systems thinking on the socially entangled knowledge processes. For organizations, it can be of help in guiding effective decisions, cultivating trust and partnering from work relationships and facilitating the exchange and flow of knowledge and information within the organization and with its environment for purposeful actions.

Sometimes systems methodologies like other instruments may cease to be effective when knowledge is more relevant to people or organizations' value judgment. However, they at least can help avoiding risk and fetish on knowledge accumulation and creation.

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