

Social and Technological Innovations for a Knowledge Society

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Knowledge building--the creation of knowledge as a social product--is something that scientists, scholars and employees of highly innovative companies do for a living. We have demonstrated that these same activities can be integral to schooling, grades one to post graduate, and extensible to a variety of health care and workplace settings. The central purpose of CSILE (Computer Supported Intentional Learning Environments), and now second-generation Knowledge Forum®--and the Knowledge Society Network that it enables-- is to democratize knowledge. The most radical possibilities arise from restructuring the flow of information within and between organizations so as to allow participants to work continuously at the edges of their competence and to marshal high levels of "collective cognitive responsibility" and "collective intelligence." The ubiquity of such human capabilities, rather than ubiquitous computing, information access, and content delivery, will define a knowledge society.

Keywords: **innovation dynamic, knowledge creation, knowledge society**

1 Introduction

Twenty-first century knowledge work and technological innovation are inextricably related, as suggested by the global economy, the ever increasing demands for knowledge management resulting from the digitization of the world's knowledge resources, and the increasingly familiar *e-* prefix to signal electronic conversion of myriad forms of communication and commerce. Information-age societies will be founded on new knowledge media and on the redefinition of social and cultural practices afforded by them. While there is general agreement that the much heralded 'knowledge society' will have profound effects on our health, educational, cultural, and financial institutions, there is little analysis of the inner workings of such a society: Do we actually know how to promote the skills and the processes that would make a knowledge society work? Is it even legitimate to speak of a knowledge society if the majority of citizens do not belong to it?

The transformation from an industrial society with a manufacturing economy, to that of a knowledge society with a knowledge economy, represents a transformation comparable in significance to major transformations from prehistoric and historic times. Since the beginning of civilization technology and social innovations have been intertwined. These transformations are occurring at an ever quickening pace, and each involves technology breakthroughs and new social forms that are in reciprocal relation to one another. A very rough chronology, as presented by Keating & Mustard (1993) [1], is presented in Table 1.

Date	Technology Innovation	Social Innovation	Overall Result
40,000 B.C.	advanced stone technology	intertribal communication	recognizable civilizations with characteristic crafts and symbolic art

10,000 B.C.	the agricultural revolution	massing of populations in fertile regions	state structures and cumulative knowledge growth
1700 A.D.	machine technology	complex organizations of labor and capital	global trade and communication; specialization of knowledge production
2000 A.D.	advanced information technology	knowledge-based societies and economies	???

Table 1: Major transformations attributable to an innovation dynamic involving technological and social innovations

There is nothing new in the dynamic that binds technological and social innovation together. What is new is the purposefulness with which this dynamic is harnessed to specific achievements. In earlier times, major transformations occurred without plan. The industrialization of Europe and North America during the 19th century came about through the cumulative effect of countless individual initiatives with no overall plan. But in the 20th century we saw many nations embarking on plans for deliberate industrialization. Now we see nations the world over, developing policies to ensure a place for themselves in the global knowledge economy. The result of the 2000 A.D transformation is, of course, yet to be determined, and it may be different in different societies. According to one scenario, technological advances will democratize knowledge. According to another scenario, there will be a widening split between educationally advantaged and disadvantaged groups, leading to the rapid decline of nations and groups that are unable to keep up with the increasing demand for knowledge and skills.

2 Capturing the knowledge-creation dynamic

An innovation dynamic favorable to the creation of a knowledge society is enabled by social and technological systems working in reciprocal relation, each biasing knowledge work toward increasingly high-level processes. Democratization of knowledge additionally requires systems that *enable rather than presume advanced knowledge processes*. We refer to the social and technological systems that enable advanced knowledge processes as knowledge building systems because they engage all community members in the core knowledge creation dynamic: ideas and achievements are continually contributed to the community, and their usefulness is magnified through availability and continual refinement in a community context.

The last row of Table 1 is reproduced as Table 2, reframed to indicate knowledge building innovations hypothesized to lead to the democratization of knowledge--an optimistic version of the 2000 A.D. transformation.

Date	Technology Innovation	Social Innovation	Overall Result
2000 A.D.	Knowledge Building Technology	Collaborative knowledge-building communities, embedded in a Knowledge Society Network	The democratization of knowledge

Table 2: The knowledge building innovation dynamic

2.1 Core facets of knowledge creation

The knowledge-building innovation dynamic is elaborated in Table 3. It begins with a brief account of four facets of knowledge creation, which take into account frequently cited characteristics of twenty-first century knowledge work, including teamwork and knowledge sharing [2] [3] [4].

In this paper terms are used that signify the ways in which these aspects of knowledge work must be extended beyond their common meaning if the result is to be knowledge creation. Thus, for example, we use the term community knowledge. Teamwork is involved, but the production of community knowledge additionally requires that all members add value to shared ideas; otherwise, teamwork settles into joint productions that do not extend the

team's knowledge. Team members enjoy information access, but access does not lead to knowledge creation. The four facets of knowledge creation presented in Table 3 are:

2.1.1 Community Knowledge

Expert knowledge-based societies are believed to gain advantage through collective contributions--what we might think of as knowledge-in-the-aggregate as opposed to the talents or contributions to knowledge of individual outliers. A growing literature suggests that the pursuit of excellence in a knowledge society will depend increasingly on what have been termed "21st Century skills" and the teamwork they imply. "In the knowledge society it is not the individual who performs. The individual is a cost center rather than a performance center. It is the organization that performs." [5]. There will be a premium on abilities over and above those that marked genius in previous centuries. Emphasis on individual excellence may even prove counter-productive to societal excellence.

2.1.2 Rise Above

It is easier to deal with the concrete, immediate, and simple than to cope with complexity, diversity, and messiness. Yet these later qualities typify most innovative environments and work at the cutting edge of a discipline. In knowledge building communities rise-above is built into the social fabric of the organization and into the technologies that support it. Its members establish shared goals that stretch their collective abilities. They move to increasingly high levels for resolving conflicts and for solving problems, thus they learn to accommodate emergent goals rather than working with goals that are fixed from the beginning. They learn to do the exceptional routinely.

2.1.3 Improvable Ideas

The history of scientific achievements teaches a lesson: ideas are improvable. Aristotle's physics was superseded by Newton's; Newtonian physics gave way to Einstein's relativity theory; relativity was further advanced by Planck's quantum theory. We still think of Aristotle, Newton, and Einstein as geniuses, but people who hold physical beliefs similar to Aristotle's are considered to hold misconceptions while contemporary physicists pursue theories that continue to advance improved versions of last year's theories. Creating knowledge new to the world, improving on existing knowledge, and grasping and applying what others say are all similarly intensive knowledge processes. Those who are able to continually build more complete knowledge are engaged in the same processes through which expert knowledge is achieved in the first place.

2.1.4 Symmetric knowledge advancement

This is a variant of what is popularly known as creating win-win situations, applied to knowledge work. Knowledge building is served when one group's knowledge serves as foundation for work elsewhere. Many institutions represent the antithesis of a model of 'symmetric knowledge advance.' Activities typically are organized so that participants do the same thing and do not learn from one another. For example, in educational contexts the teacher's knowledge does not advance appreciably in the course of instruction; outputs have no value outside the organization, except in rare cases where reports have value to others; and organizations--especially schools--form a distinct and separate community, minimally affected by knowledge advances in other sectors of society. The situations we wish to explore, in contrast, maximize knowledge resources through creating more synergistic relations both within and between communities engaged in knowledge work.

Nonaka and Takeuchi [6] present five phases of a knowledge-creation process: (a) sharing tacit knowledge, (b) creating concepts, (c) justifying concepts, (d) building an archetype, (e) and cross-leveling knowledge. The goal in listing facets of knowledge creation, as presented above, is not to identify steps in a linear process, nor an exhaustive classification, but rather to illustrate the correspondences between essential processes and technological and social supports that enable them. A row-by-row review of Table 3 highlights these correspondences, and planfulness in aligning them with technological and social innovations fine-tuned to their production. The implication is not that there is a one-to-one correspondence between these processes and these innovations. Rather, there is productive redundancy, with many routes, and no set pathways to the complex of socio-cognitive processes supported by knowledge building technologies.

<p><u>Core Facets of Knowledge Creation</u></p>	<p><u>Technology Innovation:</u></p> <p>Knowledge Forum®</p> <p><i>Bolded items refer to processes specifically supported by Knowledge Forum software</i></p>	<p><u>Socio-Cognitive Innovation:</u></p> <p>Collaborative Knowledge Building</p> <p>Knowledge Society Network</p>
<p><u>Community Knowledge</u></p> <p>Contribute to collective knowledge advancement and shared goals; contribute ideas to communal design spaces; serve as a valuable team member; cultivate openness in knowledge work</p>	<p>Individuals and teams contribute ideas in the form of notes and views to collaborative and public design spaces; ideas are shared and refined as collaborators read, build-on, reference, search, summarize, add keywords, collect and annotate knowledge artifacts contributed by participants. Openness in knowledge work is supported through links to views of different team members and to the production of higher-order conceptual frameworks</p>	<p>Knowledge jointly constructed; priority given to the production of ideas of value to others, not simply to demonstrations of personal achievement</p>
<p><u>Rise Above</u></p> <p>Move to increasingly higher levels to resolve conflicts and to solve problems; transcend expectations; accommodate complexity, diversity, and messiness; translate ideas into action and new contexts; engage in progressive problem solving and self assessment</p>	<p>Rise-above notes and views-of-views support increasingly high-level formulations of problems and ideas, as well as coherence and synthesis of ideas; the rise-above-it principle is reflected in publication-and-review, in a multimedia journal, in individual and group portfolios and in multiple representations of ideas, viewed from different perspectives; customizable scaffolds for high-level knowledge processes support theory refinement, evaluation of evidence and counterarguments, constructive criticism, experimentation, and a host of high-level knowledge processes.</p>	<p>Community members view conflicts and problems from high-levels; they engage in theory refinement and explanatory coherence: Do our ideas fit together? Where are the gaps in understanding? What new information has been found that we must take into account? What is missing from our current conceptualization?</p>

<p><u>Improvable Ideas</u></p> <p>Cultivate promising and improvable ideas; sustain inquiry at the edges of understanding; move beyond current best practices; work with emergent goals; approach problems as opportunities</p>	<p>Idea improvement is supported through peer review, coauthored notes and views, links to views of different team members, higher-order conceptual frameworks, reorganization and revision, and integration of new information; process models and knowledge-building discourse are supported through animation and video notes</p> <p>Analytic tools work in the background and record processes automatically--research and reflection become integral to the workings of the organization; participants serve as ethnographers of knowledge building.</p>	<p>Communities living at the edge of their collective understanding, sustained by a culture that prizes reflection, critical analysis, emergent goal states, and high-level integrations that do justice to the ideas of all contributors</p>
<p><u>Symmetric knowledge advancement</u></p> <p>Progressive refinement of ideas within and between communities; work at the cutting edge of inquiry; situate and refine ideas in the context of broadly distributed communities</p>	<p>Interleaved local-and wide-area networks support the work of local and globally configured communities; replication, merger of workspaces, and a system of virtual visitations, support knowledge building discourse within and across communities; online-offline synchronization, wireless capabilities, and Palm KF will soon provide anytime, anywhere access</p>	<p>Distributed and opportunistic workgroups treat diversity as strength and enable integration of work across disciplines and communities</p>

Table 3: The knowledge-building innovation dynamic: core facets of knowledge creation, knowledge building technology, and knowledge building social structures

2.2 Knowledge building technology

Column two of Table 3 indicates technology supports to enable the core facets of knowledge creation listed in Column 1. The technology that provides these supports is Knowledge Forum, a second-generation CSILE (Computer-Supported Intentional Learning Environment) product [7] Knowledge Forum is designed to make the underlying, hidden aspects of knowledge creation transparent to its users. There is not space to elaborate here, but we have found that the facets of knowledge creation listed above are in evidence with Grade One students using Knowledge Forum. This finding is suggestive of the goal underlying its design--to provide ‘a way in’ for everyone, and thus to take the essential first step in democratizing knowledge. These same processes are supported by the same technology and the same social structures in health care, graduate school, business, cultural organizations, and other workplace environments. Thus we have demonstrated that these activities are integral to schooling, grades one to post graduate, and extensible to a variety of health care and workplace settings. This opens the way for a knowledge society.

2.3 Knowledge building social structures

Column 3, Table 3 indicates the social innovations that correspond to Knowledge Forum’s technological innovations and, in turn, to the core facets of knowledge creation it is designed to support.

2.3.1 Knowledge building communities.

Knowledge-building communities [8] are not simply collections of people who individually pursue knowledge, even though their individual interests may be diverse. They are a community in the sense that they share their knowledge, support one another in knowledge construction, and thus develop a kind of collective expertise that is distinguishable from that of the individual members. Participants may be co-located or distantly located. The defining characteristic is their commitment to the collective goal of improvable ideas--the essence of knowledge creation. Advancement of knowledge is pursued strategically and with deliberate investment of resources. Participants aim to redefine problems at deeper or more inclusive levels as they proceed rather than to eliminate problems. The result is continual advancement of the community's knowledge and capabilities, similar to the process of expertise in cutting-edge research and development teams [9] [10]. Although knowledge creation depends on chancy processes of discovery and invention, we take it for granted that some communities will make advances with greater regularity than others. That is what we expect of knowledge building communities, as they represent a social organization that invests its resources in the advancement of the group's knowledge, so that the group as a whole is striving for advancement beyond present limits of competence.

Participants within a knowledge building community, supported by Knowledge Forum, share an electronic design space in which important aspects of their intellectual work are recorded in digital form and entered into Knowledge Forum's communal workspaces. Processes of reflection, review, and publication encourage each community to create high-level syntheses of their work. Analytic tools work in the background of these design spaces and record processes automatically so that research becomes integral to the day-to-day workings of the organization, encouraging the community to reflect on their processes and to continually improve them. The design spaces support multimedia--video, animation, audio, graphing--and cross-application inter-operability is on the design agenda. Knowledge building discourse is the dynamic that brings various knowledge operations into the service of knowledge advancement.

2.3.2 The Knowledge Society Network. Experts seldom exist in isolation. Nor do expert communities. Often they are linked together by associations or informal networks, but even when that is not the case they are connected through a tradition in which expertise evolves over generations. Globally networked knowledge building communities enable the Knowledge Society [11]-- a network of networks, providing a natural extension of the progressive refinement of problems, knowledge sharing, and group interactions that define work within a community. Knowledge Forum supports this process through integration of knowledge work within and across communities. Select portions of the design spaces of local communities can be opened to cross-community searches. Features such as replication and merger of design spaces allow communities to replicate portions of one design space into another and to create new cross-community discourses. Thus, for example, elementary school biology communities might work with high school biology communities, and they in turn with pre-med students. However, there is no predetermined alignment, and communities may find their cutting edge in unanticipated places. The work of these communities is enriched by virtual visitations, and also made increasingly demanding by the commitment to openness in knowledge building that these visitations entail. Participants agree to allow their design space to serve as an object of inquiry, giving new meaning to work at the cutting edge. By making use of talents within and between communities, knowledge building communities have access to enhanced knowledge resources, and continual effort does not have to be exerted to make the system function, as knowledge building is built into the dynamics by which participants communicate and pursue organizational goals.

3 Conclusion

Knowledge creation must operate at all levels of an organization and across a wide range of organizations if we are to democratize knowledge. In order for this to happen, both technological and social innovations are required that go beyond what is presently regarded as the state of the art. Inquiry into the social and technological innovations required for a knowledge society is in its infancy. The goal of this paper is to contribute to an understanding of the issues and possibilities of a special form of a knowledge society--one that enables rather than presumes advanced knowledge processes; one that is committed to giving away its understanding of these processes.

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