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Organizational knowledge and the Intranet

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Abstract

The Intranet phenomenon has been driven by the push of technology standards and the pull of organizational need to (1) communicate across geographic, organizational and functional barriers, and (2) collaborate among sites and with suppliers and customers. The objective of this study is to generate a theoretical framework for the interaction between organizational knowledge and the Intranet. The contribution of this paper is 4-fold. First, we generate a theoretical framework using the paradigm model of grounded theory. We show interactions between the Intranet and three organizational knowledge strategies taking into account drivers, the context, and intervening conditions. Second, previous research on organizational knowledge creation theory is incorporated into the framework. Third, the framework forms the basis for future empirical research on the business value of the Intranet. Finally, the study raises implications for IS developers, IS departments, management and researchers.

Keywords: Organizational knowledge; Intranets; Knowledge management; Knowledge creation; Integration

1. Introduction

The Intranet has been hailed as the solution to organizational technology issues as far reaching as faster information systems development, access to legacy system data, integration of incompatible systems [79], and progress towards the ‘paperless office’. Moreover, Intranets enable work-flow management and project management, and are a platform for process redesign [23,51]. Yet possibly the most far reaching impact of the Intranet is on organizational knowledge.

Intranets are providing institutions and organizations with opportunities to create knowledge. A high proportion of the pioneers are high technology companies making use of intranets for knowledge intensive new product development. Intranets enable community expertise to develop, as engineers brainstorm and give each other feedback in discussion groups, and share product specifications and product test result queries [22,70,95].

The scope of interest in intranets is evidenced by diverse articles and applications in the medical [44], legal, engineering, training, travel [11], technical, computer-related and manufacturing industries [22,59]. Although some definitions restrict intranets to internal information on internal webs [23]; accessed exclusively by internal users [79], in this paper we adopt a broader definition that includes customers and suppliers in the extended enterprise (also called an ‘Extranet’ [45]), and industry wide applications [51]. Thus, an intranet is a ‘‘powerful tool for institution-wide communications, collabora-

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tive projects, and the establishment of a sense of community on a manageable scale'' [59].

Despite the fact that many organizations have adopted the Intranet with great enthusiasm, and there has been an avalanche of web and journalistic articles on the Intranet since the end of 1995, theoretical research has been lacking. Evidence of the business value of the Intranet has been convincing but largely anecdotal [84]. In addition, negative reports have surfaced on hidden costs [33], performance limitations [29], and organizational resistance [10,21]. Such issues have been researched with political theories that explain how some constituents gain and others lose when there is organizational change associated with IT implementation [65,76,80]. Organizational learning theories also explain such contradictions by examining what affects the creation, integration and management of knowledge and facilitation of organizational memory [34,35,80,89,92]. For example, the theory of organizational knowledge creation posits that autonomy, intention, redundancy, fluctuation and creative chaos, and requisite variety are conditions that induce the transfer of tacit and explicit knowledge in a spiral from individual to group, to organization levels [71,72,74].

The findings from this analysis of reported implementations of intranets generate a theoretically-based model relating organizational knowledge to the Intranet phenomenon. We extend the inductive concepts [36] by analyzing examples of enabling conditions and organizational knowledge creation modes on intranets, using Nonaka's [72,74] theory of organizational knowledge creation as a guide. Our contribution is to develop a theoretical understanding of the Intranet phenomenon, with an initial framework to guide further conceptual and empirical research on the impacts and business value of the Intranet, and to present implications for IS developers, IS departments, management and researchers.

2. Methodology

We attempt to describe Intranets in terms of the theory of organizational knowledge creation. Qualitative secondary data, in the form of case studies on Intranet implementations are widely available on the Internet, provided by vendors, such as Netscape and Sun, and numerous consultants and academics [10,22,51,70,95]. The articles could be biased but the veracity is likely given the multiple sources and the ease of refutation [93]. The objective of this paper is to use the paradigm model of grounded theory [93] and this secondary data to develop a framework for facilitating organizational knowledge with the Intranet, and for proposing the impacts and business value of the Intranet, to guide further conceptual and empirical research on this topic. The paradigm model is the basic tool for relating concepts in grounded theory [93]. At the heart of the model is a phenomenon, which is explained by causal conditions, context, intervening conditions, action/interaction strategies and consequences. Connecting emergent grounded theory with aspects of existing theory and literature enhances the generalizability of the new framework [30,36,76]. In this analysis, we will examine the Intranet phenomenon (see Fig. 1), guided by the theory of organizational knowledge creation [72,74].

3. The paradigm model of the intranet

Each component of the paradigm model is analyzed in this section.

3.1. Phenomenon

According to the Scott, Foresman dictionary, a *phenomenon* is defined as ''an extraordinary or remarkable thing.'' The term is usually applied to an extreme situation that is growing and spreading quickly, and is surrounded by hype and high expectations. Such is the case with the Intranet, and statistics attest to the Intranet's phenomenal growth. For example, Intranets, a US$400 million market in 1995 [101], are predicted to grow to US$1.2 billion by 1997 [88] and US$8 billion by 1998 [14,21,66,105]. Seventy-five percent of Fortune 1000 firms initiated intranet projects in the past year [88], and other sources conclude that 43% to 90% of surveyed organizations have intranets or plan to have them [51,101].

3.2. Causal conditions

It is not possible to pinpoint a single causal condition for the Intranet phenomenon. Instead, there

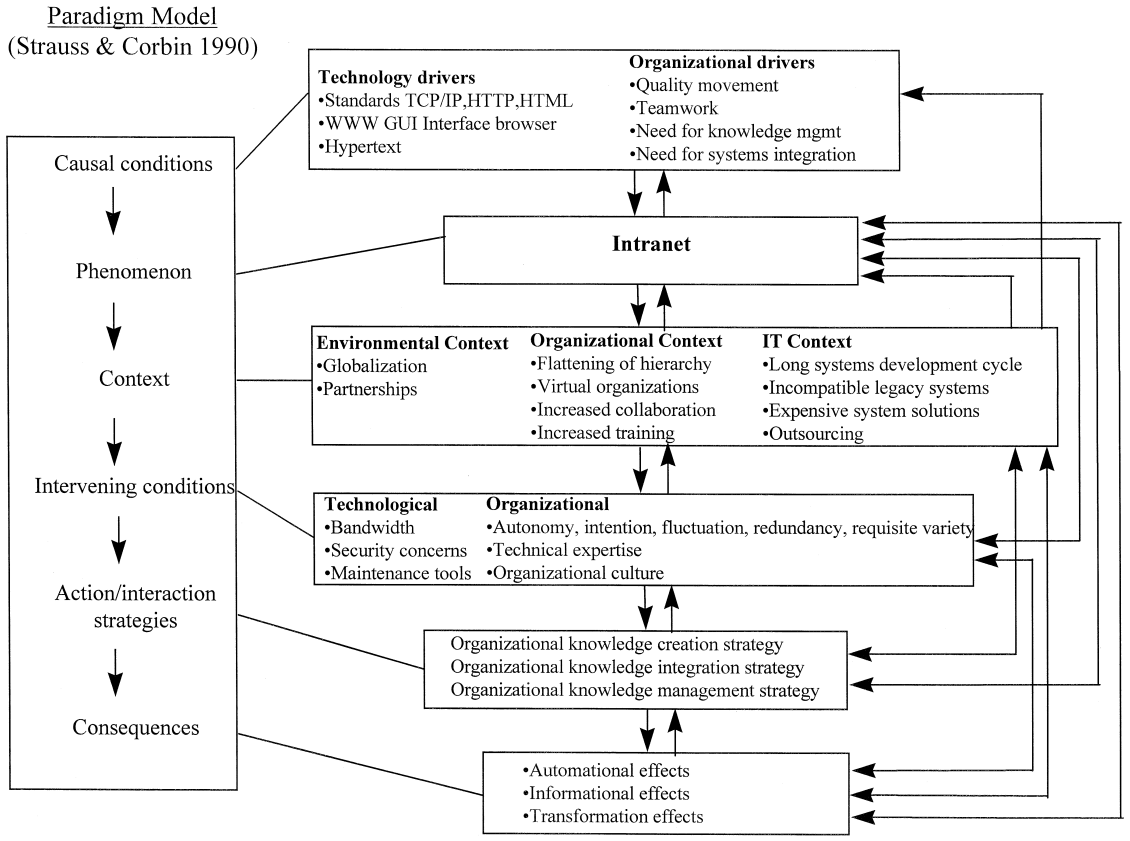

Fig. 1. A framework for organizational knowledge and the Intranet.

has been a complex interaction between technology and management factors. Thus intranets have emerged from both the push of technology and the pull of management needs [104]. On the technology side, standards have laid the foundations for an easy-to-use, cross-platform, open standards environment [8,9]. TCP/IP was introduced in 1983, and the World Wide Web in 1992. Commercial organizations were exposed to the advantages of Internet technology with HTML in 1990, and although practiced by technology leaders such as Digital and Sun among others, there was a three year lag before the media and businesses started becoming interested on a larger scale. Exponential growth began after the introduction of Mosaic, the first browser with a graphical user interface, in 1994 [6].

On the management side, trends such as the quality movement and teamwork have created a need for increased communication and collaboration across functional, geographic and organizational boundaries. These virtual corporations [27,75,78] have highlighted the importance of organizational knowledge management. The Intranet has responded to management's pent-up demand for organizational knowledge by enabling systems integration, access to information in legacy systems, and easy to use hypertext electronic documents [4], which provide an alternative to high cost paper-based delivery [91].

3.3. Context

In this section we will examine the context for the Intranet phenomenon, specifically the environmental context, organizational context and IT context.

3.3.1. Environment

The current environment is characterized by turbulence and a high rate of technological change. This

environmental fluctuation induces organizational knowledge creation if employees reflect on the chaos, which is then creative rather than destructive [72]. Universal reach in communications both makes globalization possible and enables more effective collaboration. For example, asynchronous communication such as email and the Intranet, with posted electronic documents, electronic discussion groups and transaction systems, are more convenient across different time zones and so more ideal for global communications than synchronous communication by telephone, teleconferencing and videoconferencing.

The Web helps to bridge time differences. You can publish something and let someone draw from it after you go home. It's better than dragging someone out of bed for a conference call, [70].

Potentially, employees on opposite sides of the world could work together as easily as colleagues in adjoining offices [29]. At National Semiconductor, ''the internal Web has connected people from different departments and countries that have never interacted before'' [70].

3.3.2. Organizational context

The organizational context for knowledge creation has been influenced by management revolutions such as flattening hierarchies, downsizing, and reengineering, all of which have exerted pressure on a smaller remaining group of employees to collaborate, cut costs and increase productivity. Management needs not only to amplify and legitimize informal social interactions [72] and to focus extensively on training [19], but to hold down training costs and to promote receptivity to tools that are easy-to-use. Moreover, with fewer people and declining costs relative to performance for technology, organizational knowledge is increasingly systems-based [97]. The Intranet addresses (1) collaboration with tools such as discussion groups and common repositories of knowledge, (2) just-in-time training with posted multimedia documents, and (3) ease-of-use with the hypertext feature [4,21,47].

3.3.3. IT context

In the IT context, IS departments are under pressure to reduce costs and speed up services. Cost and time overruns for systems development [56], incompatible legacy and client/server systems, and a diversity of application platforms and operating environments, are common IS woes. Dissatisfaction with IS departmental knowledge has resulted in two trends. The first trend is outsourcing IT [39,63]—a formal provision to build knowledge at the interorganizational level [72]. The second trend is a grassroots revolution or shift by users to gain more control of systems' implementation and development [51]. With the Intranet, users have welcomed the prospect of solutions to (1) speed up systems development, (2) integrate systems, and (3) access data in legacy systems.

3.4. Intervening conditions

Intervening conditions in this model are both technological and organizational [60]. On the technology side, improvements in bandwidth and tools to address security concerns [32] and maintenance of intranets are needed [15]. In the words of Bowen and Wong [13], ''technology plays catch up'', since easy to use maintenance tools are lacking. These tools are being developed at a furious rate, so this problem may be temporary. Intranets are hampered by lack of technical expertise, with knowledgeable webmasters reported to be in short supply [15]. Moreover, as we move from the beginnings when almost anyone could create a web page, to a stage where mission-critical applications run on the Intranet, the tools and applications become more sophisticated, and increased expertise will be in demand.

The organizational culture [80] will determine how readily an intranet is accepted. Resistance to change is a classical problem [65], but is alleviated by the ease-of-use [28] of the Intranet environment. Nevertheless, according to Murphy [69], ''There is considerable resistance from three factions: [Lotus] Notes proponents, legacy dogs too busy to learn new tricks, and three-tier architects''. These factions have invested time, money, and skills into training and proprietary IT solutions and perceive they have more to lose than other groups. Resistance from technical support [8,9] and administrative groups, based on fears of legal, public relations or capacity management problems, has resulted in instances of reassigned domain names and URLs that bring down

sites and pages [49]. At CAP Gemini there have been problems getting employees to use the Intranet, but an Internet Cafe has had some success [21]. Apparently, resistance is greater in Asia/Pacific than in Europe and the US [15], perhaps because the Web is viewed as an 'American conspiracy' [49]. Philosophical opposition is exemplified by mistrust of the openness of the web due to possible embarrassment and the fear of sharing knowledge [20,49]. This fear arises from perceptions of losing a resource, and becoming redundant [49]—similar to resisting 'giving away' expertise during expert system development.

Enabling conditions for organizational knowledge creation are intention, chaos/fluctuation, autonomy, redundancy and requisite variety [72]. Organizational intention is exemplified by the corporate vision which induces purposeful activity. Moreover, an organization publicizes its intention and vision with a mission statement and organizational standards [74]. Among firms that use the Intranet to communicate their intention are those that post the organizational mission and messages from the CEO and other top management. Sun uses online audio reports from the president and CEO, Scott McNeally, and other top management to communicate its organizational intention on their Intranet [8,9]. Chevron's Intranet has a message from the president, and Nortel posts reengineering intentions [8,9]. Digital publishes internal standards, such as how to use the company logo and the biweekly Digital Today which is ''. . . a corporate newsletter and information service made available on the corporate Web to all of Digital's 61,500 employees, allowing them to be aware of Digital's position on many issues'' [16].

Fluctuation and creative chaos also enable organizational knowledge creation [74]. On an Intranet posted information changes frequently, enabled by the ease of making changes with web technology. This contributes to the breakdown of routines which triggers creative chaos and stimulates interaction with a fluctuating environment [74]. A broad variety of information is accessible with web technology, and competitive information is often posted on the Intranet. For example, Allen–Bradley distributes market intelligence [70]; Eli Lilly posts news feeds on their industry [70]; and Sun makes a competitive analysis available to all employees [95]. Seamless integration between the internet and Intranet also introduces fluctuations to the firm. For example, at Nortel, the web is so highly integrated between its internal and external roles, that employees are not even aware that they are outside the firewall, and when employees at Chevron need to tap information sources anywhere in the world, they do so with their Intranet and seamless integration with the internet [8].

Autonomy, another enabling condition for organizational knowledge creating strategies, has been widespread on the Intranet. Web technology use has been a grassroots movement [41,51] and ''a bottom–up effort'' [16] in most early adopting firms, where anyone could post web pages [79]. According to Carl, ''Right now anybody can have a Web server, [but] establishing a criteria for having things on the server is a top priority'' [16]. Thus, as the Intranet becomes institutionalized there is a trend to exert more formalization [16] and management control over the Intranet. For example, at Amoco, conflicting demands associated with intranet growth ''positing user needs against management mandates, are common when representatives of various corporate divisions try to hammer out an intranet strategy that will serve all equally well'' [41].

Management mandates could threaten autonomy. Organizational knowledge creation depends on preserving individual autonomy, which motivates employees and generates original ideas [74]. However, users' autonomy threatens management control, and the political and institutional factors which protect the status quo [80]. During creation of standards for presentation and content, which are becoming increasingly adopted to ensure consistency across the institution, conflict between constituencies is likely [41,50].

Autonomy is illustrated on Digital's intranet, where ''engineers may have made a groupware-like environment for their engineering team without considering what other teams were doing'' [16], because:

> . . . engineering and manufacturing workgroups can develop systems independently using their own departmental servers and LANS. No consultation or even knowledge of one another's systems is really necessary for these systems to be tied together at

some later date. And no one person or department need really be in charge [24].

The Intranet at Sun provides a balance between autonomy and control, as employees easily create web sites with the provided templates, which ensure consistency and control of standards. Similarly, autonomy was balanced with control when a cross-functional team from facilities, HR and other divisions at Nortel put together an intranet application to streamline cubicle and office moves [9].

Redundancy offers an overlap in knowledge between different groups that promotes cross-functional collaboration [74]. Wide access to corporate information [74] on an Intranet allows redundancy of knowledge, yet saves on paper, mailing and distribution costs. And even when there is an overlap in knowledge on pages from different departments, there is just one set of data for each department to keep current.

Requisite variety, where the firm's internal diversity matches the complexity of the environment, also enables organizational knowledge creation [74]. Organizational members should know who owns what information, but they should not be overloaded with information [72]. The Intranet addresses both these issues with knowledge repositories, such as 'Knowledge On Line' at Booz Allen and Hamilton [46]; and 'Knowledge Galaxy' at CAP Gemini [21]. These systems help employees find subject matter experts and prevent overload as they pull rather than push information.

3.5. Action / interaction strategies

The action/interaction strategies that firms can adopt to gain advantages from the Intranet focus on knowledge. For example, National Semiconductor has developed an internal communications network based on the World Wide Web hoping ''to make it easier to connect our employees to *knowledge*'' [70].

Organizational knowledge creation, integration and management strategies leverage organizational intelligence [43]. Moreover, organizational knowledge creation requires interaction and conversion of tacit and explicit knowledge between individuals and groups in the organization [74].

3.5.1. Organizational knowledge creation

Organizational Knowledge Creation has four modes—socialization, internalization, externalization and combination [74]. Socialization refers to the transfer of individual tacit knowledge to organizational tacit knowledge. Tacit knowledge is difficult to articulate but need not be verbal [72] and is transferred by team interaction, and sharing of mental models, technical skills, experiences and perspectives. Although face-to-face communication is ideal, virtual teams use visual cues from observation and rich media such as animation, graphics, audio, videoconferencing, the chat feature of the Internet, and virtual reality to facilitate socialization. For example, Mitre's 'Collaborative Virtual Workspace' is a multimedia groupware environment, that uses the Internet's Network News Transfer Protocol (NNTP) for discussion groups and Multi-User domain (MUD) for chat environments [46]. Multimedia capabilities of the Intranet, such as video clips, demonstrate organizational procedures that are difficult to explain verbally [18]. Rich media also helps tacit knowledge transfer across different languages, cultures and time zones. Nevertheless, socialization skills for effective global virtual collaboration need to be developed to build trust and compensate for the lack of face-to-face interaction [57].

Internalization is a mode exemplified by an iterative process of trial and error and experimentation with explicit knowledge, resulting in organizational learning and tacit knowledge creation [74]. For example, simulations and spreadsheet-like 'what if' scenarios are possible on an Intranet with Java applets incorporated into Intranet decision support applications. At Sun the Supply Planning group developed a site with supporting assumptions and definitions for iterative plans using trial and error for enhanced data analysis and decision making [95]. At National Semiconductor, ''...people are experimenting and not taking things for granted. The organization can adopt change more readily and not get stuck, rather than leaving business processes the same way they've always been. This means we can create new products faster and be more proactive about giving customers what they want'' [70].

Externalization is the conversion of subjective tacit knowledge based on experience to objective explicit knowledge [72,74]. It is challenging because

tacit knowledge is difficult to articulate, communicate, formalize and encode [72,74,99,102]. Tacit knowledge is 'sticky' because the rules of expertise are unknown [99], and to progress through to higher knowledge stages requires an increase in understanding of causal influences [12].

Nonaka [72] proposes repeated, time-consuming dialogue, sharing one's original experience and a metaphor–analogy-model sequence for effective externalization. Metaphor, experiencing one thing in terms of another, is an intuitive cognitive process to relate concepts, which are then resolved through analogy to things that are already understood, and finally made explicit through prototypes [72]. Iterative prototyping has been used successfully to externalize 'sticky' user requirements [99], and is one of the recommendations for applying the stages of the technological knowledge framework [12]. Prototypes and models are explicit representations of new products. Potentially, three-dimensional graphics, animation, video clips, virtual reality and other technologies enhance presentation of prototypes on the Intranet. Moreover, Intranet-based prototypes for enterprise decision support have been developed [3].

On the Intranet, discussion lists can facilitate dialogue and interaction; graphics can enhance the use of metaphors, analogies and prototypes to clarify what was originally fuzzy and obscure. Hyperlinks relate concepts and organize knowledge repositories for better access with drill down to ease cognitive overload. For example, in product development, dialogue includes ideas exchanged in discussion threads that focus on specific expertise, forums for brainstorming new ideas and critiquing proposed approaches; and discussion on customer feedback on new products from sales, marketing, and customer service. This dialogue increases understanding of customer requirements and technical capabilities. At National Semiconductor, Electronic Arts and Olivetti, virtual workgroups quickly assemble to access information, teams debate topics, discuss projects and project results, and share knowledge and experiences; engineers troubleshoot technical problems, and share tools, design methodologies, successes, mistakes and ideas [21,70].

Ford's intranet, linking design centers in Asia, Europe and the US, facilitated development of the 1996 Taurus [21]. Virtual new product development teams use worldwide talent, videoconferencing and simulations to share designs, and to build and test prototypes of a global car [61,78]. The teams avoid redundant efforts by using globally coordinated engineering-release databases, common CAD tools, common global specifications for manufacturing, and a common repository of national environmental and safety laws [50,78,86]. Designers transmit three-dimensional images of prototypes over the intranet for computer-animated examination by executives in Europe and the US. If they give the go-ahead, the designs are translated into numeric data, which are input into an automated rendering of a clay model [96].

Combination is the organizational knowledge creation mode whereby individual explicit knowledge is converted to group and organizational explicit knowledge [74]. This mode is facilitated by categorization and traditional information processing [73]. Although transaction processing with web technology is not yet as common as electronic documents and discussion lists, leading edge companies like Sun are automating processes on the Intranet. We will discuss web-based transaction systems further in the section of the framework on consequences. In addition to organizational knowledge creation, two important Intranet strategies are organizational knowledge integration and organizational knowledge management.

3.5.2. Organizational knowledge integration

Organizational knowledge integration is made possible by the cross-platform open-standards capabilities of the Intranet [1], which allows data access from multiple sources, including legacy databases, presented on one interface [54]. Furthermore, the Intranet is proposed as a potential alternative to integrated enterprise systems such as SAP R/3 [21,54]. Technology in the form of knowledge bases, data dictionaries, and online databases, along with people reengineering processes, facilitate integration of systems, knowledge, and data [7,37,58]. Standards are important for integration, specifically for data definitions and formats, and interoperable network protocols [58,64,81,82]. A Fortune magazine article explains that on an intranet:

You don't have to abandon or struggle to integrate existing legacy databases or different platforms where

your information resides. There's no need to retrofit. It gives companies the flexibility to do what they need to do internally, and it's a lot easier to implement than some of the more complex proprietary systems [23].

For example, at AT&T, a web system integrates disparate billing systems, [70]; at John Deere, a cross-functional parts database is used by purchasing for quotes, by the shop floor to find out how a part is put together and by engineering ''to automatically develop bills of materials for their designs'' [70]; and at Sun Microsystems, 'Asset Managers Workbench' is a Web-based reporting tool that allows instant queries and standard reports from Oracle Financials —a process that used to take several days [95]. Web queries to mainframes at Sandia Labs, Federal Express (to track packages), the US Postal Service (to search for zip codes), and to corporate databases at Allen–Bradley, Silicon Graphics, HBO, Tyson Foods and Dreamworks fetch information more quickly and at less cost than traditional systems. Web based forms are also front ends to ordering systems at AT&T for office supplies, and at Allen–Bradley for help desk support.

3.5.3. Organizational knowledge management

Organizational knowledge management uses repositories and improved access [26] to make critical knowledge available wherever and whenever it is needed.

... Intranets also help companies get maximum efficiency from various experts and departments, no matter where they work or where they are located. So Web technology offers the kind of application that really fits well with the current trends in business—more coordination, more collaboration, more virtual offices [23].

Collaboration in virtual teams is made possible by such technology developments as groupware and other forms of group support systems [76,85]. The intranet has generated a great deal of interest as a cheaper and less complex alternative to groupware, such as Lotus Notes [21,38,40,52,66,77,83,87, 98,103].

For example, Olivetti uses a 'virtual laboratory' to link their main sites and labs worldwide. The goal is to use the Intranet for *knowledge management*— ''so researchers access the largest possible amount of current information, both inside and outside the Olivetti Group, recognizing that in an R&D environment, the free exchange of ideas and information is a powerful catalyst for innovation'' [70].

Conversion of paper-based delivery systems to electronic Intranet documents generates substantial cost savings [95] as processes are reengineered and electronic documents enhance organizational memory [53,91] with a knowledge repository of technical information [17,18,22,31,48,55,90,92,100]. For example, at Booz Allen and Hamilton, 'Knowledge On Line' (KOL) has email that is sent to discussion conferences tightly integrated to a 'knowledge *repository*' [46]; and at CAP Gemini, 'Knowledge Galaxy' is a giant *repository* of technical information that helps the consulting firm respond more quickly to customers [21]. At Olivetti, ''...if a problem has already been solved by one employee, we can find out about it immediately and avoid duplicating efforts. Before the Web, there was no central repository of information, so researchers often spent time looking for information that was already available in-house'' [70]. In a manufacturing context, the Web could provide 'cyber-instructions' [22] or a repository of technical data, ''including voice clips, video clips, model data, drawing data, even part programs for rapid prototyping... all could be exchanged via the Internet during the supplier selection process, and later during product development'' [24].

3.6. Consequences

We analyze the organizational consequences of these knowledge-oriented strategies for exploiting the Intranet with an IT business value approach. Studies of IT business value typically report organizational improvements in efficiency or effectiveness [5]. Cost reduction has been documented on the basis of the 'paperless office' and a shorter systems development cycle. Increased efficiency generates tangible benefits such as cost reduction and faster processes, while increased effectiveness produces intangible benefits such as enhanced communication and collaboration. More recently, a process-oriented view

offers three dimensions of IT business value [68], encapsulating the nine suggested categories of IT impacts of business process innovation [25]. Applying the three dimensions of IT business value—automational effects, informational effects and transformation effects—to Intranets is revealing.

3.6.1. Automational effects

First, automational effects from Intranets have not been reported widely yet. An exception is Sun Microsystems, which has automated check processing (CheckMate), expense reporting (SunTea), and processing employee raises (Saltool). Checkmate saves more than US$100 K per year, and transaction costs fell from US$35 to US$2 per check issued. SunTea saves US$2.5 million a year and the time to process went from 5 days to 2 days. Saltool returned its development cost of US$300 K in the first three months of use [95]. The Intranet is creating a revolution in systems application development [29,79]. Development is faster because browser capabilities reduce interface coding from a traditional 80% of the application to about 40% [29]. Faster development translates into increased productivity, and lower development and maintenance costs. For example, at National Semiconductor:

New applications can be rolled out very quickly. ''Development time is extremely rapid. Because we can develop applications so fast, we can modify applications or try new applications very quickly,'' he says. ''And the costs associated with deploying and using the Web are lower compared to what we were doing before.''

On the other hand, although browser capabilities are improving at a frantic pace, they limit the features in current web applications, disappointing some users [29].

Additional front-end web interfaces to applications across platforms are in place at Allen–Bradley, John Deere, Sandia Labs, Silicon Graphics, Genentech, HBO [70], and Tyson Foods [77].

3.6.2. Informational effects

Second, informational effects encompass informational, tracking, analytical and intellectual opportunities [25,68]. Web pages of regulations, standard operating procedures, and employee benefits provide examples of informational effects. Information abounds on the typical Intranet, as organizations post electronic versions of paper documents. Although we can dispute the term 'paperless office' in the absolute sense, there is no doubt that reducing paper in the office has tremendous advantages, not the least of which is cost reduction. Substituting electronic documents for paper-based systems provides superior search and retrieval, and increased ease of maintaining current information. There is no confusion as to the correct version when electronic documents are kept up-to-date in a central location. Furthermore electronic documents are not limited to text, and there is no printing cycle.

Electronic publications offer timely content, and immediate event coverage at lower cost [95]. For example, Sun shifted the publication of its quarterly employee magazine, *Illuminations*, to the Web in April 1995. Now they can report up to the previous day's events while eliminating about two-thirds of the production and distribution costs by ''jettisoning pre-press, printing, postage and mailing-list maintenance'' [95]. Sun saves an estimated US$25 million a year on documentation distribution, that includes literature fulfillment, manuals, catalogs, price books, white papers, newsletters and magazines [95]. However, some cultures, such as US West, resist giving up the print media. If both print and electronic media are used, cost savings are sacrificed [10].

Tracking and monitoring project status and scheduling [21,70] are widely used applications on the Intranet.

At Olivetti, project leaders now instantly have administrative data such as expenses, man-hours spent, and the status of procurement requests. ''These services help us cut down on project management overhead and let project leaders focus more on technical problems than on administrative issues,'' [70].

Customer service and support groups monitor status reports on problems, while sales and marketing groups check order status [70]. Federal Express has a successful web package tracking system, which saves US$2 million and gives customers better access than the information system it replaces [21,94].

Analytical systems on the Intranet, for decision support, are being developed with Java and other web languages, using 'on the fly' spreadsheets with 'what if' capabilities, or group support features [29]. Software agents also hold promise for decision sup-

port [42]. An Intranet of the future could use agent technologies to facilitate integrated decisions in real time supply chain management [42]. Enterprise modeling systems and client–broker–server decision support systems are being researched [2,3].

Intellectual opportunities are exemplified by systems on the Intranet that promote and capture organizational knowledge. For example, community expertise is generated with brainstorming, feedback, information exchange on experiences—what has succeeded or failed—and discussion on accounts and issues surrounding winning deals against a competitor [70].

The Intranet enables this with discussion groups, electronic posting of organizational documents, bulletin boards to target areas of expertise, multimedia groupware environments, and Multi-User domain (MUD) for chat environments. For example, (1) the 'Community of Practice' at National Semiconductor is a forum for engineers to share knowledge, tools, design methodologies, successes, mistakes and ideas; National Semiconductor developed an intranet largely to help its customers get their products to market faster. Tim Stuart, information services consultant for National Semiconductor, says, ''When we develop a new product, we go through cycles of learning. The faster you can get a product out and look at it, the better you can make the next generation of product. If you can learn faster, you can end up ahead of the competition.''

(2) At Electronic Arts, virtual workgroups assemble quickly to collaborate and use newsgroups to discuss projects, access information, and come up to speed quickly by reviewing the history of discussions; (3) at Mobil, employees collaborate and share knowledge on research; (4) Sandia Labs use 'knowledge preservation' [101], to enhance scientific collaboration and allow employees to find experts; (5) at Silicon Graphics, their Intranet ties together more than 100 offices around the world so field teams share expertise globally; during new product development they use real-time information retrieval of schedules, roles, changes, test results, benchmarks, bugs, lists of work in progress, and have a sales guide for product launch; (6) at Genentech, bulletin boards target areas of expertise; (7) Mitre's 'Collaborative Virtual Workspace' is a multimedia groupware environment, that uses Internet's Network News Transfer Protocol (NNTP) for discussion groups and Multi-User domain (MUD) for chat environments; (8) 'Knowledge On Line' (KOL) at Booz Allen and Hamilton has 3000 users in 30 offices worldwide able to send email to discussion conferences tightly integrated to a 'knowledge repository'; (9) at Lockheed Missiles and Space, engineers around the country collaborate in real time with 'Multimedia Engineering Collaboration Environment' (MECE); and (10) CAP Gemini's 'Knowledge Galaxy' is a giant repository of technical information that helps the consulting firm respond more quickly to customers, prepare sales bids faster, and cut down the project time. The repository is a virtual storehouse for software objects that can be reused, and has a database of current projects with links to employees working on them [21,46,70,94].

3.6.3. Transformation effects

Third, transformation effects offer new products and services, effectiveness rather than efficiency and encompass sequential, geographical, disintermediating and integrative opportunities [25,68]. These opportunities are realized by removing barriers. On the Intranet, sequential barriers are removed by the concurrent possibilities of web groupware [29].

Geographical barriers are removed by the technology's global reach. For example, 3M's Global Economic Overview disseminates corporate economists' quarterly reports to employees anywhere in the world, instantly and securely [70]; Silicon Graphics sends video and audio feeds on the Net to more than 7200 employees at 100 offices around the world [21,70]; Eli Lilly will link 16,000 workers—almost two-thirds of its worldwide staff—in 2 dozen countries, by the end of 1996 and since each market has unique requirements, it will post regulatory information from different countries on the web [21]; Douglas Aircraft has a system to distribute aircraft service bulletins to customers around the world [70]; Federal Express will link 30,000 office employees around the world to share information formerly on hard copy reports [21,94]; and Booz Allen and Hamilton has 3000 users in 30 offices worldwide [46]. National Semiconductor uses an Intranet to share information among globally distributed manufacturing sites and finds communicating graphically helps with differences in languages, cultures and time zones.

If we can give people a new way to communicate and make that communication richer, then we can make better products faster and more efficiently [70].

Disintermediating barriers are removed by the ease of coordinating needs and services—often with self-service [95]; For example, the Intranet enables efficient software distribution, and ''...it has dramatically lowered the transaction and delivery costs of software and dataware''; With the application on the server, you can disregard the different operating system platforms and the logistics of upgrading to the latest version of client software. Similarly, with Web-supported drag-n-drop engineering, hundreds of thousands of intelligent, editable objects that contain properties and manufacturing information, could be available on the Web for purchase and rapid downloading. Without doubt, this approach will significantly change the way most part engineering is performed, and create a revolutionary impact on the CAD/CAM, CAE industry as a whole [24].

Integrative barriers are removed by the ease with which the Intranet uses standards and open systems to cross platforms. Information stored on the corporate mainframe was previously not easily accessible. However, better access to corporate information translates into increased productivity, and dynamic electronic web documents [79] streamline organizational processes [67,91], when organizations capture this information. For example, procurement of Olivetti products for internal use is more efficient because employees can now access the entire product catalog and information for ordering on the Web [70]. Another integrative role for the Intranet is as a front-end to business applications. Electronic Arts has plans to integrate the web with their back-end Oracle applications [70].

4. Discussion

We increase our understanding of the Intranet phenomenon by coding case studies with the paradigm model [93]. Furthermore, we incorporate existing theories and literature on organizational knowledge to enhance the generalizability of the new framework [30,36,76]. An analysis of the causal conditions and context furthers our understanding of the reason for the Intranet phenomenon. An examination of the intervening conditions, action/reaction strategies and consequences of the Intranet phenomenon provides alternatives for management action. For example, reaching a goal of intellectual capital improvement with knowledge strategies is helped by promoting the enabling conditions—autonomy, intention, redundancy, fluctuation and creative chaos, requisite variety—from the theory of organizational knowledge creation.

Organizational knowledge emerges as an important concept for the Intranet. Existing theories on organizational learning, [48,62] and organizational knowledge creation [72] support the anecdotal evidence of successful Intranet applications. Whereas traditional sequential text-based IT supports explicit knowledge transfer, the multimedia, hypertext capabilities of the Intranet also facilitate tacit knowledge transfer and externalization of tacit knowledge to explicit knowledge. Furthermore, unlike traditional IS, the Intranet is characterized by autonomy, redundancy, creative chaos and variety.

5. Conclusion

The contribution of this paper is along four dimensions. First, using the paradigm model of grounded theory [93] we show interactions between the Intranet and organizational knowledge strategies taking into account drivers, the context, and intervening conditions. Second, previous research on organizational knowledge creation theory reinforces the paradigm model of the Intranet, and is incorporated into our framework. Specifically, intervening conditions for organizational knowledge strategies include Nonaka's enabling conditions for organizational knowledge creation. Third, the framework forms the basis for future conceptual and empirical research on the business value of the Intranet.

Finally, there are many implications of this study. The economic implications suggest lower transaction costs [24]. For example, Sun decreased the transaction costs of check processing from US$35 to US$2 with their Intranet application called CheckMate. Furthermore, the study raises implications for IS developers, IS departments, management and researchers.

5.1. Implications for IS developers

The web has generated a revolution in systems development [29,79]. Browser capabilities and new web languages such as Java reduce interface coding resulting in faster and cheaper development and lower maintenance costs [29]. However, because of a perceived threat that traditional programming skills will become obsolete, there is some resistance from ''legacy dogs . . . too busy to learn new tricks'' [69]. Many IS developers need reskilling, training, motivation and the time to gain web systems development skills.

The cross-platform integration capabilities of web technology has reduced the need to write software interfaces and recode systems for different platforms. ''CAD/CAM, CAE vendors, standards organizations, specialty suppliers and individual manufacturers are sizing up strategies for incorporating [Web technology] into their overall programs, processes and product lines'' [24]. Some strategies are: including Internet viewers, interoperability with Web technology, creating systems with Web technology, or making sure ''their value added [is] readily distinguished from what can be put together with standard Internet browsers and viewers'' [24].

5.2. Implications for IS departments

Traditionally, IS departments produced and delivered voluminous paper-based reports to user departments. With Web technology, documents on the server can be (1) outputs produced from a user query in a decision support system or (2) formatted reports produced by management or transaction processing systems. Thus, IS departments that adopt this environment will not 'push' information to users, but instead make the information available for users to 'pull' when they require it [79].

Training is essential to keep IS department skills aligned to current needs. Although users of intranets get a friendly point and click interface, IS personnel need to learn new technical skills and cope with maintenance problems. They need to manage (1) the volume of information and huge numbers of disorganized electronic documents posted in many organizations [15], (2) decaying links, (3) obsolete information and (4) information redundancy. Despite more distributed systems development, enabled by independent development capabilities of web technology, IS departments need to provide expertise (1) to take advantage of advanced features such as interactive forms and scripts that can be integrated with corporate client/server databases, (2) to manage information flow and coordination, and (3) to speed intranet construction and channel its development in directions most beneficial to a corporation with ''guidelines based on a clear vision and philosophy of a company's intranet goals, objectives, architecture, and how it fits, overlaps and augments existing corporate systems including EDM/PDM, MRP, SAP and others'' [24]. There are signs that IT acceptance of centralized administration and distribution of systems is growing.

5.3. Implications for management

By examining the technical and organizational intervening conditions in the model, we discover how management could make a difference in facilitating organizational knowledge creation with the Intranet. First, management can allocate resources to purchase or develop tools for control and maintenance of the Intranet. Second, management can obtain and retain technical expertise by hiring, training and reskilling personnel. Third, management can nurture an organizational culture that explores and adopts new technologies, minimizing resistance to change with incentives and reward systems. Fourth, management can encourage socialization skills for effective global virtual collaboration. Fifth, management can show its support for using web technology for systems development. Finally, management can enable organizational knowledge creation on the Intranet by promoting autonomy, intention, redundancy, fluctuation and creative chaos, and requisite variety.

5.4. Implications for researchers

The framework developed in this study shows the most promising areas in which to focus empirical and further conceptual research efforts. Although the causal conditions and context help to explain the Intranet phenomenon, these aspects are largely out of management's control. In contrast, intervening conditions and action/interaction strategies are a fertile

area for further research that is relevant to management. Impacts are highly probable and prescriptive studies could benefit management practice with conceptual material to guide the development of decision support systems.

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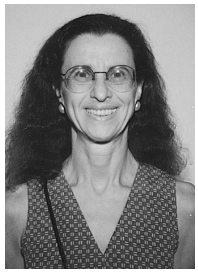

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