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Enabling Collective Knowledge Work through the Design of Mediating Spaces: A Framework for Systemic Socio-Informatic Change

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ENABLING COLLECTIVE KNOWLEDGE WORK THROUGH THE DESIGN OF MEDIATING SPACES: A FRAMEWORK FOR SYSTEMIC SOCIO-INFORMATIC CHANGE

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ABSTRACT

We propose a framework for designers of business organizations and designers of information systems that portrays three forms of "space" that mediate social interactions: physical space, social space and informatic space. The framework aids organizational designers and information technology designers to understand some of the complexities of enabling knowledge work, by contrasting the properties of the spaces and their interactions:

- Social interaction enabled by *physical spaces* is the focus of architects of buildings and urban planners, managers locating individuals and team who work together, and conference organizers who plan events to encourage networking.
- Social interaction enabled by *social spaces* is the focus of organizational designers who develop supporting social structures such as centers of excellence or practitioner support networks.
- Social interaction enabled by *informatic spaces* is the focus of knowledge architects and process analysts, who administer and moderate groupware and workflow applications.

In addition,

- *Informatic spaces* hosted in *physical spaces* are the focus of Information Technology architects, who ensure appropriate geographical coverage, performance, availability and security through appropriate computer hardware and software (e.g. servers, access points and networks).

Since the ways in which knowledge work can be carried out vary from person to person across a community, and innovations are naturally introduced over time, an enabling infrastructure should be capable of adaptation to those changed needs. We draw on research in general systems theory, architectural theory, and social theory to inform our practices in advising on business design, and methods and tools for information modeling.

Keywords: knowledge work, social system, information system, mediating spaces,

INTRODUCTION

The designers of business organizations and the designers of information systems that support organizations have traditionally been two separate communities with two separate

sets of concepts, and two sets of languages. Managers design their business organization under the consultation of the human resources department, with an interest in placing appropriate individuals in productive roles. Business analysts translate requirements for information system designers, who seek effective methods for configuring computer-based resources, often within a predefined Information Technology architecture. The former understand business strategy as a prescribed intent towards which work teams are directed. The latter understand business strategy as a description of what business professionals do, for which information systems must be developed and maintained.

In many of today's "knowledge-based" businesses, the separation between the design of social systems and information systems is not so clean. Information is not just a byproduct of making things or serving customers, but may be the main product itself. This is true for client-driven customer services businesses, where the bulk of the value added is not in the product itself, but the customization to the needs or tastes of an individual client. This is true in businesses where expert knowledge that is difficult to codify resides in human minds, and the company assets "go down in the elevators" at the end of the day. This is true in the "net generation" of information businesses such as e-marketplaces, where no value is created unless people can access the company over the Internet.

We propose to bridge these two worlds of social systems and information systems in a systemic approach to business. The way that people work together, based on advances in information and telecommunication technologies is discussed. An approach to understanding collective social work is framed in terms of three mediating spaces. Some early applications of this mediating spaces framework are reviewed, and some future research directions are proposed.

WHY DO WE NEED TO RETHINK THE DESIGN OF ENABLEMENT FOR COLLECTIVE KNOWLEDGE WORK?

The conception of "work" by much of today's society is largely rooted in concepts refined over the industrial age, where physical labor controlled machines that produced things. Enlightened researchers, such as psychologists at the Tavistock Institute in the 1950s, suggested that a mechanistic view of the enterprise did not take full advantage of the ability of workers to think and to make choices. The more that the core activities in business are based on teams of smart people collectively pooling their knowledge to create value, the more that the conception of work and enablement needs to evolve.

Over the past ten years, computer technology has advanced so that collective work amongst mobile knowledge workers is practical and common

Well-respected management theorists such as Peter Drucker (1994) have heralded the coming of the "information economy" and the rise of the "knowledge worker" for some time. However, the technological infrastructure to actually support knowledge work in the collective sense has only been established over the past few years.

The state of computer technology in 1992 demonstrates how far we have come. In 1992, Microsoft released Windows 3.1, and IBM introduced OS/2 2.0. These operating systems

popularized multi-tasking graphical user interfaces, so that knowledge workers could easily switch from one work item to another on the computer desktop, just as they would on a physical desktop. Notebook computers had been produced prior to 1992, when IBM introduced a ThinkPad with an i486 and a unique pointing device – the Trackpoint. By developing a substitute for the mouse and mouse pad, knowledge workers had their first true "laptop" computers, and began to use them as their primary workstations, supplanting desktop computers. Creative Labs had just introduced the Sound Blaster 16, marking the beginnings of multimedia standards in the computing industry. AT&T introduced a new breakthrough with a 28,800 bps modem, so that dial-in networking was more practical, at least with character-based interfaces. In 1992, the first hypertext-based web browser – Mosaic – was developed at the NCSA in Urbana- Champaign, but the Internet was still viewed as an environment primarily for academics and researchers.

For knowledge workers in 2002, notebook computers have commonly become an entitlement for all mobile employees, and for a significant number of office worker who occasionally "take work home". E-mail appears to be a ubiquitous medium for communication, supporting the exchange of word processing documents, spreadsheet calculations and presentation graphics as attachments. The web browser has become a standard interface to Internet web sites accessible around the world. There are large numbers of web sites useful for both organizational and personal interests, and high-speed access prices have fallen to consumer-affordable levels for home use.

Although these powerful computing resources are literally at the fingertips of each and every knowledge worker, the difficulties of sharing information and work together have become ever more apparent. The informal newsgroups and discussion forums of early IT-based collaboration have evolved into more purposive environments for online communities, such as teamrooms or document libraries where revisions can be shared and/or progress can be tracked. Synchronous instant messaging has replaced some asynchronous communications such as e-mail and voicemail, and may eventually converge with short messaging services on cellular telephone devices. E-meetings, where a telephone conference is supplemented by jointly viewing one participant's computer desktop over the Internet, are becoming common for normal business reviews.

As social interaction in shared physical workplaces has declined, shared informatic workplaces have become more popular

The concept of work – where employees come together into a central "office" for the same eight hours every day – has changed. Telecommuting is common both for salesmen and consultants who are likely to spend as much time with their customers as they do at their home offices. When more extensive work facilities are desirable, employers make short-term "hoteling" facilities available so that workers can sign up for a desk, a rerouted phone extension, and a network connection to high-speed printers and other resources. Permanent ownership of an office cubicle has become less important for many knowledge workers. The ability to book meeting rooms to enable occasional face-to-face interactions with a work team has become much more important.

The "kickoff meeting" that sees hundreds of people annually flying into a designated hotel for 5 days of internal meetings is now considered to be a luxury, rather than essential to business. Large conventions and trade shows, popular in the 1980s, have declined in attendance to become smaller, more focused events.

In 2002, however, the idea of "meeting" electronically has often become an acceptable substitute for meeting in-person. Although the use of video conferencing for work teams is still rather limited, many teams schedule weekly teleconferences by phone monthly, if not weekly. While periodic face-to-face meeting is still important, the idea of collective work with other team members "anytime, anywhere, anyhow" has become a reality. This has become true for long-time co-workers who communicate over the Internet with each other, many times per week. Halverson et. al. (2001) reported on WorldJam, a large-scale experiment to effect cultural change within IBM, in a 72-hour web-based synchronous and asynchronous electronic event. Over 50,000 IBM employees around the world participated in an environment where "best practices" towards tough business issues were debate. This trend towards social interaction over the Internet is not, however, limited to just employees inside of the most technologically advanced businesses. "Anytime, anywhere, anyhow" is also becoming true for interactions between businesses, with interactions such as B2B e-marketplaces or electronic exchanges over the Internet.

Collective work obviously still is at the center of today's business environment, but the style of interaction has often changed with the new information technologies. Much of the coordination and activity that occurs can be handled asynchronously and/or at a distance. "Meetings" are still integral to any collective work, but the "places" in which they happen can be "informatic", enabled by information technology. These new information technologies obviously demonstrate features and properties that are different from interactions in physical spaces.

A reductive approach to a social system and its associated information system is not well-suited to a design that enables collective knowledge work

In business design, the social system and information system are understood to be inter-related, but are often studied as if they were separable concerns. As a response to this challenge, Henderson and Venkatraman (1993) portray a necessity for "strategic alignment" between them.

> The Strategic Alignment Model … identifies the need to specify two types of integration between business and I/T domains. The first, termed strategic integration, is the link between business strategy and I/T strategy reflecting the external components. More specifically, it deals with the capability of I/T functionality to both shape and support business strategy. This capability is particularly important, as I/T has emerged as an important source of strategic advantage to firms. The second type, termed operational integration, deals with the corresponding internal domains, namely, the link between organizational infrastructure and processes and I/S infrastructure and processes. This type highlights the criticality of ensuring internal coherence between the organizational requirements and expectations and the delivery capability within the I/S function.
>
> [….] A third premise … is that the effective management of I/T requires a balance among the choices made across all four domains. ….
>
> [… The] Strategic Alignment Model calls for the recognition of multivariate relationships, or more precisely, cross-domain relationships. [pp. 8-9]

Four dominant alignment perspectives are identified amongst the strategic and infrastructural aspects of business/organization and IS/IT.

1. Strategy execution: [business strategy] → [organizational infrastructure] → [I/S infrastructure]
2. Technology transformation: [business strategy] → [I/T strategy] → [I/S infrastructure]
3. Competitive potential: [I/T strategy] → [business strategy] → [organizational infrastructure]
4. Service level: [I/T strategy] → [I/S infrastructure] → [organizational infrastructure]

Yet alignment between the separate concerns does not necessarily lead to a system-level understanding.

Reductive approaches such as these are common. As an analytical model, this reductionism is helpful in describing a business world, through an account of how designs are coordinated between the business-organizational domain, and the information technology domain. As a prescriptive model for design, however, this reductive approach does not truly reflect the mutual adjustment between domains, as each one changes in response to changes in the other.

A management theorist grounded in systems theory, such as Russell Ackoff (1994) would suggest that synthesis of social and informatic domains – as parts of a business as a coherent whole – should precede analysis.

> Systems thinking reverses the three-stage order of Machine-Age thinking: (1) decomposition of that which is to be explained, (2) explanation of the behavior or properties of the parts taken separately, and (3) aggregating these explanations into an explanation of the whole. This third step, of course, is synthesis. In the systems approach, there are also three steps:
>
> 1. Identify a containing whole (system) of which the thing to be explained is a part.
> 2. Explain the behavior or properties of the containing whole.
> 3. Then explain the behavior or properties of the thing to be explained in terms of the *role(s)* or *function(s)* within its containing whole.
>
> Note that in this sequence, synthesis precedes analysis.
>
> In analytical thinking, the thing to be explained is treated as a whole to be taken apart. In synthetic thinking, the thing to be explained is treated as a part of a containing whole. The former *reduces* the focus of the investigator; the latter *expands* it....
>
> These two approaches should not (but often do) yield contradictory or conflicting results: they are complementary. Development of this complementarity is a major task of systems thinking. Analysis focuses on *structure*; it reveals *how things work*. Synthesis focuses on *function*; it reveals *why things operate as they do*. Therefore, analysis yields *knowledge*; synthesis yields *understanding*. The former enables us to *describe*; the latter, to *explain*. [pp. 16-17]

The key to collective knowledge work is social interaction. An analytical approach to social interaction would view interaction between workers as independent from the interaction between a worker and his or her information system. We propose a synthetic view of social interaction as a socio-informatic system. Changes in the socio-informatic system do not occur "first" in a social system, followed by the information system. Nor do changes occur "first" in an information system, followed then by the social system. In a socio-informatic system, changes in the social system and information system simultaneously occur for knowledge workers in interaction.

HOW CAN WE SYSTEMICALLY ENABLE COLLECTIVE KNOWLEDGE WORK?

Collective knowledge work results in products that are partially purposive and partially emergent. In the traditional command-and-control style of management, the supervisor specified the activities, the worker carried out the activities as specified, and the supervisor inspected the product. If there were defects in the product, and the worker had performed as directed, the accountability would fall to the supervisor – who would then need to revisit the specification. For products where knowledge work is significant, the command-and-control model fails, because the supervisor rarely understands the trade-offs and complexities in the tasks at hand. The knowledge worker, in a role as an "expert", makes those judgements in the process of carrying out the work. In today's workplace, the style is one of empowerment. In these situations, a supervisor or customer is more likely to specify the end product, rather than the means of production, and the worker becomes accountable for developing the activities and in-process inspection of progress.

Etienne Wenger (1998) describes this type of work in a vignette about insurance claims processing.

> As an occupation, medical claims processing at Alinsu is very much focused on procedures, how to follow them, and one how to use such artifacts as forms, worksheets, computer screens and manuals. This focus starts during training and continues as trainees join their units. What claims processors learn cannot be easily categorized into discrete skills and pieces of information that are useful or harmful, functional or dysfunctional. Learning their jobs, they also learn how much they are to make sense of what they do or encounter. They learn how not to learn and how to live with the ignorance they deem appropriate. They learn to keep their shoulders bent and their fingers busy, to follow the rules and to ignore the rules. They learn how to engage and disengage, accept and resist, as well as how to keep a sense of themselves in spite of the status of their occupations. They learn to weave together their work and their private lives. They learn how to find little joys and how to deal with being depressed. What they learn and don't learn makes sense only as part of an identity, which is as big as the world and as small as their computer screens, and which subsumes the skills they acquire and gives them meaning. They *become* claim processors. [pp. 40-41]

If the supervisor has a role neither in activities specification nor in inspection, what can he or she do for knowledge workers? That role should transform to become one of an enabler, possibly as a sponsor providing workers with the resource and facilities in which the work can be carried out productively. An analytical approach to work might suggest two parallel, but separated concerns: the social system as best supported by a human resource management department; and an informatic system separately supported by an information systems development department. In collective knowledge work, we suggest that changes and interventions largely impact both the social system and the informatic system simultaneously, and should be considered as a systemic whole.

Social interaction is commonly understood as mediated by physical space

In the design of built physical environments – e.g. office buildings, public places and homes – there is a long tradition of understanding the mediation of social interaction. This understanding is reflected in works such as the pattern language of Alexander et. al. (1977).

> Volume 1, *The Timeless Way of Building*, and Volume 2, *A Pattern Language*, are two halves of a single work. [….]
>
> *The Timeless Way of Building* describes the fundamental nature of the task of making towns and buildings. It is shown there, that towns and buildings will not be able to become alive, unless they are made by all the people in society, and unless these people share a common pattern language, within which to make these buildings, and unless this common pattern language is alive itself.
>
> In this book [A Pattern Language], we present one possible pattern language, of the kind called for in *The Timeless Way*. This language is extremely practical. [….]
>
> The elements of this language are entities called patterns. Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without doing it the same way twice. [pp. ix-x]

In order for a place to "become alive", it is not sufficient to simply construct a built physical environment. People must occupy that environment. The scales at which the patterns occur range from ones in which a large number of people participate (e.g. cities) to ones in which only a few participate (e.g. private homes). Below the neighborhood level, Alexander et al. (1977) describe an environment that emerged naturally in an agricultural era, but requires attention in an industrial age.

> 67 COMMON LAND
>
> … just as there is a need for public land at the neighborhood level … there is a need for smaller and more private kinds of common land shared by a few work groups or a few families. [….]
>
> **Without common land no social system can survive.**
>
> In pre-industrial societies, common land between houses and between workshops existed automatically – so it was never necessary to make a point of it. The paths and streets which gave access to buildings were safe, social spaces, and therefore functioned automatically as common land.
>
> But in a society with cars and trucks, the common land which can play an effective social role in knitting people together no longer happens automatically. Those streets which carry cars and trucks at more than crawling speeds, definitely do not function as common land; and many buildings find themselves isolated from the social fabric because they are not jointed to one another by land they hold in common. In such a situation, common land must be provided, separately, and with deliberation, as a social necessity, as vital as the streets. [pp. 336-337]

A second example demonstrates the close linkage between the built physical environment and social interaction, through a need to support varying degrees of publicness and privacy.

> 127 INTIMACY GRADIENT
>
> [….]
>
> **Unless the spaces in a building are arranged in a sequence which corresponds to their degrees of privateness, the visits made by strangers, friends, guests, clients, family, will always be a little awkward.**
>
> In any building – home, office, public building, summer cottage – people need a gradient of settings, which have different degrees of intimacy. A bedroom or boudoir is most intimate; a back sitting room or study less so; a common area or kitchen more public still; a front porch or entrance room most public of all. When there is a gradient of this kind, people can give each encounter different shades of meaning, by choosing its position on the gradient very carefully. In a building

> which has its rooms so interlaced that there is no clearly defined gradient of intimacy, it is not possible to choose the spot for any encounter so carefully; and it is therefore impossible to give the encounter this dimension of added meaning by the choice of space. This homogeneity of space, where every room has a similar degree of intimacy, rubs out all possible subtlety of social interaction in the building. [p. 610]

In a third example, the social interaction between close family members is still described as requiring some consideration of the designed environment.

> 179 ALCOVE
>
> … many large rooms are not complete unless they have smaller rooms and alcoves opening off them. [….]
>
> > **No homogenous room, of homogenous height, can serve a group of people well. To give a group a chance to be together, as a group, a room must also give them a chance to be alone, in one's and two's in the same space.**
>
> This problem is felt most acutely in the commons rooms of the house – the kitchen, the family room, the living room. In fact, it is so critical there, that the house can drive the family apart when it remains unsolved. Therefore while we believe that the pattern applies equally to workplaces and shops and schools – in fact, to all common rooms wherever they are – we shall focus our discussion on the house, and the use of alcoves around the family common rooms. [pp. 828-829]

These example patterns demonstrate that careful selection, occupation and/or reshaping of built physical environments are obvious means of enabling social interaction.

Social interaction is also enabled by social spaces

Organization within a social structure can similarly enable or disable social interaction. In a social system, a role can be described as a contribution of an individual towards an effort for a social group as a whole. In systems language, Ackoff (1994) uses "role" when speaking about the purposes chosen by an individual, whereas "function" is used for an organizational unit or non-purposeful parts. Hierarchies and networks are two different social structures in which roles are obviously played.

Social hierarchy is an anthropological concept, with authority demonstrated in families (e.g. with roles of parents and children) and tribes (e.g. with roles of leaders and followers). Alfred Chandler (1977) even defines business enterprises in this way.

> Modern business enterprise is easily defined. [… It] has two specific characteristics: it contains many distinct operating units and it is managed by a hierarchy of salaried executives.
>
> Each unit within a modern multiunit enterprise has its own administrative kept office. Each is administered by a full-time salaried manager. Each has its own set of books and accounts which can be audited separately from those of the larger enterprise. Each could theoretically operate as an independent business enterprise. [p. 1-2]

Social hierarchy is how the "formal organization" works. At the same time, there is also recognition of the "informal organization", which is based on peer-to-peer social networks. In characterizing collective knowledge work, Etienne Wenger (1997) identifies communities of practice as an important type of social network.

> Being alive as human beings means that we are constantly engaged in the pursuit of enterprises of all kinds, from ensuring our physical survival to seeking the most lofty pleasures. As we define these enterprises and engage in their pursuit together, we interact with each other and with the

> world and we tune our relations with each other and with the world accordingly. In other words, we learn.
>
> Over time, this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relations. These practices are thus the properties of a kind of community created over time by the sustained pursuit of a shared enterprise. It makes sense, therefore, to call these kinds of communities *communities of practice*. [p. 45]

In these peer-to-peer networks, however, every person does not play an identical or equally-valued role. Karen Stephenson (1999) suggests three patterns in which key roles transmit information within an organization.

> If one closely examines patterns in ancient trade networks and early settlements, … we do find a constellation of three prototypical patterns. [….] From the remains of daily routines, these same patterns unfold to tell us how people organize at work. [….]
>
> Let's examine this notion more closely by reviewing the patterns. The first repeating pattern is to be **central** [Freeman, 1979], like the **hub** in a "hub and spoke" system on a bicycle wheel. This pattern represents an optimal distribution system for trading, settling in the flat lands and for centralizing work processes. The second pattern is the **gatekeeper** on the critical pathway between hubs and thereby connecting hubs to each other. These gatekeepers serve as important links or bridges along waterways, connecting one part of a society to another, or one part of an organization to another. The third pattern is the **pulsetaker**, someone who is maximally connected to everyone via the shortest routes. Pulsetakers have their finger on the pulse of the organizations and know what everyone is thinking and feeling. Machiavelli was a pulsetaker, someone behind the scenes and arguably all seeing if not all knowing. These three **culture carriers** are pivotal and operate as change agents in a general sense, that is, they can resist change if they want or, by the same token, can rapidly catalyze change if they choose. Once identified, culture carriers can be used to retard or speed the rate of a restructuring or an acquisition or divestiture of another company. [pp. 7-40 - 7-41].

In another approach to describing social epidemics, Malcolm Gladwell (1999) describes role types of “mavens”, “connectors” and “salesmen”. Paul Revere is described as an effective “connector”, carrying information about the oncoming British Army on a ride northward from Boston, whereas a fellow revolutionary, William Dawes, was ineffective on his ride westward. William Dawes was, literally and figuratively, in the dark about who the most important revolutionary contacts were, whereas Paul Revere knew exactly upon which doors to knock. These types of informal roles, as described by Malcolm Gladwell and Karen Stephenson, often emerge based on the personal characteristics of the individual.

The design of formal roles, in relation to informal roles, can either enable or disable social interaction. In a complicated map of interpersonal ties within a large company, Stephenson discovered an unlikely group: a “smoking circle”. High-level executives through lower-level managers were shunned, when engaged in their smoking habit, to a common area outside of the building. This provided an informal venue for the exchange of company information, often more frequently and rapidly than through formal channels. In addition, Stephenson has suggested that an awkward feeling in a social network can sometimes be resolved by promoting a problem individual, and thereby changing the dynamics of an information peer-to-peer group, into a hierarchical association. Such a promotion, in effect, creates a larger social “distance” between the individuals.

Although some work communities emerge without intervention, social mediation is often actively encouraged. Teams, workgroups or task forces are commonly formed to work on

specific projects or to focus on important issues. When work quality or skills require attention, practitioner support networks or centers of excellence may be established with a mission to ensure vitality. Call centers with 1-800 numbers are often promoted as a first point-of-contact for business professionals seeking help, or as a centralized point from which resources are dispatched. These forms of mediation serve two purposes. They bring together specialists or experts so that knowledge can be consolidated and/or reproduced within a community of peers. They also signal the importance that sponsors place on the supporting of the community of knowledge workers at large, through the legitimation and funding of specific roles.

Advances in supporting persistent conversation draws attention to spatial aspects in information

In a non-complex world, mediating the social interaction between community or team member in a single physical space and encouraging coherent social support should enable strong collective performance. In practice, however, it is neither always feasible nor desirable to do so. The demand for skills around the world may drive geographic dispersion of resources. Providing direct social access to experts may not be the most effective method of supporting a wide range of requests for knowledge, ranging from the simple to the very complex.

The spirit of social interaction means that so-called "knowledge bases" should be more than just databases, where a business professional keys in a search and the computer regurgitates pre-structured facts and figures. As more of the world's knowledge appears in the context of opinions, discussion and debate in online "virtual" environments, information systems are being reconceived as a medium through which people converse. In research around text-based, multi-user dialogue systems (MUDs), Thomas Erickson (1993) suggested that social interaction can be influenced in an informatic space, just as it can in physical spaces. Analogues described include:

- Evocative objects, that can generate and catalyze interactions (e.g. playing with a sculpture in an urban environment)
- Spatial constraints that can generate social activity (e.g. stoplights that result in waiting pedestrians browsing a news-stand)
- Spatial elements used to structure activity (e.g. a crack in the pavement signaling a gap between an ATM user and people waiting)
- Places as spaces with meaning (e.g. closets and drawers to store things; libraries for storing and browsing artifacts)
- Rituals and places that suggest social interaction (e.g. "sacred" places such as a post office where neighbors meet each other to chat, or a corner store where business is done).

Until recent years, much of the focus in human-computer interaction (HCI) research was centered on the man-machine interface, i.e. the ways in which humans input data into a computer, and the ways in which the computer responds to human with visual images or sounds. As computer-based collaborative environments have evolved, the focus has shifted much more to human-human interaction, with networked computers as the mediating environment. Technology as a medium is not a new idea. Telephones and televisions are

clear examples where human interaction is mediated by electronic means. The advances in computers, however, have enabled a level of interactivity that allows individuals not merely to exchange assertions, but to converse in a give-and-take that is more personal. In contrast to telephone conversations that are practically ephemeral, Thomas Erickson (1999) suggests that a digital medium that supports "persistent conversations" introduces some new dynamics to interaction.

> Persistence expands conversation beyond those within earshot, rendering it accessible to those in other places and at later times. Thus, digital conversation may be synchronous or asynchronous, and its audience intimate or vast. Its persistence means that it may be far more structured, or far more amorphous, than an oral exchange, and that it may have the formality of published text or the informality of chat. The persistence of such conversations also opens the door to a variety of new uses and practices: persistent conversations may be searched, browsed, replayed, annotated, visualized, restructured, and recontextualized, with what are likely to be profound impacts on personal, social, and institutional practices.

To construct informatic spaces that better support social interaction, Erickson et. al. (1999) draw on their experiences with the Babble prototype to suggest adding physical and social cues. These include …

- Social translucence: I can know you're active in the informatic space (even though I can't physically see you).
- Social proxies: I can see your participation and/or interest in topics in the informatic space
- Indexability: I can search and trace the threads of conversation back in the history of the informatic space
- Shared context: I can understand why certain things were said by consulting the history of exchanges we've had in the informatic space

Information technologies at the leading edge in 2002 portray informatic space as a "place" for social interaction. Web conferencing or e-meetings combine visual presentations with either teleconferences or audio playback so that workers located at many distributed sites can view and discuss specified business topics together. Features such as "I am away" appear in instant messaging communications. On the Internet, it usually doesn't matter where the computer servers are physically located, and the social interaction can still occur in the shared informatic space.

Space has common features in the social interaction of physical, social and informatic contexts around proximity

Why is "space" a natural concept for social interaction, in the physical, social and informatic senses? We suggest that there are common properties in each mediating space around centers and neighborhoods. It is natural to think about things as closer or farther apart in each of these spaces.

In physical space, we can refer to a site as a center, with a territory as a neighborhood. As an example, a multinational business enterprise will commonly have one or more head offices, which represent centers for geographic regions. The territories of customers served by each head office are usually partitioned by geographic and/or political boundaries. To

be close in physical space could mean a distance visible to the human eye, or maybe a short walk away. The enablement of social interaction in physical space usually requires investments in real estate and/or shared office facilities.

In social space, we can refer to a role as a center, with a community as a neighborhood. As an example, a plant manager in San Jose, California may have a formal reporting structure up through a worldwide vice-president of manufacturing. He may participate in multiple communities as a result of his position, such as a community of plant managers around the world, or local senior managers in the western U.S. The communities may or may not align to formal organizational structures within the enterprise. To be close in social space could mean a relationship sufficiently close to address the other person on a first name basis, or the ability to access him or her on the telephone with minimal effort. The enablement of social interaction in social space usually requires an understanding of common purpose and definition of role towards shared goals.

In informatic space, we can refer to a representation as a center, with a classification as a neighborhood. A representation is an abstraction of something real, possibly an artifact such as a drawing or written document. Thus, a database entry labeled as a "car" in a product catalog is not the car itself, but an informatic representation of the car. The representation may be portrayed as being categorically closer to some other representations than others, based on a context. Thus, a car may be categorized as close to a bicycle in an informatic space, in the context that they are both transportation vehicles. In another context, a car may be categorized as close to a house in an informatic space, because these two represent the largest two outlays in capital that the average consumer will ever make. The enablement of social interaction in informatic space requires development of a shared context, so that the representation will make sense to the social participants. This may occur through formal methods such as training, or over long-term exposure through mutual experiences.

This analytic distinction between physical, social and informatic spaces is artificial, but can be employed as a framework to ensure that social interactions are properly enabled, particularly in purposive activities such as business. The different properties of each mediating space can be leveraged to advantage in improving the quality of social interaction, or observed as inhibitors to their improvement.

Social interaction occurs naturally in compact designs, but must be actively enabled in expansive designs

In the agricultural economy, telecommunication technology didn't exist. Travel was largely considered a luxury, and most people lived and died close to where they were born. Even in the latter part of the industrial age, telecommunications technology used to be considered expensive. When telephone companies were still monopolies, a long-distance call was considered to be a special, if not major, event. Business was conducted in a compact design, where social interaction was mediated by three spaces that largely overlapped. Worker performing activities together would tend to come to the same physical location, day after day -- a physical mediating space. Each worker would naturally know the names and roles of almost everyone else in the workplace – a social

mediating space. Most of the workers would share a similar understanding of their world of work, notwithstanding special expertise, but at least at a latent understanding – an informatic mediating space. Long periods of social interaction with the same people, in the same place, on the same subject matter would reproduce coherency in the workforce, sometime described as *social capital* by sociologists such as Robert Putnam (2000).

The mobile workforce of the information economy has seen the overlap in these three mediating spaces gradually being been pulled apart. Today, it's not uncommon to interact only in socio-informatic space while ignoring the physical mediation. When a business professional has a problem, and telephones into a help desk, does it really matter where the help technician is located? An interaction in only the socio-physical space, downplaying informatic mediation, may be practical for historical, cultural or political reasons. A multinational, such as IBM, often has a country general manager at least as a figurehead in each country it works, even though the professionals within the organization effectively report to hemispherical or continental lines of business or industry alignments. Finally, interactions in physical-informatic space can occur as digitally-codified information is replicated without ever consulting the authors or community from which the materials originated. Internet web servers cache documents closer to their sources of demand, so that while it may appear that a click of a mouse may be accessing a document in New York, it is in fact really accessing it through a server in Paris or Hong Kong.

As indicated earlier, analytically treating the three mediating spaces as completely independent parts of a business is artificial. In the real world, we try to take advantage of the unique properties of the three mediating spaces, either singly or in pairwise combination. In addition, we try to minimize the impact on social interaction from the third, de-emphasized space. In the end, however, working only in two-space intersections always begs the third. Teams who work primarily in social-informatic space usually break down unless there are some opportunities for face-to-face meetings – in a physical mediating space. Work oriented primarily towards socio-physical spaces, such as geographically-oriented sales units focused on local accounts, are always looking to share "experiences" and "best practices" from elsewhere. These would be naturally shared in an informatic mediating space. Finally, interaction in a purely physical-informatic space is barren. Would you believe facts and figures cited in a document downloaded off the Internet if there were no references or citations that substantiated credibility – in a social mediating space?

The value of this framework of three mediating spaces is not inherent in the model itself, but in the way that it has been applied. The next section describes how these concepts have been used as foundations in the contexts of both business design, and information systems design.

WHAT PROGRESS HAS BEEN MADE USING THIS APPROACH?

Since 1997, the co-authors of this paper have been conducting joint research into concepts and techniques that would improve the linkages between business/organizational strategies and the information technologies that support them. The "application development backlog" and "business-I/T gap" have encouraged us to find ways in which both the design

of the organization and the design of the information systems can more naturally co-evolve and responsively adapt to change.

The experiences of applying the framework of three mediating spaces are described first in a context of business design, and then in a context of modeling and tools for information systems development.

Business Design Discovery Workshops included the mediating spaces framework to qualify the scale and scope of Net Generation business investments

In 2000 and 2001, the IBM Net Generation Business Unit focused on newly emerging Internet-based businesses, such as e-marketplaces and application solutions providers. A frequent challenge with these start-up companies was that their business designs, funding through venture capital and technical architectures were all intertwined. The business executives were challenged with demonstrating business results rapidly, and with continual scale changes in response to changing demand.

The *Business Design Discovery Workshop* program was a pre-sales facilitation designed to elicit elements of the business strategy context, that could be extended later into technical architecture discussions. Earlier modules of the workshop focused on understanding customer value and organizational purpose, as described by Stephan Haeckel (1999), and as issues of strategic control suggested by Adrian Slywotsky (1996). These led to dialogues about investment in key capabilities, which then had to be deployed in the three mediating spaces, and enabled by infrastructures in two-space intersections.

Examples of questions intended to generate dialogue included:

- Sites & Territories [work deployment in physical space]
    - Where are the key capabilities to be located? [function, region]
    - What territory will each site serve? [customers, suppliers]
- Roles & Communities [work deployment in social space]
    - Who will be accountable to provide capabilities? [sponsor]
    - What expertise defines the community [skills, knowledge]
- Representations & Classifications [work deployment in informatic space]
    - What representations are relevant in foresight? [forecasts]
    - What classifications help? [making sense, keeping order, coordination]
- Workplace Infrastructure [physical / social enablement]
    - How much workplace facility will be required to properly support capabilities? [physical dimensions, features required]
- Conversation Workspaces [social / informatic enablement]
    - How much conversation space will be required to properly support capabilities? [volume of conversations, features required]
- Information Architecture [informatic / physical enablement]

- What information architecture will be required to properly support capabilities? [amount and quality of computing, networking and storage features required]

These workshops were conducted with business executives in the United States, China and Australia. The questions provoked serious dialogues about business strategies and the directions for investments. In more than a few instances, the discussions revealed misalignments and ambiguity across the executive team, and presented an opportunity to correct the gaps. The results provided order-of-magnitude estimates of the scale, scope and speed of the business designs, at a detail sufficient that information technology architects could properly size expected computing workloads and the number and location of web servers required.

Research into information modeling and system envisioning tools leverage the mediating spaces framework in the pursuit of adaptable information systems

At the IBM T.J Watson Research Center, the Enterprise Builder project aims to improve the way in which business information systems are conceived and constructed, through development of a system envisioning technology. Much of the challenge in building and maintaining an information system is in the definition of a shared understanding of the business domain, from two perspectives. Information systems developers seek an understanding of the way business is conducted, so that they can construct computer-based tools as resources for action for the business professional. Business professionals, often knowledge workers engaged around a collective set of activities, are interested in tools that will improve their productivity and effectiveness. The communication of requirements between these two groups can be an abstract exercise of unintended miscommunication: the information systems developers take away an impression of what they think business professionals need; and the business professionals take away an impression of what they think they're getting.

Prototypes can greatly facilitate communication between designers and users. In the process of designing a new building, an architect will sometimes take a client onto a proposed site, to give a concrete impression of the proposed building in situ. This can be aided by delimiting spaces with string, or even constructing a mock edifice of some space out of corrugated cardboard or other cheap materials. The client may then "look out the window", or "walk around the floor plan". A system envisioning technology for computer-based information systems is intended to support a similar function, as a "straw man" upon which dialogue on features and trade-offs can be based.

The Enterprise Builder project involves two major activities: an approach to visually representing the information systems that support a business domain in a way that both business professionals and information systems developers can have joint dialogues on meaning; and the construction of a software tool that produces low-powered prototypes that supports that dialogue.

The visual representation of the information system requires definition of a programming language that can describe the information entities of interest, and the relationships between them. Explicit understanding of the business domain as a mediated social system drives a

less procedural view of work: the ways in which people in a team "get things done" doesn't always follow the codified "procedures manual". Traditional "workflow" approaches emphasize the modeling of paper trails, assuming that individuals perform tasks as in a mechanistic production line, signing off their work step by step. Collective knowledge work is much more fluid, and therefore requires a richer understanding. The knowledge workers in today's businesses should not be treated merely as cogs in a machine, but as sentient beings who can respond to needs in the real world, and adapt their roles and tools in a process of mutual adjustment within the work team.

The current alternatives in software tools used in practice do not provide an appropriate level of support for the flow of conversations that happens in requirements-gathering sessions. Paper-based artifacts such as Post-It notes allow flexibility in moving ideas around, but are difficult to connect together in multiple dimensions, and are not easily transported and stored. Drawing and presentation graphics tools such as Visio, Freelance or PowerPoint make distribution of artifacts simpler, but their document-orientation doesn't support the richness of programming languages. Computer-Aided Software Engineering (CASE) tools such as Rational Rose are useful in implementing computer-based designs once the business domain is "understood", but are heavyweight tools designed for hardcore computer systems developers, rather than business analysts working on the boundary between the two worlds of business and information technology.

The contribution of the three mediating spaces framework has informed the direction of the products from the Enterprise Builder project. The idea of socio-informatic space moves beyond reductive views of data, and portrays a world where meaning can be negotiated and socially constructed. An example of an online auction (e.g. eBay) reveals some of these features.

- Instead of modeling work as a series of procedures (or means), work can be modeled as pre-condition and post-condition states. A potential bidder may join an auction as result of actively being notified by a "watch this item" computer monitor, or due to a casual telephone conversation within the community. It doesn't matter how the person knows to join the auction; it is sufficient to recognize that he or she (a) was not previously a participant in the auction (i.e. a pre-condition state); and (b) has now become a potential qualified bidder (i.e. a post-condition state).
- A conceptual information model of the business domain reflects the multiple classifications of entities. A design for implementation in conventional information technology can bring conceptual constraints such as a single hierarchical classification. A socio-informatic approach suggests retaining the multiple and dynamic classifications within the business domain. Thus, in an auction context, it is not necessary determine the prioritization of classifying an auction as (a) being a reserve auction, (b) having bids against it, and (c) being complete and awaiting payment. The auction can be in all of these classifications simultaneously, and representing it in any other way reflects the intent of the information systems designer, and not the real world.

As a continuing research project, the Enterprise Builder team is refining its approach and tools in consultation with the community of business analysts who are the potential target users.

WHAT RESEARCH NEEDS TO BE FURTHER DEVELOPED?

In many respects, the framework of three mediating spaces reflects the authors' progress over five years of joint research into business design and information systems design. We are continuing to refine our understanding, based on these foundations

The understanding of three mediating spaces builds on General Systems Theory, and Computer-Supported Cooperative Work

At the foundation of our understanding businesses and information systems, General Systems Theory clarified a common set of language and concepts across both domains. As an example, Gharajedaghi (1999) adds to clarity, with concepts such as:

- Function – the contribution of a part to its containing whole, also expressed as the outcome, the results produced, outputs, ends or effects.
- Structure – the part-part arrangement in space, also expressed as the components and their relationships, inputs, means, or causes.
- Process – the part-part arrangement in space, also expressed as the sequence of activities and know-how required to produce outcomes.

These definitions are applicable for all types of systems. A business, however, has special properties in its definition as a social system, as does the information system that supports it. Sir Geoffrey Vickers (1967) provides a helpful definition of a social system:

> … a set of ongoing relations between persons and organizations, governed by mutual expectations which are usually embodied in roles. It is of course a very complex pattern. Each of us forms part of several subsystems and each of these is incorporated in varying degrees in others … [p. 59]

In a business context of collective work, we have been particularly interested in social systems as purposeful and purposive entities. Ackoff & Emery (1972) explored human beings as ideal-seeking (purposeful) individuals, and Emery (1977) revisited the pursuit of objectives as purposive groups.

Different people understand "information systems" in different contexts. In our work, we seek to be careful in our language, and selectively use the words "informatic", "information" and "informational". Krippendorf (1986) write that informatics …

> … includes computer science, the more application oriented efforts of management information systems, automation of production but also data processing including statistics for decision making.
>
> Because of its technological commitments, informatics has disemphasized the study of information flows and computation within organisms and largely ignored the organizational consequences of information flows, human communications and the use of computes in large social systems. [p. 38]

When we refer to an "information system", we mean more than just a system that retains data, because information has elements of "informing" individuals within a social system. Gregory Bateson (1970) provides a definition where information has a function for human beings.

> … what we mean by information – the elementary unit of information – is a *difference which makes a difference*, and it is able to make a difference because the neural pathways along which it travels and is continually transformed are themselves provided with energy. [p. 459]

In a business-related context, Barabba and Zaltman (1991) provide an interpretation of Haeckel and Nolan (1993) that differentiates between data, information and knowledge.

> … we have modified Haeckel's conception of an information hierarchy. The basic objective is to achieve more with less. We start with many codified observations which we described as DATA; by putting data in CONTEXT -- a decision framework -- we develop INFORMATION; by applying INFERENCE (judgment) to contextual information we generate INTELLIGENCE; as we gain CERTITUDE (greater certainty and acceptability) it leads to KNOWLEDGE; and by applying SYNTHESIS -- holistically bringing together knowledge parts -- we create WISDOM. In this way we can simultaneously decrease the volume of the data while increasing their value to the user. [pp. 45-46]

Through these definitions, we expand the mechanistic view of informatic, to include humans as part of an information system.

The above understanding of social systems and information systems was supplemented by knowledge of how groups of people work together using information technologies. The Association for Computing Machinery regularly convenes a community of practice around Computer-Supported Cooperative Work, in which we participated. In a discussion on accountability, Simmonds & Ing (2000) discusses the relationship between the use of empowered coordination of work, and the information technology supporting it. An effective understanding of the foundations blends knowledge from sociology, psychology and human systems, drawing directly from social theory (e.g. Bourdieu & Wacquant (1992)), and from architecture, (e.g. Alexander et. al. (1977)).

Further enrichment is expected through postmodern social theory and development of a socio-informatic pattern language

In practice, the direction of this research program has gradually shifted from understanding business and information systems per se, in favor of changes in their designs. Our interests tend neither towards starting up entirely new organizational systems in business, nor to constructing de novo information systems, but instead adapting and refining the systems that already exist. Thus, the interests in organizational components are shifting towards postmodern social theory, and the interests in information systems are shifting towards development of a socio-informatic pattern language.

Social theory, as a philosophical foundation for sociology, provides a rich foundation on which an understanding of business can be constructed. The social practices view suggested by Brown & Duguid (1991) and Wenger (1998) provide a different perspective in describing collective knowledge work, but more research needs to be done on prescriptive approaches. A promising direction builds on the framework of style and

disclosive spaces from Spinosa, Flores & Dreyfus (1997), and a foundation of "Being-in-the-World" from the commentary by Hubert Dreyfus (1991) on Heidegger.

The development of a socio-informatic pattern language is likely to be founded less in theory, and more in practice. In a purely informatic sphere, the popularity of Gamma et. al. (1995) has demonstrated that patterns are not just for architects designing buildings, but can serve as a common language amongst designers of object-oriented program code. A similar effort by the community interested in socio-informatic contexts needs to be developed. In a system envisioning approach to information systems development, such a pattern language would be helpful when incorporated directly into a computer-based tool.

The expected benefit of this research is businesses that better adapt to change, in the contexts both of social systems and information systems

In continuing this program of research, we seek clarity in our theoretical foundations in order to inform the approaches and techniques which are to be applied in the real world. Thus, we expect the intellectual development of our understanding of social systems and information systems to develop in conjunction with practice. Although many managers have hoped that the increased pervasiveness of computing in our society would result in business people who understand information systems inside and out, this has not yet proven to be the case. The design of information systems and the design of social systems still largely require different skills and orientations. We hope that our contribution of the three mediating spaces to the conversations between the two domains will result in business that are more alive, and information systems that are more naturally adaptable to change.

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