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Groupware adoption in a distributed organization: transporting and transforming technology through social worlds

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Abstract

In this paper, we draw on theory from social worlds to analyze how different organizational contexts affect groupware adoption. We report on a study of the adoption of data conferencing in a large distributed organization. Our data show that the diffusion process, which was driven by the users, was a result of communication and transformation of the technology across different social worlds. We also discovered that membership in multiple social worlds in an organization creates a tension for the potential adopter who is in a distributed team. To function effectively, team members must uniformly adopt the technology, yet some may face resistance from other social worlds to which they belong. Our study showed that adoption was affected by organizational sites having conflicting views of the value of collaboration, different amounts and needs for resources, and different acceptance of technology standards. Potential technology adopters on distributed teams are faced with conflicting loyalties, constraints, and requirements between their distributed collaborations and organizational homes.

Keywords: Groupware adoption; Diffusion of innovation; Social worlds; Data conferencing; Distributed teams; Empirical study

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1. Introduction

Contrary to the common view that technology diffusion is a rational, top-down, well-planned process, groupware adoption is in fact, a messy process. The history of groupware adoption reveals much resistance, attributed to both group and organizational factors. For example, decision-makers who introduce groupware in an organizational culture that is noncooperative works against the goals of groupware (Orlikowski, 1993a). Without a critical mass, there are little benefits for potential collaborative technology users (Markus, 1987). Resistance has also been attributed to characteristics of the group. A review of distributed team studies concluded that lack of common ground, collaboration readiness, or collaboration technology readiness can lead to technology resistance (Olson & Olson, 2000). An imbalance of benefits to costs within a group (Grudin, 1988), and unanticipated extra work for some group members (Rogers, 1994) is also responsible for resistance. The early failure of widespread video-conferencing adoption has been attributed to a misinterpretation of it as a replacement for meeting face-to-face (Egido, 1988).

Groupware has not always been a history of failures. Yet even successful groupware adoptions are not always well-planned and predictable. For example, Palen and Grudin (1995) found that the evolution of technical features and the realization of collaboration benefits influenced the adoption of shared electronic calendars. Bikson and Eveland (1996) describe how a group decision support system was integrated into the World Bank, though it was rarely used for the originally intended decision-making tasks.

The trajectory of groupware diffusion is especially errant when potential adopters are geographically distributed. Studies of groupware adoption have focused on decisions made at the individual, group, or organizational level. Yet in complex, distributed organizations, new forms of work exist in distributed teams, whose boundaries span different work units or even organizations. Such teams need to adopt networked and collaborative technologies to conduct their work. Studying adoption at the individual, work unit or organizational level cannot adequately capture adoption decisions that are made by distributed teams. New units of analysis are needed to understand how collaborative technology diffuses. In this paper, we introduce the notion of social worlds as a way to understand how technology adoption spreads across distance. We assume that people are commonly members of multiple social worlds whose boundaries are based on work practice, and not on geographical location.

Surprisingly, diffusion of groupware across geographic distance has not been a topic of investigation. Such adoption is particularly challenging as it involves the coordination of a number of actions when people are distributed: people must inform each other about the technology, coordinate in the decision to use it, and implement it. These challenges are quite different than those that face collocated potential users such as with GDSS systems (Bikson & Eveland, 1996; Grohowski, McGoff, Vogel, Martz, & Nunamaker, 1990; Post, 1992; Tyran & Dennis, 1992).

In this study, we report on the diffusion of a collaborative technology in a large, complex, distributed organization. Unlike many other studies of groupware, which

revealed resistance to adoption, we found that the groupware technology diffused rapidly across organizational sites that were geographically distributed. This diffusion occurred despite the fact that there was no management mandate, nor any "rational" plan to deploy it. As organizations and work groups are becoming increasingly more distributed, the process by which technology can diffuse to distant settings is becoming more important to understand. We therefore ask the following research questions. First, how can we explain theoretically the diffusion of collaborative technologies in complex and distributed organizations? Second, how can people learn about technologies across distance when no management plan exists to deploy the technology? Last, how do users learn to use and adapt the technology as it diffuses across time and distributed settings? The first research question will be addressed in Section 2, where we discuss the theory of social worlds in relation to technology diffusion. The second and third research questions will be addressed in Section 4, where we present empirical results of the technology diffusion.

2. Theory: social worlds in organizations

2.1. Social worlds in organizations

Distributed organizations are fluid organizations. The boundaries between work units may be in continual flux as teams reconfigure to incorporate expertise drawn from any geographical location in the company. Thus, distributed organizations have multiple adoption contexts depending on, for example, whether people are working with collocated or remote colleagues. We propose social world theory as a framework for understanding technology diffusion in a distributed organization.

A social world is a unit of collective action (Strauss, 1978). More specifically, Clarke (1991) describes social worlds as "*groups with shared commitments to certain activities*, *sharing resources of many kinds to achieve their goals*, *and building shared ideologies about how to go about their business*" (p. 131). A social world can refer to any type of collective unit, such as a task force, an academic department, or a distributed project team. In this paper, we address the social worlds that exist in organizations, in particular those whose primary collective activity is related to work in the organization. In order to distinguish our focus from a general notion of social worlds (e.g. a political action committee), we also use the term *working spheres* to denote social worlds within an organization that are concerned with organizational work.

We consider a social world as the unit for adoption of groupware in a distributed organization. Social worlds is a rich concept as it can describe either collocated groups or distributed teams. People typically are members of multiple social worlds in the workplace, and they act as bridges between their social worlds. Technology diffuses as individuals introduce it into their other working spheres (see Fig. 1). Thus, we are proposing to use *boundaries of work practice* as the adoption unit as opposed

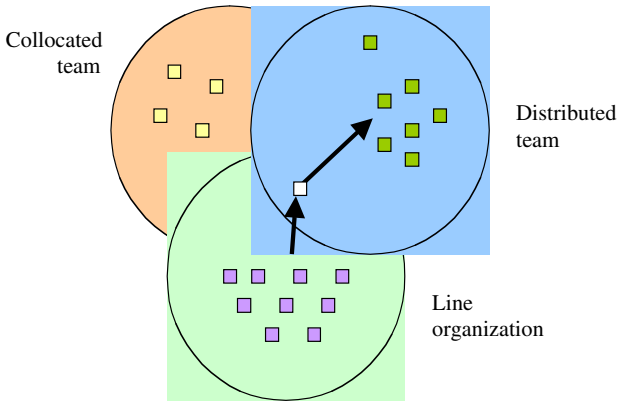

Fig. 1. A diagram showing how technology diffuses through social worlds, often "seeded" by an individual.

to approaches that use an organization, a physically collocated work unit, or individual as the locus of impact. Rather than focus on a single adoption unit, we instead view adoption as occurring in multiple social worlds that intersect in an organization. Similarly, Fitzpatrick, Kaplan, and Mansfield (1996) used social world theory to explain how people structured the interfaces of a prototype virtual work environment system, i.e. according to their multiple social worlds.

What are the properties of a social world that can influence technology adoption? A social world has properties related to its individuals, the collective group, the work environment, and the task. First, a social world's behavior and decisions are influenced by the characteristics of its members: their experiences, values, and knowledge. Individuals who are technically savvy might be expected to be more knowledgeable about new technologies and more open to trying them. A social world's collective shared knowledge, skills, and history also affect the nature of its discussion and decisions. For example, a team with a long history is likely to have developed more trust among its members, and this trust makes any team member's advocacy of a new technology more persuasive. The environment of a social world includes its structure (e.g. hierarchical or networked, distributed or collocated), policies (e.g. rules, standards), and its stock of material resources (e.g. infrastructure, monetary). A social world which has management support and appropriate resources (e.g. for purchasing equipment) would be readier for technology adoption than a world that lacks these. Last, the nature of a social world's tasks influences adoption. A distributed social world that holds meetings has a need for technology to support synchronous interaction.

2.2. Other approaches to technology adoption

Studies of IT diffusion have seldom addressed the role of distance as a variable in adoption, focusing primarily on individual, structural, technological, task-related,

Table 1
Examples of different models and studies of technology adoption, using the individual, the work unit, the organization, and hybrid models, as the locus of impact

Individual	Work unit	Organization	Hybrid models
DOI (Rogers, 1995), TAM (Davis, 1989; Davis et al., 1989), Mathieson et al. (2001)	Brabston (1993), Umanath and Campbell (1994), Kwon (1990)	Structural adaptation theory (Barley, 1986; Orlikowski, 1992; Poole and DeSanctis, 1990), Orlikowski (1993b), Majchrzak et al. (2000)	Zaltman et al. (1973), Gallivan (2001)

and environmental factors (see Fichman, 1992; Kwon & Zmud, 1987; Prescott & Conger, 1995; for reviews). In this review, we describe approaches that focus on adoption at the individual, work unit, and organizational level. Hybrid models combine different levels of adoption. Table 1 gives an overview of these models and studies. A comprehensive review is beyond the scope of this paper, but we instead give examples of each category. All of these adoption units have rigid boundaries which we argue do not adequately explain how technology is transported within and across geographically distributed organizational sites.

Individual level of adoption. The most widely applied model of technology diffusion, which focuses on the individual as the unit of adoption, is diffusion of innovation (DOI, Rogers, 1995). DOI identifies four main elements that influence technology diffusion: the innovation, the communication channels, the rate of adoption, and the social system. According to DOI, adoption is related to the degree of compatibility of the innovation to practices, values, and needs of the users. Adoption is also related to the technology's compatibility with values and norms of a social system, how well others can observe the innovation, and whether users perceive it as having a relative advantage over other technologies. Type of communication can influence adoption, e.g. as with mass media channels or informal communication. A second well-known model is the Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) which focuses on the usefulness and ease-of-use to explain adoption. The model has been expanded to include perceived user resources (Mathieson, Peacock, & Chin, 2001).

Work unit level of adoption. The assumption used in considering the work unit as the locus of impact is that differences at this level, e.g. history and relationships, are profound enough to explain adoption at a more detailed scale than the organization (Brabston, 1993; Umanath & Campbell, 1994). Kwon (1990) examined differences in work unit climate. However, none of these studies proposes that such work units may be interdependent, as in the case of adopting collaborative technologies to support work between units.

Organizational level of adoption. Models where the organization is the locus of impact are concerned with how adoption changes the structure or processes of the organization, or conversely, how the organization's policies and structures affect

adoption. Structuration theory has been widely used to explain how users shape technology within the context of use (Barley, 1986; Orlikowski, 1992; Poole & DeSanctis, 1990). One study of distributed teams by Majchrzak, Rice, Malhotra, King, and Ba (2000) found that they experienced emergent group and technology structures, while the organizational structure reverted back to its pre-existing structure before the adoption. Orlikowski (1993b) compared organizational contexts, variations in the change process, and key players in two organizations showing how they affect adoption. Inter-organizational adoption has been studied with BITNET and ISDN which used critical mass as an explanatory factor rather than organizational characteristics (e.g. Gurbaxani, 1990; Lai, Guynes, & Bordoloi, 1993).

Adoption at multiple levels. Hybrid models assume that adoption occurs at different levels of an organization, in a stage process. Zaltman, Duncan, and Holbeck (1973) explained adoption first by a decision made at the firm level, and then at the individual level. Gallivan (2001) proposes a two-stage model where first a decision is made at a higher organizational level, and then by an individual.

There are major drawbacks to these approaches in explaining collaborative technology diffusion across distance. First, the models of individual adoption, e.g. DOI or TAM, consider adoption as a solitary individual decision, which does not apply well to cases where decisions are interdependent (Fichman, 1992; Gallivan, 2001), networked (Lyytinen & Damsgaard, 2001), and coordination intensive (Gallivan, 2001). Clearly in the case of groupware adoption, a single user's decision is dependent on others' choices. DOI assumes that persons' roles in an organization are fixed and enacted by "an individual occupying a given position" (p. 376, Rogers, 1995). This contradicts empirical results of Kaplan (1987) who found that individual roles can change and consequently affect adoption. In complex, and especially distributed organizations, people often are members of multiple collaborations, assuming different roles in each (e.g. engineer, manager, task force committee member).

With some exceptions (e.g. Kwon, 1990), models of individual and work unit adoption generally assume a homogeneous diffusion arena. This fails to consider different adoption contexts with unique technology requirements. An assumption of homogeneity is in direct contrast to findings where organizational differences have been shown to affect adoption (Markus, 1983; Orlikowski & Gash, 1994; Orlikowski, 1993a). These adoption studies also do not consider that individuals belong to multiple working spheres, each with different environments favoring or hindering adoption. Hybrid models explain decisions made within bounded contexts such as a work unit. DOI explains that the social system "constitutes a boundary within which an innovation diffuses" (p. 24, Rogers, 1995). The assumption of fixed boundaries does not account for interdependencies among actors and networked technologies (Fichman, 1992; Lyytinen & Damsgaard, 2001; Wolfe, 1994). These models neglect to account for inter-organizational adoption across disparate social systems and do not account well for collaborative technologies that connect partners in different work units or organizations.

2.3. Groupware adoption in social worlds

In contrast to models focusing on the individual, work unit, or organization, we present the following reasons for how social worlds can explain technology diffusion in a distributed organization.

Social worlds have fluid boundaries. First, in contrast to most organizational theory, the structure of social worlds are fluid. They are connected through communication, and not by geographical location (Shibutani, 1955). Strauss (1993) describes how social worlds intersect with each other and have fluid boundaries. Distributed teams are a type of social world that can span *boundaries* of different organizational units. The fact that distributed teams are composed of members who often cross intra- and inter-organizational boundaries has led researchers to study how these teams can develop social properties such as trust (Jarvenpaa & Leidner, 1998), identity (Wiesenfeld, Raghuram, & Garud, 1998), member involvement (O'Hara-Devereaux & Johansen, 1994), conventions (Mark, 2002), and common ground (Olson & Olson, 2000). Social world theory can account for networked collaborative technologies such as data conferencing because social worlds are connected by communication and not by fixed organizational boundaries.

Social worlds are diverse. Each working sphere has a unique constellation of colleagues, collective experience, organizational and environmental conditions, and tasks. This leads to unique requirements for supporting coordination and communication. Mark, Grudin, and Poltrock (1999) found that people who were members of the same distributed team experienced different barriers to adoption from their local sites: lack of local technical support, lack of local management support, limited resources, and discouragement by local colleagues. Organizational resources, the degree of infrastructure readiness, and technology standards are just some examples of what can differ across social worlds to affect adoption decisions. Distributed organizations are a collection of heterogeneous social worlds with unique cultures and practices (cf. Schein, 1985).

People belong to multiple social worlds. People can belong to multiple working spheres in an organization: e.g. as a member of their organizational home, of a local work group, or of distributed teams. As people move in and out of different social worlds, changing activities, they change social contexts and corresponding reference groups (Shibutani, 1955). A perception of relative advantage, compatibility of a technology to work practices, and value of the technology may depend on the reference world that one considers. Compatibility may be judged to fit the organization's policies and structure (Perry & Danziger, 1980; Perry & Kraemer, 1979) and these can differ across social worlds. Different social worlds also offer varied opportunities for experimenting with and observing the use of an innovation, such as in collocated vs. distributed worlds.

Communication channels can vary across social worlds. In a networked organization, people may learn about a technology and be persuaded to use it through a variety of ways across different working spheres: a team, a newsgroup, distribution list, neighboring colleague, or distance learning class. Mass media channels can also efficiently communicate an innovation to the entire organization, as in the World Jam project at

IBM (Halverson et al., 2001). Communication channels may differ for informing and persuading about technology adoption within and across social worlds.

Rate of diffusion can vary across social worlds. Each social world has its own state of readiness for adopting technology. The experiences of the members, infrastructure available, amount of resources, or management policies are examples of what can affect the state of adoption readiness. Where an innovation is regarded as a better fit to work practices in one working sphere, or where the conditions of a world are more favorable to adoption, then the innovation will be adopted faster for use in that social world, compared to another. Mark et al. (1999) describes a scientific team that was an early adopter of desktop conferencing compared to the rest of the organization. Another team, though also an early adopter, struggled with organizational barriers to achieve adoption. Others have found that organizational influences can lead to adoption resistance among some work groups but not others in the same organization (Markus, 1983; Orlikowski, 1993a).

2.4. Research questions arising from social world theory

The notion of social worlds can be used to examine certain aspects of groupware diffusion across geographic distance. Based on the characteristics of social worlds, we developed empirical research questions. First of all, as social worlds are not confined to geographically collocated boundaries, we were interested to discover the role that these worlds play in the diffusion of groupware technology in a geographically distributed organization. Can groupware adoption across distance be explained as diffusion via social worlds? Are the communication channels that exist in distributed social worlds (such as distributed teams) sufficient to enable people in the team to learn about and make decisions to adopt a common technology? In the absence of any management mandate, as we found, can in fact distributed teams across the organization adopt a common technology?

Second, as social worlds are diverse, we expect their different characteristics to affect adoption. Some worlds may have different states of readiness for technology adoption (see Olson & Olson, 2000). With the right combination of resources, expertise, savviness about technology, openness, etc., some social worlds would be expected to adopt technology more readily than others. However, what happens in a distributed organization when some social worlds have a higher state of readiness for adoption than others?

Third, as people are members of multiple overlapping social worlds in a distributed organization, how does this membership affect the diffusion process? What happens when a distributed team wants to adopt groupware and its members belong to other social worlds that resist the technology? Does the adoption of a groupware technology in one of their social worlds enable people to overcome resistance in their other worlds? These basic questions have led us to formulate our questions discussed earlier in the paper, which address: (1) explaining theoretically the diffusion of groupware in a distributed organization, (2) how the groupware can diffuse without management mandate, and (3) how the users can appropriate the groupware technology and adapt it to their worlds as it diffuses across distance.

2.5. Related ideas to social world theory

A closely-related conceptual idea to social world theory is that of communities of practice (Wenger, 1998). A community of practice is defined by three aspects: people's mutual engagement, their joint pursuits, and a shared repertoire. Communities of practice are not the most suitable locus of impact for studying distributed organizational diffusion as the boundaries of communities of practice do not necessarily match those of the adoption units. As Wenger (1998) describes, a community of practice is not synonymous with group, team, or network. Distributed teams that adopt a collaborative technology and that consist of software developers and financial analysts do not necessarily constitute a community of practice. It is only by achieving a mutual engagement in practices that a community of practice exists. The limitations for distributed teams in communication, their sporadic meeting, the difficulty in constructing team identity (Wiesenfeld et al., 1998), and the lack of common ground (Olson & Olson, 2000) make it difficult for distributed teams to achieve mutual engagement in their practices. We prefer to use the notion of social worlds which does not make assumptions about members' involvement. Further, collaborative technology can be introduced to people outside of one's community of practice. Mark et al. (1999) reports of a scientific team that adopted desktop conferencing. Yet some members of that team introduced the technology to people in their line organization (another of their social worlds) who worked outside of their community of practice.

The concept of social networks is also related to social world theory in that people in a social world are networked together. People's interconnectedness has been examined in relation to power structure, information transfer and adoption decisions (e.g. Burkhardt & Brass, 1990; Coleman, 1966; Granovetter, 1973; Rogers, 1995; Rogers & Kincaid, 1981; Valente, 1994). Networks across distance have been examined in the stages of the adoption of database tools (Nilakanta & Scamell, 1990) and in the interaction with work climate (Kwon, 1990). In contrast, Rice and Aydin (1991) found that attitudes toward adoption are affected more by those who are proximate as opposed to those in a person's network. However, social network studies generally focus on a person's "ego network" which is more likely to be a collection of individuals as opposed to a distributed work group with unique properties. These studies suggest that social networks can describe how people learn about technology, but they do not explain particular characteristics that distinguish different networks (e.g. resources, task, or experience) that can affect an adoption decision.

Other related ideas to social world theory in organizations are found in the notion of the web of computing (Kling & Scacchi, 1982), symbolic interactionism which views computing as an arena of actors with intersecting interests (e.g. Kling, 1980), and hard and weak ties across organizational boundaries (Granovetter, 1973; Pickering & King, 1992). In addition, the open systems model of organizations accounts for influences from groups external to one's workplace or organizational home (Kling & Jewett, 1994; Scott, 1992). We believe that social world theory provides a more encompassing view of types of working spheres where people may intersect and learn about a technology.

3. Research setting, history, and methodology

In the late 1990s The Boeing Company underwent rapid growth both in size and geographic diversity as a consequence of merging with McDonnell Douglas and acquiring the aerospace business units of Rockwell International. Before these mergers, about 80% of Boeing employees were located in the greater Seattle area and could attend most face-to-face meetings by driving less than $1\frac{1}{2}$ hours. Following the merger, the company grew to about 235,000 employees and only about 40% were located in the Seattle area; the rest were distributed across the United States, with the largest concentrations in Southern California and across the Midwest.

The mergers suddenly changed the cost/benefit ratio for data conferencing technologies, as employees were now called upon to collaborate with people hundreds or thousands of miles away. With data conferencing, people can use a shared whiteboard, share application windows to all other participants, allow others to interact with the shared applications, and send short text messages or files to the other participants. In this study, the core element of the data conferencing service that we focus on is Microsoft NetMeeting (NM). See Appendix A for more description of data conferencing and its history in the company.

The Boeing Company was an excellent site in which to study the research questions we are interested in. It is a large geographically distributed organization with numerous distributed teams. Further, we were able to study the diffusion of a collaborative technology from its early adopton stages.

Over a decade ago Robinson (1991) wrote that groups using shared information need to be supported by technology that includes both information sharing and communication channels. Since then, syntheses of these technologies have been made with systems such as Lotus Notes, which are semi-structured documents which add communication features to asynchronous information sharing capabilities, and data conferencing, such as NetMeeting, which adds data or application sharing to real-time communication systems such as audio, video, and text chat.

Data conferencing usage has grown dramatically since its introduction in the organization in 1998. The rapid and widespread adoption of data conferencing was surprising because there was no formal mandate from management encouraging its use and there was no plan to deploy it throughout the enterprise (Mark & Poltrock, 2001). The information systems organization assigned experts to manage the data conferencing service, but these experts were not chartered to advocate its use, and did not advertise it. They implemented the infrastructure required for reliable data conferencing, and established a website with installation instructions. Fig. 2 shows that total usage per month grew to over 60,000 user hours from February 1998 through December 2001, a relatively steep diffusion curve. [1] This curve is more linear than a typical S-shaped diffusion curve which indicates a stretch of early and

[1] Note that a steep rise in usage occurred shortly after September 11 when people traveled less. The steep dip around 12/01 occurred during the winter holidays.

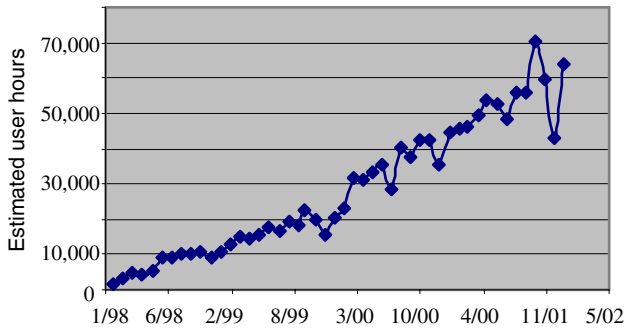

Fig. 2. Estimated NM use over four years. Note that a steep rise in usage occurred shortly after September 11 when people traveled less. The steep dip around 12/01 occurred during the winter holidays.

late adopters. We interpret the sharp rise at the beginning of this curve as due to the fast diffusion of the technology by early adopters through multiple social worlds. The current curve does not flatten at the later time points because adoption is still increasing and has not yet reached the point of late adoption.

3.1. Data collection

Data were collected from November 2000 to February 2002. As our interest was in organizational adoption across distance, we also looked for data that could inform us of the adoption process at different company sites. We collected data from a log of all requests for permission to use NM at one site that resisted its adoption long after it had been declared a company standard. An archive of 354 email messages over two and a half years revealed the reasons why people wanted to adopt NM. The archived messages started in October 1997, and continued through March 2000, when the site discontinued its policy of requiring permission. Each message consists of a thread of correspondence asking for permission, some discussion about the technology, and an approval or disapproval. Most requests were from individuals, though some were from teams ranging in size up to 60 people. This archive gave us a remarkably detailed picture of how different parties viewed the software, and how it diffused across the company.

We also sent a questionnaire to users across the company who were identified through their registration with the Internet Locator Service (ILS). The questionnaires were sent to every Boeing employee actively participating in a conference on three separate occasions (chosen randomly) during the mornings (Pacific Standard Time) of November 6 and December 18, 2000, and January 10, 2001. We deliberately chose users of the technology rather than conducting a random sample across the enterprise. It was our intent to question adopters to understand their reasons for adoption. The questionnaire was sent to 146 people. We received 83 responses for a response rate of 57%.

To understand different interpretations, we interviewed eight key people involved in the technology introduction: the NM product manager, a technology champion

and her managers from one site, and high-level technical support people who had an overview of adoption. Using a paradigm commonly employed in adoption studies, to understand users' reasons for adoption (see the classic study by Ryan & Gross, 1943), we also interviewed users. Follow-up semi-structured telephone interviews were conducted with 55 respondents of the questionnaires, ranging from 30–60 min each, asking about their adoption history, their working spheres, any resistance they encountered, and why.

We collected usage data from our neT120 conference servers and monitored the ILS directory, which indicates who is actively participating in a meeting. We cannot determine how many people use NM or how frequently each person uses it, but can only show the estimated number of user hours per month. These can be only estimates because there are multiple methods of data conferencing. We have precise data using one method, which we have used to calibrate the ratio of this method to total usage (see Fig. 1).

We also examined a collection of artifacts related to the adoption process. These artifacts included corporate standards descriptions, white papers on NM adoption, and an archive of memos and emails from one of the authors that traced the history of NM deployment and adoption from 1997 to the present.

3.2. Methodology

We used triangulation (e.g. Jick, 1979) of quantitative and qualitative methods to provide an overview of the diffusion process and also to examine in more depth the reasons and experiences associated with adoption. Grounded theory (Strauss & Corbin, 1998) was used to identify and relate concepts in our interview, open-ended questionnaire responses, and archived email data. Through open coding we first identified the following general categories: learning about the technology, using the technology, different adoption attitudes, adoption difficulties, overcoming conflicts, and roles. Axial coding was then used to search for causal relationships and to relate these concepts. Through selective coding, we further refined these concepts into understanding the central role of social worlds in adoption: how the technology was learned about in social worlds, how the technology was adapted for use in different social worlds, conflicts that occurred between social worlds, how social worlds could control adoption, how differing resources and standards affected adoption in social worlds, how power of technology promoters was influenced by their social world, and how critical mass could influence adoption in social worlds. The data was validated through additional interviews and by comparing the interview responses with the email archived data.

4. Results: technology diffusion across social worlds

In this section, we present empirical results that address our research questions. In the first section, we present survey and interview results which describe how people learned about the technology and transported it within their social worlds despite the

fact that no management mandate existed. We also describe cases that illustrate how the users appropriated the technology and adapted it to fit the needs of their social worlds. The next sections address the question of how different social worlds can have conflicting influences towards technology adoption. We explain how technology promoters can be caught up in this conflict. Last, we show how resistance in a social world can be overcome by the spread of adoption in overlapping social worlds.

4.1. The process of technology diffusion: transport and transformation through social worlds

We first examined how the technology was diffused across the organization. Our survey data shows that a majority of people (55%) first learned about NM from others in a social world that was at a geographic distance: a member of a distributed team, or from a collaboration with a remote partner (Fig. 3). Twenty-four percent reported that they learned about NM through face-to-face contact at their local site, and only a few (2%) learned about NM from their local managers. Thus, managers and company web pages, which are not social worlds, were not a significant source of learning about the technology.

We asked the reasons why people introduced the technology to others. 83% reported their reason for introducing NM to others was so that they could participate in a collaboration, e.g. distributed meetings or in small group collaborations across distance (Fig. 4). Again, this supports the idea that people introduced the technology into their social worlds.

Our interview data enabled us to understand a richer view of how the technology diffused across distance. We found that people act as bridges in transporting the

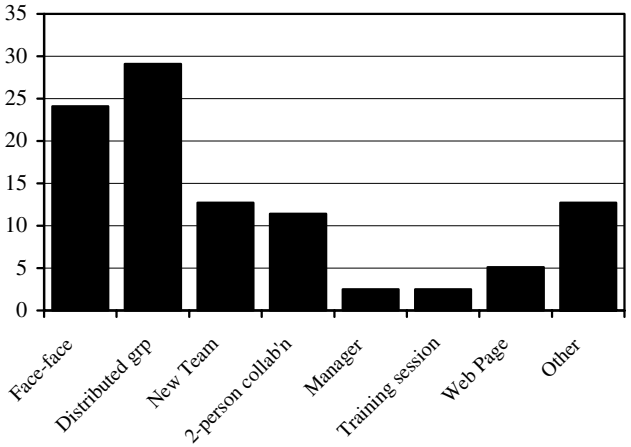

Fig. 3. Percentage of users who first learned about data conferencing from different types of sources. $N = 83$.

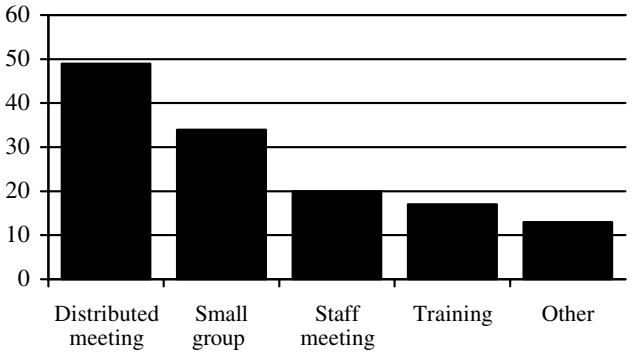

Fig. 4. Percentages of each reason why respondents introduced the technology to other people. Respondents could check more than one reason. $N = 83$.

technology across social worlds. Social worlds are "seeded" by one member who has adopted the technology. People learn about the technology in one of their social worlds, and as they are members of multiple social worlds, they introduce it into another of their worlds.

We also discovered that the technology is often transformed as it passes into other social worlds to fit the work practices of that world. We present scenarios from interviews to illustrate how people acted as bridges and to convey how the technology was transformed as it migrated across different social worlds.

Sarah works at a Boeing site in the Midwest. She learned about data conferencing from a colleague with whom she shared a social world in her line organization at her site. Her colleague showed her the basic capability of NM to share applications. One of the jobs that Sarah has in the company is to test a particular software application developed by an independent vendor and teach engineers how to use it. She used to meet with people face-to-face almost daily at first for training, and then every couple of months. While sitting at her desk, Sarah used NM for remote teaching and testing of the software with her trainees who were located in another part of the city. Sarah then introduced NM to another social world she belongs to – a team distributed in California, Arizona, and Missouri to discuss issues related to her software application.

Joe works on an enterprise team and was an early adopter. He first learned about NM in 1998 when it was used as a presentation tool in one of his social worlds – a distributed salary review team. Another of his social worlds is an enterprise team of eight people distributed around the country. He discovered that he could use NM with this team for document sharing of spreadsheets to explain nuances in the data and to collaborate in producing the spreadsheet. In other distributed collaborations he often will ask people in a phone conversation to launch NM and explains to them how to use it.

Graham works at the computer help desk at a small site of 750 people in the southern part of the country that makes airplane parts for the entire company. In

Graham's words, because their site is small, "every person wears 82 hats". Graham learned about data conferencing from a visitor, which led Graham to search for it on the company web pages. Graham realized he could use data conferencing to provide remote computer support to users at his small site. Even though a user might be in a neighboring building, Graham preferred showing someone how to use Excel from his desktop. Graham introduced NM to the social world of his computing group, who at first saw no use for it but later realized its value after seeing Graham help users from his desktop. Graham communicated to others that NM can be used to debug software applications, to give Web support, and even to adjust the control panel on workstations.

Thus, our data suggest that people learned about and introduced the technology within their social worlds, many that were geographically distributed. We find no evidence that formal organizational communication or management mandates were responsible as communication channels for the technology.

These cases illustrate that uses of the technology changed as people discovered new ways for the technology to fit their collaborative work practices. Sarah communicated to her social world of engineers that NM can be used as a remote training device. With her distributed team, she is communicating that NM can be used to share and edit documents. The use of NM changed for Joe from a presentation tool to a collaborative tool for working on spreadsheets as it moved through and was adopted in his different social worlds. For Graham, he shaped NM as a tool for giving remote technical support. We found many other examples in our interview data where users described similar situations. Different work practices in social worlds created the opportunity for the technology to transform. As more uses for the technology were found, people found it easier to adapt the system to fit the tasks of different social worlds.

4.2. Social worlds for and against adoption

Our next research question led us to examine conflicts that can exist when social worlds have different properties. We found that social worlds can work for and against adoption. We present two contrasting social worlds – two different organizational sites – in the distributed organization to illustrate this idea. Management at one company site became gatekeepers who tried to control the technology whereas another company site enabled easy adoption. Many distributed teams existed, composed of members from both sites.

When news of NM started to spread across the company, Harry, the director of IT at an organizational site we call Central City [2] made a decision that NM use would not be allowed except in special cases. As a manager, he needed to worry about the collective impact of NM use on the computer network. He was afraid that conferencing traffic would strain the network, and interfere with other higher priority collaborations that involved exchanging large CAD files

[2] This site name and all people's names are pseudonyms.

between Central City and Seattle organizational sites. A high-level manager under Harry described that without necessary bandwidth, production work could not get done on the factory floor. Although Seattle network engineers had concluded that NM use would have little network impact, and explained this to Harry, he was not convinced. He was not willing to accept the risk that his network would not function.

Second, cost affected Harry's decision. Central City had less organizational resources than Seattle. Central City had another conferencing system using desktop video and data conferencing that was a standard. Because this product required installation of ISDN lines for each participating group, the costs were borne by the groups and the bandwidth was not carried by the central infrastructure. In contrast, operating costs for NM would be charged to the network – and to the IT department.

Third, allowing an unrestricted use of NM meant having lack of control over people's work, which could lead to increased technical support, among other consequences. One high-level manager at Central City expressed his concern that NM use might lead to new work practices with unknown effects:

You might say, what's the harm in using it? On the surface, there's no harm, but the really damning thing of what happens is that people then begin to alter or implement new processes and procedures surrounding that capability on that product. And then it becomes this is the way we do it, at that site vs. this site.

Harry established a policy that people needed to apply for NM as an "exception", thus forcing potential users to prove their need for NM. Because NM was freely available from both the company and NM commercial websites, in reality it was impossible for the Central City IT staff to actually prevent users from using NM if they wished. Our data suggest though that many users followed the procedure of requesting permission, and believed that they needed approval to use NM. For example:

[message 243]: Without [Rick's] approval, you will not be able to enter into any meetings even if you have NM loaded ...

Employees followed this policy to avoid repercussions. They reported that to be caught using NM without permission might affect their job. (One user who downloaded NM without permission wrote: "*I am sorry, I didn't know. I'll delete it now*!") Some users "confessed" in their emails that they had already downloaded NM and were using it. They requested permission (and forgiveness) in order to follow the organizational site's policy. One user reported that their group was using it, saying they were "*unaware that usage of NM was being controlled.*"

As adoption increased in other parts of the organization, the Central City gatekeepers constructed stronger barriers to maintain control over the distribution of NM. Their policy stated that Central City users who received permission could not use audio and video features, for fear of causing a major impact on the network. NM could also not be used for collaboration within the two-mile long Central City campus. "Unnecessary" local meetings would tie up the network. Potential users were not supposed to assist each other to install NM: each situa-

tion was to be reviewed by the IT staff before approval could be granted and the software set up. According to messages from Harry, NM should not be "available for general use," nor used to invoke technical support. Lastly, the IT staff was strictly forbidden from presenting the software to potential users, or "selling the use of this product." When one group of 580 people asked for a presentation of NM in December 1998, Harry turned down their request. From his perspective as a manager controlling costs, the effects of nearly six hundred new users would make NM use too difficult to control. He expressed his fear of "*the potential impact of such a presentation*" and the "*possibility of turning this on to 580 additional people*". He did not want it to be perceived that he was "*promoting such a growth in NM usage*."

The IT staff enforced the rules. They repeatedly informed users that support would "*be very limited*" as NM was "*not a standard product*." In addition, the IT staff willingly tracked the users of NM and collected a database of them, based on the permission requests.

In contrast to Central City, the Seattle IT staff believed that the requirement for NM already existed, and so made NM available to all those in Seattle who wanted it. The IT group in Seattle implemented a "self-service" strategy for deploying NM. All information for deploying the system was found on a web page. The web page also had rules for meeting etiquette and an online tutorial. Users who needed further help could seek technical support. Thus, in Seattle, employees who wanted to adopt NM could do so fairly easily.

The conflicting Central City and Seattle strategies for NM reflected a deeper difference between these different social worlds, namely, in the value they placed on synchronous collaboration. As one Central City manager described, "*Somewhere, someone, would need to place a value on collaboration. What's the payback? What are you gonna get out of it to offset the costs*?" In Seattle, synchronous collaboration was viewed as a benefit; the cost of providing technical support was viewed as an investment that would be paid back by cutting travel costs.

Though NM was made a company standard, Central City declined to accept NM as a company standard, preferring to maintain the exception process. Thus, different views of the company "standard" in the different social worlds played an important role in the adoption. To Seattle and other sites, following NM as a standard would ensure technical interoperability, making collaboration easier. Central City, however, by not recognizing NM as a standard, was able to justify their control of the adoption process by calling it an "exception" that needed special approval. A technical support person recommended to Harry that NM be made a standard in June 1998; he replied with "*a firm no*," though he agreed that this would happen someday.

Thus, social worlds have unique environments that can favor or hinder adoption. Different resources, views about collaboration, and policies can affect adoption. Further, social worlds can have their own interpretations of standards and may not uniformly adopt a company standard. Not only can this hinder adoption for a world but it can also lead to interoperability problems for collaboration between social worlds.

4.3. The tension in distributed social worlds

People can be members of different social worlds with opposing views about adoption. Many people whose organizational homes were at Central City also belonged to social worlds outside of Central City – distributed teams. The policies at Central City created tension for distributed teams that had some members in Central City. Not being able to adopt the technology prevented Central City members from fully participating in their teams.

To get approval to implement NM, Central City employees needed to state a valid business case. The only valid cases were pre-existing remote collaborations that required NM use. For Central City managers, merely sharing files asynchronously was not considered sufficient to require NM because the company had an extensive file sharing system in place. A request without a valid business case was not approved. Typically, an IT staff member sent a message much like the following when people asked permission:

[message 180]: Please provide details of your requirements to use NM. A business case has to be presented before approval, because NM is not a standard for [Central City], but with a business case, it may be approved for your use on an exception basis.

The users were not concerned with the collective problem of increased network traffic. They were concerned with acquiring the technology needed to collaborate with their teams. Some users wrote very detailed descriptions of which sites and meetings they would connect to, how often, why NM would save costs, and what benefits NM would provide.

In general, the email archive suggests that most applicants who had collaborations with distributed teams across other sites were granted approval, but not those who collaborated with teams that were distributed locally. Some denials were discretionary. Here is an example of a request to participate in a non-local team (the Corporate Ethics committee meetings) that was turned down by Harry:

[message 233] Sorry, but I need a better reason to accommodate than some committee is going to use NM. If they are doing interactive meetings they should use NM, if a file on exchange [email server] will do, then the answer is no. My experience so far is that 95% of the time, the information via a file on exchange is fine. Let me know if there is a business reason for an exception.

Not surprisingly, company hierarchy made a difference. A less specific and perhaps less valid request to join the NM of senior management was quickly approved by Harry.

Jim, another high-level IT manager, was very strict about enforcing the rule. In the early phases of NM adoption, in March 1998, Jim wanted to make sure where exactly NM would be installed. For example, he gave approval for NM to be downloaded in the Usability lab, but only on the workstations needed to participate in the meeting. Further, in this early stage of adoption, he forbade training for large groups. A request to install NM at a shared computer center was denied by Jim. He wrote:

[message 282]: ... at this point in time I cannot expend these kind of resources to put this "[Central City] non-standard product" on the [shared computer center] servers.

4.4. Technology promoters and organizational conflict

Promoters of technology within distributed organizations can face hard obstacles if they are situated in worlds with differing views of adoption. They may be able to promote the technology in one of their worlds, but face difficulty in introducing it into another. One user described how he had problems in promoting the technology in a working sphere where most members were located across the country. Promoters have to act according to the norms and conditions within a social world and these norms may be contrary to the goal of technology adoption.

We discovered in Central City that a dedicated promoter of NM worked to overcome the resistance of the management. This person, who we call Mary, belonged to different social worlds in the organization and directly experienced the tension between the desire of Central City employees to participate in distributed collaborations and local management resistance.

Mary learned about the technology as a member of the distributed IT group (mostly based in Seattle), which encouraged users to freely download NM. In Central City, Mary was a system-administrator in charge of deploying software for end users' desktops. Her regular job was to be on-call for PC services. She reported to her manager Jim, who in turn reported to Harry. Her local job at Central City demanded that she represent the interests of Central City, i.e. to restrict the use of NM.

Mary was genuinely excited about NM as a technology that would provide benefits: even her license plate reflected the name of the technology. She thought of NM adoption not in terms of the load on the network or its cost, but rather as a benefit for users. Her enthusiasm is expressed here to a user:

[message 193]: ... and I'm always interested in how groups are using NM to increase communications. I particularly find it rewarding to hear back from people when they are using the more powerful tools of NM to collaborate on documents together (as mentioned in the note below) as I think this product can change the way we work together as a company.

In her social world of the Central City IT group, Mary was not supposed to appear as if she was promoting NM use. All permission requests and responses were sent to her, and then she forwarded the results on to her managers. Mary was caught in a precarious role. She needed to abide by the rules of the site, yet she wanted to promote the use of the system. Mary did several things to promote the use of NM at Central City. She gave the Central City users cues on what they needed to write for approval, as in this example:

[message 248]: NM is not an official standard for [Central City], but people with a valid business case can write to [Jim], my manager and myself, to request for an exception to install and use NM. [Joanne] can briefly explain how they plan to use NM; in a teleconference with Seattle counterparts, for example.

She also took the initiative to make it easier for those who had obtained permission to adopt NM. She compiled a web page of FAQs about data conference servers, and wrote a users guide and reference card for the software. She made herself

available to help with installation. She also ran training sessions twice a month, conducting the training using NM. She offered to hold special training classes, and wrote to users that she was available for one-on-one assistance. We found no one else in the company that offered this type of training. In the early adoption days of spring 1998, her classes were in demand, and were often filled to capacity. The sessions sometimes filled to the NM system capacity of 32 persons, and she scheduled extra sessions. Users praised these events as accelerating the learning curve. This was a rare degree of involvement. She wrote:

[message 120]: ... As far as I know, there isn't anyone else in the company providing "live" training. I enjoy the training and plan to keep it up as long as they'll let me.

Stretching the rules at her site, Mary also sought out potential users of NM, offering to help them get started with the product.

[message 93]: While looking up another call about NM, I noticed that you called the Help Desk. Since NM isn't a [Central City] standard, and everyone is supposed to get approval to use NM, we don't have official Help Desk support – but I do provide assistance and I have a web page, plus the Boeing NM web page.

[message 200]: When I was sending out the meeting notice I was going through email checking on approved, new users to send a training notice to – and thought you might be interested, since you are involved in the Distance Learning activities.

Over time, potential adopters began to seek her out for help in adopting and using NM:

[message 95]: ... I understand you are the expert ... Can you help me????

[message 139]: P.S. I hear your a wiz at NM. I'd like to use it more, do you think maybe we could have a couple of meetings using it, both for my personal practice ... and to get others in the know of how to use it. Good to meet you.

Though Mary was taking risks in promoting NM, she was not officially authorized to approve users for NM. Periodically she gave an ad hoc approval that she would later justify to Jim and Harry:

[message 105]: Since this was for a telecon with Seattle I went ahead and approved him and [Tom]. My note to him was brief, since I was talking with him at the time – just wanted to send him the URL.

When her reasons were insufficient, she was reprimanded by her manager:

[message 126] I'll approve this one but there is certainly no requirement defined. In the future you might ask users to provide a little more info on why they think they need the capability.

As NM became more popular, and users began to install the software without permission, she found herself conflicted between the demands of her two social worlds: enforcing management rules and helping adoption. In this message, sixty users who belong to the same group inform her that they already have NM on their laptop. Mary writes her manager, Rick:

[message 47]: I'd hate to have to ask them to take it off their PC's – we aren't the NM Police; although Harry might prefer we do ask them to remove it, it's hard to say. But there are probably tons of people using NM who either don't know or don't care if it's a standard or not, and if we start asking people to remove NM – they will just stop

asking permission and load it anyway – then ask for support later . . . Should I go ahead and add them to the "exceptions list" – do you think?

At this point, management resistance was also weakening, and Rick replied to add the users. Thus, Mary was able to bring her enthusiasm and support of NM, that she gained from her membership in the distributed IT NM group, into her Central City social world. Her membership in one of her social worlds supported her in taking risks in another of her worlds.

4.5. Overlapping social world membership and critical mass

Social worlds are interdependent in a distributed organization because people are members of multiple worlds. In a world that has not adopted technology, critical mass from the rest of the organization can exert pressure and weaken resistance in that world. Gatekeepers of Central City could not prevent its members from being influenced toward adoption from their other social worlds. Thus, the overlap of membership in different social worlds influences diffusion across a distributed organization.

Nearly all the requests for using NM in Central City were from people wanting to connect to a distributed team. The following are examples which show how people's teammates have already adopted NM:

[message 011] I am the [Central City] representative for the Boeing [XYZ] Team, also representing [other sites]. This is an enterprise-wide team and we are planning to change our weekly telecons to net-meetings. Some of my teammates in Seattle, etc. have already installed NM on their computers and are waiting for the remainder of the team to be able to participate via NM.

[message 143]. . . I was told yesterday that I was the only one that did not have the NM software.

[message 301]. . . My counterparts in Seattle asked me to download NM and gave me the website in which to do that. . . With the Synergy Teams going on there will be more and more of these NM going on. . .

As NM use increased across the company, and as the Central City exceptions increased into the hundreds, the email archive data show that by 1999 the resistance of Central City management began to erode. Rick's message shows the position against local use was weakening by April of 1999:

[message 116]: I am currently getting management direction to not give NM approval to people who are wanting to use it just locally. We are concerned about network bandwidth being unavailable for other production purposes. However, a few exceptions have been approved. Can you tell me the number of people you might be dealing with, do they have NM, or will they too need to get approval? Approximately how many hours will you be using NM during the week? Any other justification you might be able to provide would be helpful.

Rick himself was caught at the intersection of different social worlds: as a member of Central City and of the larger organization. He slowly learned about the role of NM in the larger organizational context. Rick began to understand how NM was providing benefits for distributed teams as more and more people at Central City

began adopting the system. Thus, the larger organizational adoption influenced Rick's attitude toward weakening control of NM, and he became substantially more lenient on granting exceptions. In April 1999, he wrote that he was developing a business case and intended to leverage the database of exceptions to convince Harry to make NM a standard at Central City.

As critical mass increased, the data suggest that management was beginning to lose control of the approval process. More users were turning up who had already installed NM. In March 1999, Jim wrote:

[message 150]: "We aren't going to be able to stop these people from downloading it if they want to. If they download it, and then call for help, you might ask if they've been approved, and if not, find out how they are using it".

The language of the requests changed over time as NM continued to spread throughout the company. As NM adoption grew, in their emails we found that users stopped asking for "exceptions" in their messages and started requesting "approval" for NM use. Critical mass from the large numbers of social worlds that adopted across the company eventually wore down the Central City policy. In August 2000, it was made a standard in Central City.

5. Discussion

Contrary to most studies of groupware adoption that have found user resistance (see Palen & Grudin, 1995 for an exception); we discovered widespread adoption that was not a result of management mandate. In this paper, we have argued that the technology diffused across distance as people learned about it and introduced it into their social worlds. As people are members of multiple social worlds in the organization, the technology diffused rapidly. As more worlds adopted across the organization, it eventually broke down resistance that occurred in one organizational site. However, the notion of social worlds was not the sole factor responsible for the diffusion. The organization's mergers in 1996 changed the geographic distribution of the organization and led to the formation of large numbers of distributed teams. The organizational restructuring created the need for a collaborative technology to support teams in communicating across distance. Also, data-conferencing is a very malleable technology. As the technology was introduced in new social worlds, it became transformed to fit the work practices of the new social world.

5.1. Theoretical implications of social world theory for adoption

There are several theoretical implications of a social world perspective for the study of groupware adoption. Collaborative technology adoption in a distributed organization should not be expected to follow a well-planned rational course. One reason is that social worlds have different conditions that affect adoption choices. We consider that the boundaries of work practice should be used to chart the course of adoption, as opposed to the traditionally considered individual, work unit or

organizational boundaries. In this way, the circuitous adoption path can be better understood. In distributed organizations, the boundaries of work practice can extend beyond collocated work units and they can fluctuate as teams form and reconfigure. Our study builds on the work of Fulk (1993) who discovered that members of work groups influenced each others' attitudes towards technology. We suggest that these influences can also occur with distributed work groups. In fact, in a recursive way, the adoption of electronic communication and data sharing technologies creates flexible group boundaries as it provides access for people to connect from anywhere inside (or outside) the organization.

A social world perspective of adoption is an alternative to that proposed by DOI, TAM, and other models which assume a single adoption context and single adoption choice for the individual. Instead, we argue that individuals are faced with making adoption decisions in multiple contexts, according to their different working spheres. An individual may adopt a technology for use in a distributed team, but not for use at the home site due, for example, to organizational constraints, such as what occurred at Central City. A DOI perspective would conclude that the individual had adopted the technology when in fact it is more accurate to say that the individual had adopted the technology only for use in one of her social worlds. A social world perspective explains that an adoption choice depends on the social world that one is referencing. Social world theory has the potential to identify more fine-grained adoption behavior, i.e. in particular social world contexts.

Social world theory predicts that informal communication can operate at all stages of the adoption decision process. We found in our data that most people learned about data conferencing mostly from collaborating partners with who they shared a social world across geographic distance. Interpersonal and informal channels of communication are known to influence diffusion (Granovetter, 1973; Kwon & Zmud, 1987). Our findings are in contrast to DOI, which describes how mass media channels are more important in disseminating information about an innovation, whereas informal communication is more critical in persuading people to use an innovation. Again, we found that technology can be disseminated through informal channels.

With social worlds, it is possible to focus on factors unique to the collaborating working sphere that affect adoption. Using this perspective, we uncovered differing policies, technology standards, views on resources, and values placed on synchronous collaboration that influenced adoption. Central City's decision not to adopt NM as a standard illustrates how political and social influences of social worlds affect standards (Bowker & Star, 1997). Company standards are thus subject to different interpretations across social worlds. Nonuniform technology standards are especially problematic for the adoption of collaborative technologies as they create interoperability and support problems.

Our data has shown that people can be members in social worlds that differ in being beneficial and hindering to groupware adoption. Conflict is inherent to different social worlds in an organization (Kling, 1980). Tension arises within a social world when its members have different constraints hindering the uniform adoption

of a technology within their world. The tension is especially strong within distributed teams, where members can be constrained by different organizational policies. For employees of Central City, their adoption choices for their distributed collaborations were affected by the attitude in their organizational home. The different organizational units, Central City and Seattle, eventually came into alignment to support adoption after more than three years. A major challenge in groupware adoption in distributed organizations is that potential adopters are faced with conflicting loyalties, constraints, and requirements, between their social worlds.

5.2. Shaping a technology across social worlds

Collaboration can take on many different forms. We have continually argued how different social worlds, with unique properties, offer different ways for people to collaborate. Within a social world, the collaborating partners transform the technology. Tuomi (2002) writes of the heroic user who influences the course and development of innovations. We found that the uses of NM multiplied, beginning for most worlds as a presentation device, but then being shaped into use for remote software testing, spreadsheet development, document production, collaborative editing, remote technical support, and other support.

The technology itself played an important role in its transformation. Data conferencing is a medium by which users shape their interaction, as opposed to a mechanism that structures their interaction (Bentley & Dourish, 1995). As a medium, it enables emergent work practices to occur as people experiment with different functionality. Bijker (1992) describes how technological artifacts have interpretive flexibility. The contexts of different social worlds, due to their unique tasks, members, environments, and policies, create settings for the interpretive flexibility of the technology. People's membership in different working spheres thus created the *opportunity* for inventing new uses of the system, as the technology needed to be reinterpreted to fit different working practices. This offered more benefits for later adopters, as people's interpretations about the purpose and value of the collaboration tool expanded. Thus, a process of mutual adoption and adaptation of the technology occurred as it spread across working spheres.

Technology promoters can provide new interpretations of a technology to their social world. In our study, Mary is an example of a person who was instrumental in informing users of new ways to apply the technology through her users' guide and training sessions. She was also a catalyst for the technology adoption. She took risks to promote NM against her management policy, such as suggesting how to word requests, and contacting potential users. Though her local social world did not support NM adoption, she had a broader view of the benefits of adoption by her membership in another social world, the Seattle NM team.

The transformation of technology does not end when users implement it and have confirmed its value. The use of the technology can continually evolve (Bikson & Eveland, 1996). The data-conferencing adoption led to knock-on effects: computer

projection systems have been added to many conference rooms to accommodate the widespread use of data conferencing in meetings. These knock-on effects create new contexts for the technology to be reinterpreted.

5.3. Generalizability and management implications

What situations can social world theory best be applied in? We claim that it fits best to explaining adoption where decisions are interdependent, as with collaborative technologies. With single-user technologies, such as PDA's, where the adoption choice is not interdependent, we expect that there is less of a motivation for people to introduce the technology to their social world. Distributed members of a social world need a means to collaborate, and therefore the conditions are ripe for trying a new collaborative technology. In our study, distributed working spheres provided a clear perspective of the benefits and the applicability of the groupware technology. We also expect social world theory to explain adoption decisions in complex organizations, where people are involved in multiple working spheres. Adopting a collaborative technology is not an all-or-none decision in the workplace, but is dependent on the context of the working sphere where it will be used.

This study has several management implications for introducing collaborative technologies. First, management should assess where in the organization the need exists to collaborate (and what kind of support is needed) and it should target those working spheres that need to collaborate. As in the study with Lotus Notes (Orlikowski, 1993a), the decision-makers did not carefully consider that employees would not want to share data. However, management should also understand that collaborative technologies can also open up new opportunities for interacting across distance. Second, the targeting of early adopters who have membership in large numbers of social worlds would maximize the chances for the technology to be diffused. Third, upper management should be aware that technology standards in a distributed organization can be disparate across different worlds and they should work to ensure that standards are uniformly adopted across the organization. Conflicting technology standards can create interoperability problems, impeding the functioning of distributed teams. Fourth, management policies that clash across social worlds can hinder adoption. This particularly affects members of the different worlds who need the technology to participate together in distributed teams. The problem can be much larger, though, than rectifying policies. Policies can be reflective of unevenly distributed resources in a large distributed organization.

6. Conclusions

Our study has contributed to developing the concept of social worlds as a way to explain groupware adoption across distance in a complex distributed organization. Via social worlds, users were able to communicate, learn about, and adopt the

groupware throughout the organization without management mandate. Users learned about the technology through one of their social worlds and then introduced it into another of their worlds. Even resistance by some social worlds was overcome as mounting adoption throughout the company exerted pressure on those worlds.

As social worlds have different characteristics, users often adapted the technology to fit the needs of each world. Netmeeting was a malleable technology and users found many ways to appropriate it to support different forms of collaboration. We argued in this paper that the different environments of social worlds provide the opportunities for people to interpret and shape groupware.

An alternative theory for explaining diffusion of networked technologies across distance is Actor-Network Theory (ANT) (Callon, 1987), in which the actors and the technology are treated with equal weight. A full discussion of ANT is beyond the scope of this paper. ANT is similar to social world theory in that adoption is considered to occur as a result of the decisions of actors who constitute a network. However, in social world theory, diffusion is associated with chains of worlds, rather than chains of actors (who in ANT are considered networks of heterogeneous elements). In ANT, the transformation of a technology is associated with actors, whereas a subtle difference in social world theory is that the interdependent actors transform the technology to fit the needs of their social world. In explaining the adoption of groupware in a distributed organization, social world theory enables a better focus on distributed teams because the boundaries of social worlds can span distance. In ANT, networks of relations are considered much more fluid.

The use of social world theory has strong implications for the study of groupware diffusion. Our study has opened up many future research possibilities. One of the most interesting aspects in our view is the concept's potential to explain how users transform the technology, i.e. by adapting it according to the context of the social world where the technology will be used. As each social world has its own unique characteristics, different contexts of social worlds can be compared to better understand how they affect technology transformation. Another area that can be explored in future research is to examine what influences the trajectory of diffusion. What particular influences lead some social worlds to be catalysts for diffusion while others may block the diffusion? How does this affect the overall diffusion path in the organization?

A limitation of the concept of social worlds is that it cannot explain adoption according to individual characteristics. A social world is rather a collective of all experiences, expertise, and attitudes of its members and does not enable the identification of individual traits associated with adoption. Similarly, it does not focus on characteristics of the technology. Slow system response or a poorly designed user interface cannot be isolated as reasons for resistance. Rather, the adoption or resistance of a technology is an interaction of the unique world's characteristics and the technology.

Because of this interaction, it is difficult to identify the precise characteristics of a world that leads to adoption or resistance. As so many factors vary in social

worlds due to unique membership and environment, the influence of any particular set of characteristics in the world is difficult to isolate. Further, because of overlapping membership in social worlds in complex, distributed organizations, worlds do not exist in isolation. In such organizations, social worlds are generally highly interdependent. Thus, it is rather the whole chain of worlds that need to be examined in distributed organizations to understand diffusion, rather than any single world.

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Appendix A

A prototype data conference service was developed in 1996 before the company mergers, and this service was transferred to the company's information systems organization in 1997 and 1998 (for a more detailed explanation see Poltrock & Mark, 2003). The top ten executives in the company, who comprised the Executive Council, were among the earliest users of this data conferencing in September 1997 using a pilot infrastructure. As these executives were dependent on a fragile pilot infrastructure, the IT organization quickly established a team to define and develop a production infrastructure, which included defining the desktop conferencing system as a standard.

In this study, the core elements of the data conferencing service were Microsoft NetMeeting, the Microsoft Internet Locator Service (ILS), and the Databeam neT120 data conference server. When users start NetMeeting, their names and addresses are registered with the ILS, which acts as a dynamic directory enabling calls to everyone who is currently running NetMeeting. The neT120 conference server acts as a meeting place. Users can schedule meetings at specific times and reserve the necessary space, much like reserving seats in a virtual conference room. From the point of view of end users, NetMeeting is their desktop application and they may not know about the other infrastructure components.

The following are some scenarios of how data conferencing supports virtual collocation. A team leader schedules a meeting in a conference room and a power point presentation is projected on the wall. Others join the meeting from multiple different geographic locations while sitting at their desktops. They view the presentation on their workstation monitor, and speak to others using audio conferencing. Another common scenario is that ten individuals from company sites around the country, who are members of a task force, all sit at their desktops and collaboratively view and edit a document that they are preparing.

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