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ANALYTICAL APPROACHES

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Interaction spaces in computer-mediated communication

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Abstract In this paper we describe the development of the Interaction Space Theory developed as part of the SANE project.[1] The EU funded project provided an inter-disciplinary context for the study of interactions in the hybrid workplace where physical work environment is enhanced with information and communication technologies (ICT) which enable collaboration with remote partners. We explain how the theoretical approach, empirical work and methodological strategy employed by SANE researchers contribute toward the social intelligence design approach through the development of the methodology for identification of workplace requirements for mobile knowledge workers. In addition, we demonstrate how empirical findings, based upon our theoretical approach, can lead to development of novel methods and techniques for evaluating the impact of new and emerging technologies in the workplace.

Keywords Computer-mediated communication · Remote interaction · Hybrid workplace · Empirical studies · Mobile work

1 Introduction

The main aims of the SANE project were to develop and validate a unified framework for the design of sustainable workplaces to support mobile knowledge workers who need to maintain contact with their homes and offices while travelling or working from remote locations. In the past, workplace design was location centric since much of the effort was concentrated on providing office space. However, as the number of mobile workers steadily increases, there is a need for designing location independent workplaces such

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[1]EU framework 5 IST project sustainable accommodation for the new economy,IST 2000-25-257

as airport lounges, cafés and other places used by mobile workers outside their usual offices.

One of the key challenges for workplace design is to facilitate communication and collaboration between mobile workers and their office base by ensuring compatibility between fixed and mobile, local and remote work areas. To achieve this aim, designers must implement location independent computing and ubiquitous networking as an integral part of the physical workplace. The traditional approach, focused on physical features of the workplace, has to be extended to incorporate technology-mediated settings which make it possible for people to communicate even when they are not together in the same place. In other words, to meet the requirements of today's mobile workers, workplace design must concentrate on hybrid (physical and mediated) work environments.

The main research questions in this context include: what a knowledge worker needs to do his or her work, and how we can design a workplace to meet those needs. Particular emphasis in the empirical study was given to the requirements of mobile workers and how these requirements may be met in technology-mediated settings.

In this paper we argue that an understanding of communication in a range of settings available in a hybrid workplace makes a significant contribution to answering these questions. We consider that social and organisational factors not only shape how users interact with computers (Grudin 1990) in physical collocated surroundings but also how they collaborate with other users in interactive environments that are technologically mediated. An understanding of how people draw upon social and organisational practices to create the boundaries (or zones) that define these new spaces of interaction will have profound implications for workplace design. As Crabtree (2003, p. 28) states "the social character of users is central to the re-conceptualisation of the interface".

We present a study of communication in the workplace, in multi-cultural contexts, in two organisations from two countries that provide a representative sample. We also explore the multi-disciplinary research requiring input from architects and workplace designers, experts in organisational and work ergonomic studies, engineers specialising in information and communications technologies, and social scientists studying human communication from social, cognitive and linguistic perspectives. The multi-disciplinary orientation resulted in a rich repertoire of methods and techniques which we were able to use in order to bring together people, place and process perspectives in the Interaction Space Theory for application in the design of a hybrid workplace.

At a conceptual level, communication is viewed as a synchronous process where all parties in the communicative event are present and located in the same space. In a hybrid workplace this is not necessarily the case. Therefore, to ensure compatible interaction styles for all team members in local and remote work areas, we also have to account for situations where non-collocated participants communicate in technology-mediated settings. Such settings include representations on the computer screen, from 2D diagrams to virtual and augmented reality. One of the key tasks for the design of mediated settings is to identify communicative properties of such representations so that they can function as shared artefacts.

We begin with the assumption that people jointly create an interaction space in which they work together towards achieving mutual understanding. The most important features of interaction space concern the people in it—who they are,

where they are located, what tasks and activities they are engaged in. We therefore describe interaction space as the relationship between people, location, work task and process.

To capture the complexity of these relationships, we employ a variety of empirical methods and techniques to study real-life communicative situations and, in particular, we describe the ethnographic techniques and instrumentation employed to conduct fieldwork. Our subsequent analysis draws out the key themes and trends in the data which describe the relationship between people, location and process in the real-life workplace of the partner organisations.

Finally, we reflect on this research—whilst embedded in the theoretical and empirical studies of collaboration and communication in today's workplace, it extends into the future workplace supported by new and emerging technologies. Such a workplace has to be conceptualised, visualised and designed respecting the principles of human cognition and communication. Research and design practice have to be based on the sound understanding of what we can change in our work environments and what we must preserve across physical, mediated and hybrid settings. The work on the Interaction Space Theory is a step in this direction.

2 Theoretical and methodological background

Traditionally, ethnographic studies of human behaviour have focused on discovering the tacit knowledge and shared understanding that underpins people's actions and interactions. In explicating the implicit in human behaviour, we focus on what we can observe and what our informants tell us, and on this basis, create analysts' interpretations and narratives that aim to explain why people behave the way we have observed them to behave. In other words, we attempt to describe the world of our informants through their eyes, and to some extent we become their 'voice'. To ensure maximum reliability and accuracy of our interpretations, we have developed methods and techniques for exploring alternative interpretations and ways of grounding them in the data from observations and interviews. In this respect, our research process may be described as introspective and reflexive, focused on the internal structure of the analytical framework, with clearly identified key elements and relationships between them.

However, the requirements of the SANE project to develop a unified framework of distinct perspectives, presented a challenge to extend our theories, methods and techniques in order to incorporate external features—in our case, of the workplace, the work tasks and processes as well as the available informational resources.

From the very beginning we have taken into account the multi-disciplinary influences which opened up our studies of the work environment. These influences have resulted in increased awareness of the broader work context (spatial, organisational and technological) that to some extent determine how people will behave in collaborative work activities and communicative events.

2.1 Shaping the work context

Thus, the theory of human communication in the workplace developed within the SANE project aims to incorporate organisational, spatial and technological

resources that enable and support co-operation in hybrid work environments. The initial motivation and objectives were to contribute to knowledge of how people achieve mutual understanding through interaction with one another. Since the main aim was to form the design of a sustainable workplace that supports communication in physical, mediated and hybrid environments, the study was restricted to interactions in the work context and to the resources available in the workplace that help people carry out collaborative tasks.

Our conceptual framework is based on the assumptions that, to do their work, knowledge workers need to develop and sustain communication with others and that they dynamically configure a shared work context for this purpose. The initial hypothesis was that to support natural interactions in the work context, team members together build a shared environment where they co-operate to solve their work problems. They co-ordinate their actions and focus on shared artefacts in the process of negotiating the meanings of words or images presented there (Robinson 1993). They thus create the common ground—"a sine qua non for everything we do with others"... "the sum of [the participants'] mutual, common or joint knowledge, beliefs, and suppositions" (Clark 1996, p. 92). Indeed, common ground is regarded as fundamental to all co-ordination activities and to collaboration (Clark and Brennan 1991).

In our approach we assume that the common ground is created in the interaction space that is shaped by spatial and organisational constraints as well as informational resources that determine the nature of the hybrid workplace. Within the boundaries of the interaction space, the participants can identify the objects referred to, come to understand each other's goals and purposes, co-operate, and co-ordinate their actions.

2.2 Conversations in interaction space

The study of conversations in a real-life workplace presents several challenges. First of all, in an open-plan office for example, people make use of various means for communicating. Engagement in "joint projects", whereby the action projected by the speaker is taken up by the listener, requires knowledge of a basic stock of shared information, and it is often the case that information obtained from conversations has to be integrated with information obtained from other sources, such as documents, databases and various activities in the workplace. All these elements need to be taken into account in an explanation of how people communicate in the course of performing joint work tasks. Furthermore, when the participants do not share the same physical environment, information and communication technology becomes the primary enabling factor supporting the communication and co-ordination of joint actions at a distance.

One of the implications of these observations for the theoretical framework is the need to take into account the ways in which people engaged in conversations make use of information obtained from other channels and resources. In technology-mediated conversations, ways must be found to make such information accessible to people in both local and remote work areas. Since much of this information will have to be displayed on computer screens, such requirements will have to be taken into account in the design of technology that enables and supports mediated communication in the workplace. For example, it will be necessary to design representations to show not only people and their talk, but

also the background information in the setting, along with documents, drawings and objects they use as shared artefacts to focus on and organise their talk.

The key research question is—how does access to people and information through different channels lead to shared knowledge and mutual understanding in any work environment, particularly in a hybrid one? In other words, people sharing a work environment have established a degree of mutuality, that is, they know each other, they see the same objects in their environment and they can orient themselves effectively in the same environment. However, for the purposes of interaction, they also need to establish a degree of reciprocity, that is, share responsibilities for common tasks and respond to one another appropriately in the course of conversation.

In a real-life workplace there are many different conversations taking place at the same time. Individuals may actively participate in a conversation, overhear or unobtrusively observe a conversation, or alternatively, ignore a conversation if they have more urgent tasks at hand. People work together on shared tasks, but there are often different degrees of involvement in conversations. It is often important for people sharing the same workspace to be aware of when a meeting or conversation is taking place, so that they can join in or leave at appropriate points.

Such "opportunistic" strategies are necessary to ensure effective use of individual and team effort. Consequently, the effectiveness of technology-mediated workspace may well depend on the way it supports not only the central involvement of active participants, but also the implicit communication that relies on peripheral awareness, allowing "overhearers" to determine when to join in or leave as appropriate.

As communication is an essential service for performing common work tasks, there is a wide variety of conversational modes for which a theoretical framework has to account. Interaction sometimes takes the form of face-to-face conversations in meetings, but it just as often involves "communication at-arm's-length". This is conducted by means of shared informational resources, such as documents e-mailed to interested individuals or public information spaces, such as project and bulletin boards, and, more recently, through technology-mediated channels, such as media and virtual spaces, web archives, chat logs and others.

Thus in the study of communication in hybrid work environments we need to account for different degrees of commitment and responsibility that are required of individuals, as well as identifying the appropriate conditions for changes in their involvement.

There seem to be significant differences in the nature of informational resources required by "participants" who will actively control the flow of conversation and share the contributions and responsibilities for taking up each other's actions; "overhearers" will pick up information about the conversation through observing and interpreting actions of active participants, and "trackers" will find out about it through accessing traces of participants' actions in records or other shared artefacts. In the case of overhearers and trackers in non-collocated settings, communication is possible only through the functions of communication channels provided by technology that establish informational links and boundaries of synchronous and asynchronous communication in co-located and non-co-located settings.

To help us identify key factors in the private, privileged and public spaces, we distinguish between two kinds of relationships—mutuality and reciprocity.

Mutuality is based on what a given group of people have in common. For example, in a public zone such as a restaurant, all people present share the physical space and are aware of the resources that the space provides—if it is cold, drafty, where the windows are, whether there are any free tables—and similar information that will influence their behaviour. In spite of their physical proximity, the social distance between them may be considerable, as they may not know one another, trust one another, or indeed even talk to one another.

Social proximity presupposes the relationship of reciprocity, that is, engagement in talk, work task, or any other common purpose. We define the roles of participants as those that require reciprocity, and those that involve mutuality (overhearers and trackers).

The important question for the design of hybrid environments is—how can we meet the requirements for contextual information rich enough to enable people to flexibly interact with one another in a hybrid workplace? To answer this question, we have studied communication in the real-life workplace from three main perspectives: physical space, communication space, and organisational space. The physical space provides channels and resources that facilitate interaction between people, making it possible for their actions and re-actions to become visible to all participants. The communication space enables different degrees of participation (active participation, overhearing and tracking), while the organisational space regulates roles and responsibilities in task performance.

These questions have been addressed in collaboration with architects and urban planners, as well as technology specialists who were partners in the SANE project. Key theoretical issues were addressed with reference to a spatial model that classifies workspace into three categories. ''Private'' space does not allow interruption from outsiders and is suitable for handling and exchanging confidential information. ''Privileged'' space where access is restricted to ''members only'' allows spontaneous as well as formal exchanges among them. ''Public'', open-access space is where anybody can join and contribute.[2]

Similar distinctions exist in categorization of communication zones, each with appropriate norms for acceptable behaviour and sanctions for deviations of appropriateness. For example, the private zone includes relationships involving close co-workers, and in non-work contexts, family and friends, where proper conduct is negotiated by individuals who respect each other's requirements for privacy and confidentiality. The privileged zone includes work meetings, or private dinner parties, characterised by the participation of selected members of the relevant community and where misconduct would be regulated by the norms and beliefs of the community. Many communities-of-practice belong to this zone. Finally, the public zone includes activities such as performing individual work tasks in an open-plan office or in a non-work context such as shopping or walking in the street, characterised by impersonal contact, where misconduct can be sanctioned by recourse to organizational rules, societal laws and ethics.[3] We have expectations of appropriate behaviour in each zone.

[2]The spatial model has been developed by DEGW, a partner in the SANE project.

[3]In non-work contexts we also recognise the intimate zone which includes relationships between lovers and close friends, where a greater degree of openness and trust is expected than in other zones.

Furthermore, we note that the private, privileged and public interaction spaces often interlock. For example, two lovers sitting on a bench in a park are simultaneously in their own private world where reciprocity is required, but at the same time they are expected to follow the rules of appropriate behaviour in a public space, that is, they are connected to other visitors of the park in the relationship of mutuality. A meeting in an open-plan office is likewise an interlocking space, as there is a group of people interacting with one another in a reciprocal sense, while the others in the office share the mutuality of the situation without necessarily having to reciprocate to the actions of the group in the meeting.

Our approach thus implies human ability to identify the nature and type of the spatial and communication zone, adopt appropriate behaviour in regard to access, privacy and boundary controls, and to decide when and how people may effectively cross the boundaries of a particular zone to enter another. In order to behave appropriately in these settings, people adopt appropriate roles and responsibilities which govern their actions, both individual and joint. As discussed above, we have extended the conversational roles to include active participants, overhearers and trackers, and have extended our analysis of roles to cover also the broader work-related roles and responsibilities that individuals assume in joint work activities. With these considerations in mind, we have developed a methodology to examine how conversational roles (relevant to degrees of involvement in particular communicative events) are integrated with the work or task roles that govern appropriate behaviour in different types of work space.

Thus the initial theoretical framework for analysing interactions in the three kinds of space used the distinctions between private, privileged and public as the starting point for describing key contextual features of the workplace. Special attention was given to the requirements for privacy of people, confidentiality of information, as well as presence and sharing in the work context. The fieldwork focused on describing communicative activities in these spaces in order to capture the dimensions of the work context that characterise the 'interaction spaces'.

The methodology relies on observable actions, changes in shared artefacts and the communicative effect of these ''implicit communications'' on active participants, overhearers and trackers (Rosenberg 2001).

To capture a broader range of communication phenomena than those covered by more established theoretical approaches, our work within Interaction Space Theory aims to describe distance between people in an interaction space, where distance is not only physical, but also organizational and social. The aim was to take into account those key themes and issues raised by informants in the empirical data that related to location independent computing and ubiquitous networking on the one hand, and organizational identity and creation of communities of practice, on the other.

In this way we expect to improve our understanding of the regularities and uniformities in joint activities of knowledge workers in the three type of workspace. Furthermore, based on this understanding we expect to inform workplace design by identifying the key features of human environment that must be preserved in mediated and hybrid work spaces.

3 Empirical methods

Guided by the interaction space approach, our empirical study is focused on communication and collaboration in a real-life workplace, taking into account the extra-linguistic context that includes shared resources and background information. Shared resource space and objects are available in the immediate conversational context. Background information concerns collaborative activities, tasks and organisational structures that shape interaction. These contextual features influence the description of the key characteristics of the workplace in terms of its capability to provide key services and facilities that enable people to work together effectively and productively.

To illustrate our approach, in Fig. 1 we discriminate between the zones by identifying the (same or different) places people occupy in relation to the (same or different) processes in which they need to engage. In addition, as well as situating participants relative to their activities, our matrix can be employed to display a further distinction between the zones by mapping the interlocking spaces, i.e. the spatial continuums of interaction and visibility against the communicative scales of mutuality and reciprocity.

In Fig. 2, we can see how participants who seek greater or lesser connectivity by crossing (apparently) seamlessly from one zone to another must first negotiate these interlocking spaces where the spatial and communicative boundaries between each zone determine the effectiveness of interaction.

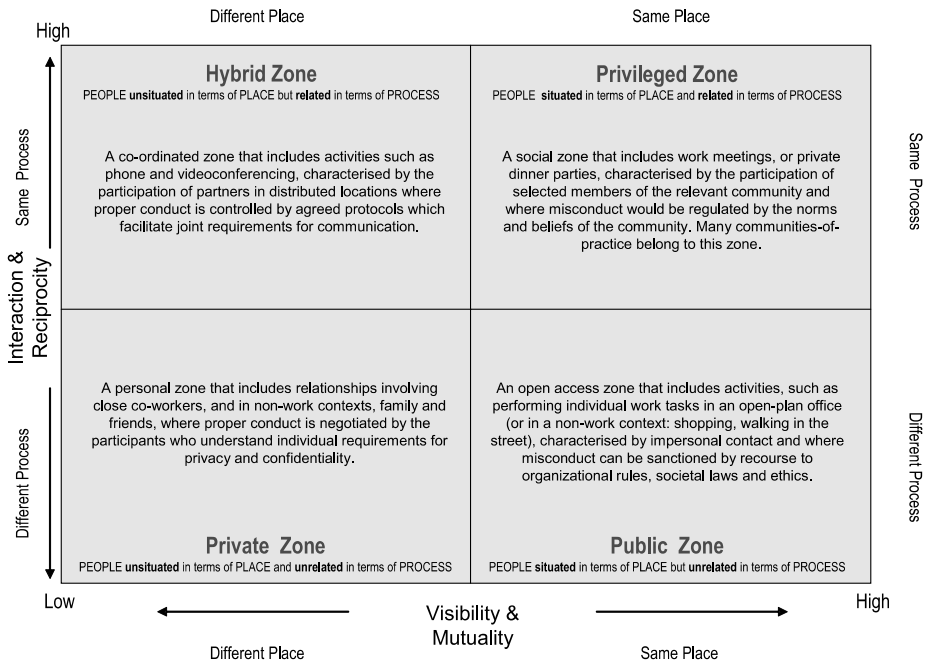

Fig. 1 Interaction zones

Spatial		Zones	Communicative	
- Visible	- Interactive	PRIVATE	- Mutual	- Reciprocal
+ Visible	+ Interactive	PRIVILEGED	+ Mutual	+ Reciprocal
- Visible	+ Interactive	HYBRID	- Mutual	+ Reciprocal
+ Visible	- Interactive	PUBLIC	+ Mutual	- Reciprocal

Fig. 2 Interlocking spaces

For example, if a participant (e.g. a CEO) were to consider crossing through the interlocking space between a private (e.g. her office) and a privileged zone (e.g. a team meeting room) she might need to evaluate the spatial and communicative constraints. In other words, before deciding to interact with a select community of others (e.g. team meeting of project director and project managers) in a highly visible physical environment (e.g. by interrupting the team meeting) she would need to be aware of the mutual social norms associated with crossing into that particular interaction zone (e.g. knocking on the door before entering the meeting room). Also, she would need to consider whether those she needed to speak to could reciprocate in that environment (e.g. she may need the project director to provide her with an update on a confidential personnel matter relating to one of the project managers present at the meeting). Clearly, in such an event, the social boundaries (sensitivity of subject matter) constraining the degree of connectivity required between the participants would appear to prohibit any direct incursion into the privileged interaction space of the meeting from the private zone of her office. The CEO may prefer to coordinate a separate meeting with the project director by crossing into the hybrid zone and electronically scheduling an appointment in a private or privileged zone later in the day.

In applying the above theoretical constructs to interpretative analysis of our empirical data, our approach was to identify a data sample within which we could analyse the interaction of knowledge workers in physical and technology-enabled spaces. To this end we focused on individuals who we considered to be at the vanguard of change, in other words, knowledge workers who are most likely to be working in the office of the future. Our data sample was drawn therefore from individuals within teams of knowledge workers in two partner organisations within the SANE project.

We approached the empirical study with the hypotheses that the concepts of private, privileged and public space can be articulated in terms of these contextual features, and that different configurations of these features will

distinguish the three types of space from one another. As demonstrated, the study of interaction in physical spaces focused on the ways people control their boundaries, that is, how they regulate access and preserve privacy. It also focused on the presence of other people in their private zones and on the varying degrees of sharing, trust, and other aspects of social relationships.

In the interaction space approach, the investigation focused on the distance between people from three key perspectives—shared space, shared communicative purpose, and shared work tasks. The methods include the analysis of interaction data (observation notes and interview transcripts in validation cycle 1 and feedback interviews in validation cycle 2) to understand the role of space, work, people and technology in providing context reference. Special focus was on identifying key communicative properties of space, how work, people and technology influence the context of communication, and on determining what informational resources or shared artefacts exist in a particular context.

Researchers followed an ethnographic approach to the collection and analysis of the data which involved an examination of the interview text and its context, in other words, what the informant says explicitly, and what he or she means. It also considered discourse and values, i.e. how the informant engaged with others and why they do what we observed them to be doing.

The main advantage of using an ethnographically informed approach to the study of communication in real settings is that it offers a range of methods and techniques to describe what people say and do in particular situations. These methods are especially suitable for bringing to light the implicit constraints that underpin their talk and behaviour. The constraints can be related to their knowledge of the language and the way it is used, the subject matter of a particular conversation, the social norms, and patterns of behaviour. In sum, these constraints are about ''what members of a community need to know in order to behave appropriately in culturally significant settings'' (Saville-Troike 1972). Within the SANE project, we used these methods to bring to light the implicit constraints and preferences that underpin and drive the work context. In addition, our aim was to illustrate how these constraints led to variations in the work context, which ultimately influenced how knowledge workers form and maintain collaborative networks.

Ultimately, using this approach we expected informants (experienced project directors, managers and consultants) to identify the most efficient work mode given the current constraints and preferences of a specified work context, as well as the favoured work mode given alternatives to those restrictions. 'Being There' is an approach in cultural anthropology that emphasizes the importance of seeing the world from the informant's point of view. This was the guiding principle of the first phase of empirical research—to identify what 'they' consider to be important in the work environment.

To ensure our research design was consistent with our theoretical approach, we further assumed that the roles and responsibilities knowledge workers adopt in the course of their work might influence how they organise their workspace, how they define their work tasks, how they use resources including technology at work and how they interact with colleagues at work. From this assumption we were able to distinguish how workspace, work tasks, technology and people interact as key elements of the work context. We acknowledge that the key features of the work context are also constrained and/or defined by conflicting

influences such as organisational culture, power relationships, timescales and other workplace features. Furthermore, these constraints are what lead to variation in the work context.

The key theoretical stance we adopted in analyzing the data was that communication and collaboration is best viewed as the interaction between individual and joint actions people take in the context of their work activities and that action, interaction and context can best be explored through a uniform concept of a shared interaction space.

Informant responses helped to clarify (1) the extent to which space, people, work and technology, are interrelated, (2) the extent to which the interrelationships between space, people, work and technology, influence communicative activity either directly or indirectly, and (3) the extent to which the interrelated settings of space, people, work and technology can be configured so that they improve communication.

In this example, David (project director) relates how he wishes to hold a meeting with his team of designers in a social environment (privileged zone). However, the client has also expressed a wish to be involved at all stages in the design process.

> They have their own full-time team there, about 20–30 people, so they sit with us; and I suppose they like to know people are there and to interact with. It can be quite challenging at times to have the client sitting so close to you, because we had an incident last week, where a few designers had a heated argument around the table, the client is sitting there watching them, and afterwards she said isn't this is a terrible thing? But we said, well, this is what the designers do and if they don't have arguments, they are not doing the job, basically. You know...*one person got up and kicked the chair, walked away and...* that is what the designers do, they have arguments during the projects, that is healthy and normal, but it can be quite oppressive if the client is sitting there watching you do it.

It is apparent that David intended to meet with his designers in a privileged zone but the presence of the client created an interlocking space to a participant in a less reciprocal public overhearing zone characterised by impersonal contact and where misconduct would normally be mutually sanctioned by recourse to an organisation's disciplinary codes. Perhaps in the future, given his team of designers' propensity for heated discussion (social misconduct) at such meetings, David might feel it inappropriate for the client to be present or to be given such visibility through this interlocking space between the public and the privileged zones. Clearly, unless David makes appropriate adjustments to the interaction context, the client may continue to feel uncomfortable and alarmed at the way in which the designers appear to flout accepted conventions and protocols of professional discourse. David may therefore decide to hold separate meetings with his designers in a privileged zone and to collaborate with the client by sending her the minutes of the meeting by e-mail from a more interactive but less visible coordinating (hybrid) zone.

The above example corresponds to the general findings of the study wherein informants concurred on the need for knowledge workers to be able to control their boundaries, that is, to regulate access and preserve privacy. Moreover they

expressed a need to accommodate the presence of other people in their private, privileged, hybrid and public zones and to assess the requisite varying degrees of sharing, trust, and other aspects of social relationships. On a broader level, the findings from our empirical studies have helped us to evaluate the continuing impact of new and emerging technologies in the workplace. Moreover, they also provide key areas of enquiry for future research into Interacation Space Theory and how the construction of new interaction spaces in the hybrid workplace might enable enhanced collaboration with remote partners.

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