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Work, Locales and Distributed Social Worlds

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Efforts to build systems to support the complex social reality of cooperative work need both a *grounding* in the social i.e., a rich abstract basis for understanding work, and a *bridging link* between the social and the technical to provide new insights into how to approach designing systems based on this understanding. We propose Anselm Strauss' (1993) Theory of Action as a candidate from which to evolve a framework to ground an understanding of work. Insights from Strauss' work on the importance of structural conditions for social world (cooperative ensemble) interactions can help us to view support systems in a new role as setting/locale for cooperative work interaction, thus providing a bridge between the social and the technical We briefly overview a locales-based environment called WORLDS we are building concurrent with our theoretical exploration

Introduction

The Computer Supported Cooperative Work (CSCW) community has two predominant strands of research: the *social*, i.e., the study of how people work in cooperative arrangements, and the *technical*, i.e., the study/practice of building systems to support this work. In order to build systems that are grounded in the real world, systems developers look to the *social* for abstractions which capture the nature of work to be supported. To date, the *social* has provided insights such as the notion of 'situated action' (Suchman, 1987) and the complex contingent nature of work,

1. The author participated in this work while visiting the Uni. of Illinois at Urbana-Champaign.

as well as many focussed studies showing the complexities of real-life workaday situations. These insights have not, however, led to CSCW systems that satisfactorily support them. CONVERSATIONBUILDER is an example of a system where the designers have explicitly cited support for the situated, contingent nature of work as an important goal, but have found achieving such support in practice to be elusive (Bogia et al, 1993).

We suggest that efforts to build systems to support the complex social reality of cooperative work need both a *grounding* in the social i.e., a rich abstract basis for understanding work, and a *bridging link* between the social and the technical to provide new insights into how to approach designing systems based on this understanding. The principled development of CSCW support environments is predicated on the existence of such a framework.

In the first section of this paper, we propose Anselm Strauss' (1993) Theory of Action as a candidate from which to evolve a framework to *ground* an understanding of work for the following reasons: (1) it already exists as a coherent, related set of abstractions - a big picture - which makes the social more accessible, and provides a background against which other concepts from CSCW can be mapped or be seen to complement; and (2) it provides analytical leverage for systems developers who do not have a social science background nor the services of a social science team member. In the second section, we propose that insights from Strauss' work on the importance of structural conditions for social world (cooperative ensemble) interactions can help us to view support systems in a new role as setting/ locale for cooperative work interaction, thus providing a *bridge* between the social and the technical. We then provide a brief overview of WORLDS, a locales-based environment we are building concurrent with our theoretical exploration.

Action, Social Worlds and CSCW

We focus on Anselm Strauss rather than other action theorists for our understanding of work, not just because he is a prominent sociologist, but because his theory of action is grounded in and abstracted from a lifetime of 'real-world' observations of how people work. Various concepts have evolved in his work, such as 'articulation work', often quoted in CSCW literature, but it is only recently that Strauss has attempted to draw out a rich coherent, related set of abstractions, concepts and assumptions about action and work as action/interaction. It is the 'groundedness' of this framework, and hence by definition its incompleteness, that we believe makes it a good candidate on which to ground systems developers' understanding of the social, and to build links between the social and the technical. We consider it a valuable exercise for our own research program to investigate as fully as possible the ways in which Strauss' theory can positively influence CSCW systems development, both to move the field forward and to identify problems that can act as springboards for further research.

We wish to stress here that Strauss is not the only candidate for this task, nor does the task demand a sociological framework. Indeed, Nardi (1995) proposes Activity Theory as a basis for studies of context in the HCI community. In a similar vein, Shapiro (1994) proposes a set of core propositions drawn from many different social science disciplines which he considers to be relevant to systems design. Other related work is discussed below. Our work based on Strauss' theory should be seen as complementary to these alternatives.

Strauss argues that the operative criterion by which his theory should be judged is not truth but usefulness. We take up Strauss' invitation to explore the usefulness of his theory in relation to the actions/interactions of cooperative work ensembles, and for the purpose of informing CSCW systems development.

Strauss' Theory of Action/Interaction

While acknowledging that it is impossible to do justice to a lifetime of research and theory evolution in a few short lines, we attempt here to summarize Strauss' (1993) main assumptions and concepts. There are two aspects of Strauss' work that we wish to emphasize: first is the foundational notion of *actions/interactions*; and second is the related notion of *social worlds*, which we argue is central to the understanding of actions within many cooperative work ensembles.

Actions and **interactions** (which are actions towards others) are pivotal concepts. Actions are always embedded in interactions and in systems of meaning - past, present and imagined future. Actions and interactions are carried out by one or more *interactants*. An interactant can be an individual, an aggregation of individuals or a collective, bringing a particular identity, biography and perspective to an interaction. Interactants are able to shape and manage the interactional course and systems of meaning by their actions.

Actions take place within the context of both direct and indirect *structural conditions* which are able to change with time and/or in response to contingencies, and which may either facilitate or hinder the interactional course. Thus, structural conditions and actions/interactions mutually shape and evolve one another. Ultimately, actions and interactions are directed at shaping various *orders* - spatial, temporal, work, technological, informational, sentimental and moral.

Actions also have *temporal* dimensions, filled with "contingencies, changes of projections and plans, even ... goals" (p. 32). Courses of interaction can be characterized along a broad spectrum of dimensions, e.g., from being relatively routine to relatively changeable and problematic. Even for routine interactions, it is likely that *contingencies* will arise which "can bring about change in ... [an interactional course's] duration, pace and even intent, which may alter the structure and process of interaction" (p. 36).

Courses of interaction may be decomposed into *sequences* of connected actions. When there are several participants in an interactional course, *articulation* or alignment of their respective actions (and/or perspectives, interpretations of shared

goals, definition of interactional courses etc.) is required.

Trajectory is Strauss' central concept for exploring work as interaction, embodying all of the assumptions of a theory of action. A trajectory is both the course of action as it evolves over time and the actions and interactions contributing to its evolution. Important subconcepts associated with trajectory include trajectory phasing, projection, scheme, arc of action and management.

The evolution of interactional courses and trajectories is shaped and carried out by interactants via two forms of processes: *interactional processes* or strategies such as negotiation and manipulation; and *action or work processes* such as division of labor, supervision, and the actual performance of tasks.

Thus, the two main ways in which Strauss explores and understands actions and interactions are via structure and process, i.e., structurally in terms of the conditions which influence and are influenced by actions, and processually in terms of the response to changes in those conditions over time (Corbin, 1991). This dualism exists at a theoretical level only, structure and process being united in the moment of action (Soeffner, 1991).

The second main notion of Strauss' theory we wish to emphasize is **social worlds**, "the fundamental building block(s) of collective action" (Clarke, 1991, p. 131). A social world is an interactive unit that arises when a number of individuals strive to act in some collective way, often requiring the coordination of separate perspectives and the sharing of resources. It has "at least one primary *activity* (along with related activities), ... *sites* where activities occur ... [and] *technology* (inherited or innovative means of carrying out the social world's activities)" (Strauss, 1978; cited in Clarke, 1991, p. 131).

Membership of a social world is constrained by the limits of effective communication rather than by geography or formal structure (Clarke, 1991). Social worlds may be well defined, e.g., an organizational hierarchy, or they may be loosely defined, e.g., the community of World Wide Web users or the participants at a conference workshop. They may be short or long lived, depending on the purpose for which they have come together. Their shared goal may not necessarily be well developed and completely knowable. They may be composed of sub-worlds, which may in turn contain sub-worlds and so on. People may be involved in many social worlds simultaneously, this membership having a significant bearing on their perspectives and thus their interactions.

The work undertaken by the members of a social world can be characterized using the action/interaction concepts and assumptions outlined previously.

Cooperative Work and Social Worlds Interactions

We suggest that Strauss' theory of action gives us a framework to describe cooperative work ensembles as social worlds that have been formed (to whatever degree of formality) to meet some shared objective (however that may be defined or agreed upon) via a commitment to collective action (however that course of action

proceeds), and whose members can be co-located or distributed, to the extent that effective communication can be facilitated[2].

Further, we view cooperative work as taking place in the context of particular structural conditions and contingencies (c.f. the notion of situated action in (Suchman, 1987)), by interactants with particular selves and perspectives, in such a way that conditions, interactants and courses of action mutually shape and evolve one another. The evolution of cooperative work involves both action and interactional processes, not only to perform actions, but to manage the interdependencies entailed in collective action, and negotiate common perspectives of the shared commitment and ongoing interactional course in response to contingencies and changes in conditions (c.f. the notion of double-level nature of work (Robinson, 1993a)).

In one sense, many aspects of Strauss' work seem familiar to us because we have seen or heard similar things before and/or we have already come across references to concepts of his, such as articulation work, e.g., in Bannon and Schmidt (1991). However, while many of the individual concepts may not be new, what is new is their positioning within a broad coherent framework of principles and concepts pertaining to action and interaction which can be related to a host of different phenomena from the most macroscopic to the most microscopic.

This highlights one of the basic problems with the theoretical work in the CSCW community to date, especially for systems developers who struggle to produce actual systems - there has been no framework against which to make sense of and work with the various concepts, approaches and experiences reported in CSCW literature. While each of the insights provided might be 'true' for the phenomenon they describe, they tend to be 'true' in the small or in isolation. Ethnographic[3] studies, describe very specific work situations at particular points of time, e.g., Heath and Luff (1992). Studies of systems in use relate to a particular instance of use of a specific system, e.g., Orlikowski (1992). Conceptual papers, while convincingly argued, offer important but isolated concepts, e.g., Robinson (1993a). While each is valuable and indeed necessary if work in CSCW is to make a difference, they are like pieces of a puzzle, without a broader context in which to position them. We believe that Strauss' work is worth exploring as a possible foundation from which a CSCW-specific framework linking action and systems can be evolved, drawing on the synergy between Strauss and the work of the CSCW community.

It could be argued that Strauss' work offers little more than what could be gained from modest inductive generalizations over a growing corpus of ethnographic studies in CSCW. This corpus, as advocated by Hughes et al (1994),

2. This coincides with Bannon and Schmidt's (1991) definition of cooperative work as being "the general and neutral designation of multiple persons working together to produce a product or service It does not imply specific forms of interaction or organization ..." (p. 7)

3 We use the term 'ethnographic' very loosely here to denote observational studies of work in situ independent of the particular methodology or theoretical framework employed.

should play an important role in informing an understanding of work and 'good practice' in the design of CSCW systems. However, generalizations to date have been slow in coming. Implications for systems development have similarly been reticent (Shapiro, 1994). Since Strauss' theory of action itself has been inducted from many studies, we believe it can help frame and complement this growing corpus of work. It will not take the place of such a corpus. Rather, by definition being incomplete and inadequate, it will be challenged, reinforced and evolved by a growing body of knowledge about work in the particular. We believe that each ethnographic study can be viewed as an in-depth exploration of the interactions of social worlds and the continual permutations of action, from which new and relevant concepts may be uncovered.

The role of artifacts in work, particularly computer artifacts, is one area where Strauss' framework can be complemented and evolved by current CSCW work. Schmidt and Simone (1995) take Strauss' concept of articulation work and explore the role of protocols embodied in (computational) artifacts as mechanisms of interaction to reduce the complexity and overhead that articulation entails. Robinson's (1993b) common artifacts can be interpreted as part of the structural conditions for work, as well as part of the mechanisms to mediate interaction and effective communication among members of social worlds. What Strauss' theory offers in return is a rich understanding of the interactional contexts in which these artifacts will be used. There are other theoretical frameworks that can also offer particular perspectives on artifacts in work. Distributed cognition (Hutchins, 1995) focuses on work at a system level where the system is a collection of interacting individuals and artifacts in the propagation of knowledge. Actor-network theory, e.g., see Law and Callon, 1988, explores the role of actants, human or non-human, in an interactional network without making *a priori* distinctions between what is social and technical.

Strauss' framework can also provide analytical leverage. For example, the problems of rigidity and inflexibility associated with systems such as THE COORDINATOR (reported in Robinson, 1993a), DOMINO (Kreifelts et al, 1991), CONVERSATIONBUILDER (Bogia et al, 1993), and PSS (Wastell and White, 1993) can be analyzed using the trajectory concept. With all of these systems, there is an implicit assumption that work could be predicted and prescribed *a priori* via a *trajectory projection* (vision of the expected course) and *scheme* (plan based on the vision). Change and evolution are interpreted as isolated or unwanted events, or as happening in a controlled manner that can be dealt with *post hoc* by the process engineer. Such rationalizations of work render invisible the work that is performed in *trajectory management* (carrying out the scheme, with a re-casting of the trajectory projection and scheme as required) in light of the actual *arc of action* (the cumulative actions and conditions arising from previous interactions and contingencies (Star, 1991)). Not only does this framework help identify what went wrong, it also points to possible solutions by highlighting 'new' areas that need to be accounted for in future support systems. Trajectory projections and schemes, such as workflow representations, are a necessary, but not sufficient condition for

the support of work. Facilities for trajectory management are required to support the evolution of projections and schemes.

Perhaps closest to Strauss' theory of action in the CSCW domain is activity theory e.g., see Kuuti, 1992. This theory has a much longer history of adaptation for use in the CSCW/HCI fields than Strauss' work. One strength is its emphasis on the change, unpredictability and continuous development of activity. The fundamental unit of analysis here is an activity, similar to Strauss' interactional phase, which exists in a material context, similar to Strauss' structural conditions, and transforms that context. Activity components include a distinguished object, an active actor (individual or collective) who understands the activity, and a community who share the same object (similar to Strauss' social worlds concept). The relations between activity components are always mediated by artifacts such as tools, rules, and division of labor. An activity is realized through purposeful actions and subconscious operations by participants, resulting in a transformation of the object.

However, while the vertical decomposition of an activity is well defined, the processes by which a community of actors articulate actions and operations in context, and develop (evolve) them in the face of contingencies are not well defined. This is because, despite more recently added notions of community and division of labor, activity theory primarily gives an individualistic perspective on work[4]. We believe that Strauss' action theory has advantages in its understanding of the interactional and processual aspects of work where more than one person is involved, and in its interpretation of the permutability of activity and the interplay of activity, actor and environment.

There are numerous other theoretical frameworks that we could explore in relation to Strauss' theory, e.g., distributed cognition, language-action perspective, actor-network theory, etc. While some have been touched upon, space does not permit a full exploration. Suffice it to say that each has its own particular strengths, weaknesses, emphases and uses; and can offer particular insights into the link between the social and the technical. A CSCW-specific framework can be evolved from Strauss' work by drawing on the complementary strengths of these many approaches.

The reader must always bear in mind that Strauss' theory is a starting point only, not a fixed point. The theory itself will undergo continual permutation as it becomes part of the structural conditions of the CSCW social world, to both shape and be shaped by the interactions in and with that world. Also, concepts such as actions, interaction, processes, trajectories, structural conditions, social worlds etc., exist as entities only in the analytical world of the researcher. They are tools to aid the uncovering and understanding of the nature of work. In the real world of the interactant, no such distinctions exist. Work is carried out in semantically rich and continually evolving social contexts, with complex interdependencies and conse-

4. We are grateful to Jesper Doepping for highlighting this notion.

quences of actions. Interactants move fluidly and unselfconsciously around the spectrum of different types of work: individual - group; structured - unstructured: routine - problematic and so on; and among different activities and social worlds. When designing computer-based support, we must respect these realities.

Bridging the Social and the Technical

At one level, Strauss' theory reinforces the need for CSCW systems to support the seamlessness of work, the continual evolution of work in response to local contingencies, and the social processes involved. Moreover, it provides us with a rich theoretical framework in which to understand these. However, we are still left with the question of how to actually go about designing systems to do this. In Straussian terms, many past efforts have focussed on the processual elements of work, usually either action (work) processes with *post hoc* attempts to add support for the above factors, or interactional process such as negotiation support. In these approaches, the computer can be seen primarily as a tool to enforce *a priori* conceptions of work, or as a mediating artifact, where interactions take place through, but in some sense external to, the artifact.

We propose that Strauss' emphasis on the structural conditions of work, as well as his notion of social worlds, gives us a way to view the computer in a different primary role - as *setting* for social world interactions. More specifically, we draw on the assumptions that: (1) interactions take place in some structural context, the conditions there shaping the possibilities for interactions; (2) many cooperative work ensembles can be viewed as social worlds whose activities require site and means; (3) site and means are part of the structural conditions for work; and (4) structural conditions, constituting the more stable, persistent elements of situations, are far more amenable to instantiation in a computer-based system than representations of continually permuting actions (noting, of course, that structure still changes, but at a slower rate, as it shapes and is shaped by interactions).[5]

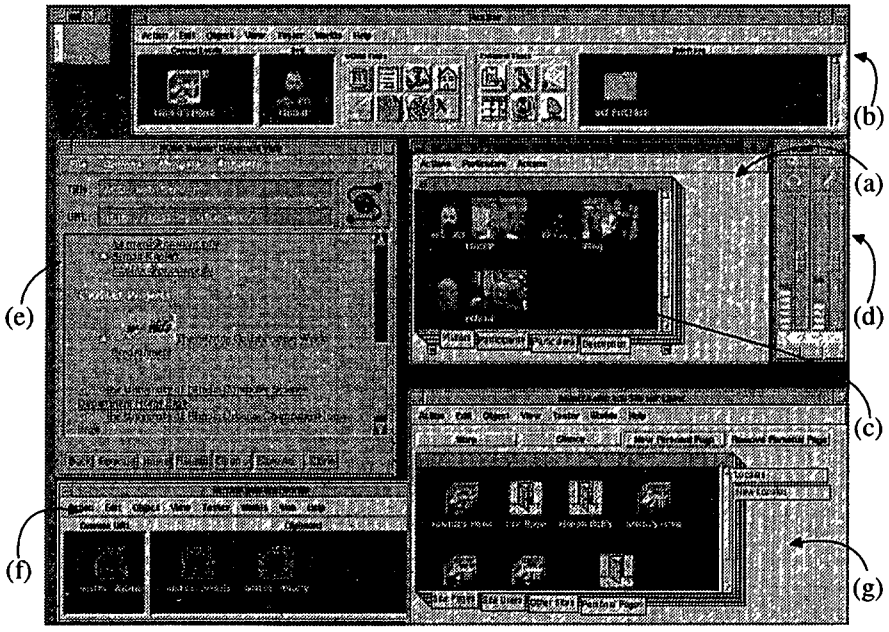
We view the role of the system as providing setting rather than structure because structural context for actions embodies far more than can be meaningfully or usefully captured in a computer, e.g., power relationships, moral codes, social norms, personal biography and so on. Hence, the computer system, as setting for interaction, is a configurable subset of conditions for action, e.g., roles, resources, tools, artifacts, action possibilities, etc. The computer can now play out multiple other roles as well, e.g., as tool or mediating artifact, part of the means available to social world interactions, but does so in relationship to the setting and the other conditions found there.

5 We note here that Strauss is not the only route by which one could have arrived at this view of computer as 'setting for interaction' Many other approaches emphasize the importance of context in work. Indeed, we have previously explored spatial metaphors for the support of work However, the work of Strauss, for us, brought these notions into the sharpest focus.

Appropriate computer-based locales can provide rich settings to enable and augment social world interactions[8]. This is not to mean that the computer 'understands' these settings in any way; rather, our view is that by providing access to shared workspaces populated by appropriate artifacts and tools, with facilities for manipulation and means for synchronous and asynchronous communication, members of social worlds can interact with and through the setting to build and evolve their own work contexts.

WORLDS Locales

To facilitate an integrated work environment and seamless transition among different work settings, we provide each person with a home locale, as well as create locales that are more generally used by larger social world ensembles. We propose that a locale can be characterized by four components. In the following discussion of these components, we make reference primarily to the *locale pane* notebook widget in the WORLDS screen (see Figure 1(a)).



(a) Locale Pane (c) NV (e) Mosaic (g) Site Navigator
(b) Tool Bar (d) VAT (f) Web Tool

Figure 1. Screen-shot of example locale in WORLDS

8. Wagner (1994) uses Gidden's concept of locale within an actor-network framework to analyze how computer networks create new regionalized space-time-geographies in which people interact. She uses locale in the sense of the new ways people can be connected together

The first component is the *primary work activity/activities* for which the setting is created or for which it is being used, as outlined in the description page of the locale pane. This work activity description is relative to the possible actions facilitated by the collection of conditions/resources in the locale rather than to the shared objective of any particular social world. Hence, it shapes rather than enforces how the setting will be used. For example, a locale set up for office work would be difficult to use for a game of tennis, though people are quite free to use the locale as they please.

The second component is the *particulars* of the setting, drawn from those aspects of the structural conditions of work that are more amenable to computer-based representation. Hence, we refer specifically to the family of artifacts, tools, resources, and possible actions that shape and populate the landscape of a computer-based locale. Meanings associated with the particulars are embedded in a web of interactions, and in interdependencies which evolve with use.

The particulars page of the locale pane holds the family of shared objects relevant to that locale, e.g., applets, which are small application objects (such as an issue-based discussion manager, a shared document annotator or a bug report); integrated external tools (such as word processors, calendars, or spreadsheets); and external objects (such as files, URLs, or database objects).

The third component is the *people* who will participate in, and interact with, the setting. Here we do not mean to specify all the individuals by name, but we do differentiate between potential participants defined by role and actual visitors present in a locale at a particular time. In the following, we clarify this distinction.

A locale has a set of *roles* that are defined in relation to the social world's negotiated division of labor for the primary activity. *Participants* in a locale are people, usually from the same social world, who have been assigned one or more of these roles. Their iconic representations are found on the participants page of the locale pane. When participants are actually present in a locale at a particular time, their video image is displayed in the visitors page of the locale pane. *Visitors* are all the people who are actually present in an locale at the current moment. Visitors are not necessarily participants. For example, a bridge game locale may have five visitors: the four participants who are playing the game, and a novice player who does not have an active role to play but is watching how the others are playing the game so that she can learn from them.

Rich communication channels are provided to support synchronous and asynchronous communication within and across social worlds. Each locale in WORLDS supports an video/audio conference (provided by standard conferencing tools such as NV and VAT, see Figure 1(c) and (d)) to which visitors are automatically added and removed as they enter and leave the locale, respectively. Audio and video channels enable visitors to be aware of each others presence and to support the interpersonal communication processes involved in work. For asynchronous communication, e.g., between participants who are not co-present, support is provided via channels such as email, post-it notes and an 'answering machine' facility.

The fourth component is *process*, the co-evolution of setting and action over time. Here we start to draw on the notion of trajectories (where trajectory schemes may be part of the resources for action available in the setting), and on the notion of the mutual shaping of action and structure. Note that process is not necessarily contained within locales but often spans multiple locales over time.

To support the definition of domain specific locales and the representation of trajectory schemes that exist within and across locales, WORLDS provides a visual/textual specification language called Introspect (Tolone et al, 1995). Cognizant of contingencies, change and the continual evolution of work, and of the way interactions can shape and evolve settings, Introspect employs a meta-level architecture. This architectural design is based on the principle of reflection to enable run-time modifications to locale definitions and trajectory scheme representations. Environments tailored to support the construction and modification of these specifications are themselves locales within WORLDS. The interactional processes involved in these activities are supported by the availability of rich communication channels.

Thus, locales are uniquely defined, and continually re-defined, not only by their expected primary activity and family of tools and artifacts, but also by people and their interactions in and with the locale over time. Two meeting rooms can be established in separate locations, furnished with the same set of tools and artifacts, but the process and outcomes of meetings in those rooms, can be entirely different because of the different people and social worlds, and different use of the setting.

Additional Aspects of the WORLDS Environment

In addition to the locale pane outlined above, the representation of a locale to users is also minimally characterized by a tool bar. The *tool bar*, see Figure 1(b), has four main components: the *current locale* pane which contains an iconic representation of the user's current locale, copies of which may be created (e.g., via drag-n-drop) and passed around as references to the locale; the *self pane* which contains an iconic representation of the user, copies of which may also be created and passed around; a collection of *tool icons* which provide users with some standard set of tools and actions, e.g., this prototype includes an XEmacs editor, an issue-based discussion applet, a 'warp to home locale' button, a mailer, a network news reader, a Web Tool which opens a web conference using Mosaic 2.5b3 (see Figure 1(e) and (f)), and a navigation tool; and a *drop area* called a briefcase which can accommodate any object you want to carry around from locale to locale.

Unlike a locale pane, the tool bar is unique to a particular user, who can extensively tailor both the bar, and the binding of buttons to tools and applets. Since social worlds are made up of individuals with particular identities, preferences etc., it is important to support flexibility at the individual as well as the social world level.

As stated previously, each user has a home locale. However, a working WORLDS environment may contain any arbitrary number of locales. Movement among locales is facilitated by *warp* and *glance* mechanisms and a *navigator* facility.

People first enter WORLDS by warping into their home locales. Warping is the most primitive way within WORLDS of moving from one locale to another. It is similar to walking straight into a room. Glancing is a more polite way of entering a locale where a person can glance a locale to see who is currently present, at which time a temporary audio/video connection is established between the glancer and those present. Those people present can then warp the glancer into the locale if they so desire. Our glancing model is similar to the work of Tang et al (1994).

As people can be members of multiple social worlds simultaneously, and can be engaged in multiple concurrent activities, WORLDS provides a *Navigator* to promote awareness of and access to other locales and users. We define the WORLDS universe as being partitioned into collections of locales called sites. Sites can be defined logically, e.g., all the locales on a particular server, or semantically, e.g., all the locales related to WORLDS code development. The Navigator, see Figure 1(g), has four components: *site pages*, one page per site, containing icons of all the locales registered at that site, from which users can warp or glance other locales; *site users* containing iconic representations of all the users who are registered at the site being navigated, plus a 'call' feature to allow users to establish audio/video conferences with other users independent of locale; icons representing *other sites* in the WORLDS universe; and *personal pages*, a 'hot-list' of locales of interest for that user.

The Navigator is not the only means of navigation within WORLDS. We support a variety of methods by which people can access one another and other locales. Users and locales can be registered with an HTTP server, accessed from the world-wide web or referenced through MIME-compliant mail messages. We seek to provide a rich family of options without enforcing any particular one because we are aware that our computer-based setting is only part of a broader structural context of work where interaction within the system as setting will be shaped not only by technical possibilities but also by social norms etc.

Support for the collective action of social worlds also requires that users be aware, subject to access constraints, of state changes to other users, artifacts, locales, etc. For example, within a locale users must know what objects are available in the locale, how they are shared with other visitors to the locale, and what actions are being performed on them. Similarly, where trajectory schemas are in use, the actual arc of action to date, the projected schema, and the range of action possibilities need to be made visible to the user. Such awareness information, often subtle and indirect, is critical for users of WORLDS to maintain their sense of what is happening in locales, and is critical in support of the temporal and processual aspects of collective work.

As part of our research and evolution of WORLDS we are investigating several mechanisms, beyond audio and video support for informal communication, to facilitate user awareness in both asynchronous and synchronous modes of work. Examples include: tracking shared object manipulation and making these manipu-

lations visible to any user accessing the shared object; monitoring events outside WORLDS (such as manipulation of files in the filesystem) and making these events, where relevant, available within WORLDS; and icon morphing to provide visual feedback to show, for example, trajectory state.

Evaluation and Future Work

Current development on WORLDS is at a 'proof of concept' level, deploying many general tools and facilities that may potentially be useful in supporting a variety of Strauss' action and interaction processes. A formal evaluation of WORLDS is planned. In parallel with the development of WORLDS we have been conducting an ethnographic study of the work practices of a group of systems support staff responsible for the computing needs of a large computer science department, framing our study in terms of Strauss' action theory. We now plan to deploy WORLDS into this group, both as a usability study of the system and to discover how using an environment such as WORLDS can evolve the practices of the group. Additionally we anticipate that this deployment will affect the design and development trajectory of our project.

In the meantime, our development team has used WORLDS as its work environment and we have made several informal observations based on this use. Firstly, once we reached a critical mass of tool integration within the system, we experienced a usefulness that was absent when these tools were used in isolation. For example, the combination of locales with audio/video conferencing, the ability to navigate easily among locales, and the ability to manipulate shared objects (internal or external to WORLDS), where the system takes care of much of the administrative overhead of maintaining consistency in locales, resulted in an environment which allowed us to work on multiple levels simultaneously.

Other observations include how quickly people adapted to using WORLDS and how adapting to the system changed communication practices among our group after only a short period of time - although we were in the same large room comprising our laboratory often we communicated via the system rather than by others means, e.g. traveling or shouting across the room.

We also experienced the normal difficulties one would expect when deploying a system of this complexity. The main issues of current concern center on the time lags in establishing connections with people and warping between locales, and the addition of more functionality via applets, together with the urgent need for wider deployment and evaluation of the system. While our framework has held up well under initial use there is no doubt that as the WORLDS user community grows stresses will appear and evolutions of many different types will be necessary.

Ongoing plans for the continual permutation of WORLDS include addressing technical issues such as: improved warping, glancing, calling and navigation; persistence; messaging, object trading, and reliable operation over the internet, secu-

rity; integration of a larger range of external information sources; and more, improved applets. We are also exploring other issues such as: regionalization, overlapping, intersection and composition of locales; presence; and availability.

Conclusions

We realize that we are embarking on an ambitious task, yet we believe that this task is not only worthwhile but essential to the advancement of CSCW systems research if the technical is to be grounded in a good understanding of the social. We do not suggest that we have found *the* answer in using the insights from Strauss' work as our starting point for bridging the gap between the social and technical. However, we believe that there is value in continuing this pursuit as we can learn from the ways in which we both succeed and fail to meet our goals.

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