Verbal and Nonverbal communication in computer mediated settings

Duska Rosenberg, John A.A. Sillince

International Journal of Artificial Intelligence in Education (2000) 11, 299-319

Verbal and Nonverbal communication in computer mediated settings

Duska Rosenberg, and John A.A. Sillince *Management School, Royal Holloway, University of London, Egham, Surrey, TW20 0EX UK. Tel 01784 414162, Fax 01784 439854, d.rosenberg@rhbnc.ac.uk.*

Abstract. The paper discusses the verbal and nonverbal communication during a video-recorded meeting between two physically separate teams as part of a 9 month multi-site construction project. In the extract analysed here, the team which was video-recorded contained three members and the project coordinator, whereas the remote team contained a single individual. Communication between the two teams was by means of telephone and shared computer meeting system. The video-recorded team used nonverbal communication on the dimensions of mimickry, embarrassment, emphasis, recognition, commitment, agreement, understanding, promise, orientation, and humour when communicating within the team, dimensions which were of necessity absent in communication with remote partners. The video-recorded team and the remote team differed markedly along four dimensions of visibility. The given-versus-new dimension influences the team ability to respond to changing circumstances. The ideal-versus-real represents the degree to which partners focus on general or alternatively particular aspects of the communicative situation. The centre-versus-periphery refers to the degree to which communication contains meanings associated with hierarchy and authority or alternatively with pluralism and empowerment. The social-versus-task is focused on the purpose of communication which may be predominantly aimed at solving a problem or alternatively aimed at creating social cohesion and team spirit. Compared to the lengthy and communicatively rich contributions within the video-recorded team, which emphasised the given, ideal, centre, and social dimensions of communication, the communications between the two teams, that were mediated by technology, emphasised the new, real, periphery and task dimensions of communication.

INTRODUCTION

Nonverbal communication research suffers from a number of shortcomings when one considers its usefulness for the study of interaction in computer-mediated settings. Existing theories of nonverbal communication are based upon face to face (mostly dyadic) settings, and are unable to deal with organisational settings when they are a mixture of computer mediated and face to face (Argyle, 1990; Rutter, 1984). Also previous nonverbal communication research has focused on settings with one focus of attention (a task or a single conversation), whereas much work in organisations requires overhearing, monitoring, and polling other people's conversations (Patterson *et al*., 1999). Also previous nonverbal communication research has focused on mode (verbal, nonverbal), rather than communication network issues. These include considerations such as who is defined as being "in" the team and thus who is chosen to be a communication partner, what degree of inclusion they receive, and thus whether or not team members are unequal and invisible within the team as a whole. Consideration of these three issues would help to make nonverbal communication research more relevant to a technology-oriented audience and would avoid the risk of distorting and limiting communication and cooperative work. Such an approach would also focus on the availability of conversational resources which organisation members can bring to bear to influence their coworkers in a common project. Such conversational resources provide the context for verbal communication and have to be designed as integral part of information and communication technology.

BECOMING VISIBLE – USING NONVERBAL COMMUNICATION

Communication partners use nonverbal communication to increase their visibility and thus to maintain a "presence", which in many ways resembles a dramatic performance (Goffman, 1959). Some important uses of nonverbal communication are as follows.

Mimickry. This is movement in which the speaker's body moves in a sympathetic or explanatory way, usually at the beginning of a phonemic clause (Argyle, 1990: 107).

Embarrassment. Gestures and avoidance of eye contact signal embarrassment (Rutter, 1984: 54-57). Embarrassment may need to be communicated both by the powerless, unpopular, weak, etc (at imposing on the powerful, popular, strong etc) and by the powerful (at being socially distant from the powerless). Nonverbal behaviour adds information which words may not convey, such as that deception is being attempted, and partly adding dramatic force to words. Nonverbal communication is useful for judgements about attempts at deception. Deception implies a deviation from the "principle of cooperation" – that people attempt to be informative, truthful, relevant and clear when communicating (Grice, 1975). Although verbal content provides clues about deception, nonverbal communication adds greatly to such clues. People share convergent perceptions about the credibility of verbal content (Burgoon *et al*., 1996). People consider deceptive communication to be less complete, honest, clear and personalised, whereas falsifications are seen as more complete but the least truthful. Equivocations are seen as the least clear and relevant but the most personalised. Also, deceivers make more use of group references, use more modifiers (e.g. "many" rather than "all"), fewer present tense verbs, and fewer self references than nondeceivers. However, nonverbal signals reveal more: deceivers swivel their chairs and speak at a slower rate (Ebesu & Miller, 1994), and equivocators and falsifiers show a general deception profile of greater kinesic expressiveness, and shorter response latencies (Buller *et al.*, 1994; Burgoon & Buller, 1994).

Emphasis. Posture, gesture and eye contact are often used for emphasis. Eye contact, which is actually a flash of no more than 0.75 seconds is used by speakers for emphasis, or by speakers who look at listeners to get their reactions (Kendon, 1999).

Recognition. Communication is reciprocal in the sense that it is not just the sender sending a message to the receiver, but also knowing that the receiver agrees with and supports the sender's intent. Requesting and getting recognition can be communicated via the feedback provided by eye contact (Rutter, 1984: 47-52). Emotions associated with recognition depend on what is being recognised and range from guilt (at exposure) to pride (at being congratulated).

Commitment. In getting feedback about commitment, the speaker wants on occasion to get some commitment from the listener, in terms of how serious and sincere the listener is (Rutter, 1984: 60-61). Nonverbal communication is crucially different from nonverbal behaviour, because communication is reciprocal and involves the acquisition of knowledge about the effects of one's own statements and the intentions of the other person. Consider a situation where person A wants to ask a question of person B. "First, person A has to turn towards person B, and look at him or her. Person B has to respond by looking in turn at person A, and indicating that he/she recognises person A's intention to communicate. Person B has to display some sign that A's intention to communicate has been recognised as such, and has been accepted" (Forrester, 1996: 50). Commitment ranges from weak (acknowledgement that an engagement has been previously agreed) to strong (a firm promise to do something new).

Agreement. Eye contact combined with gesture serves to provide feedback on the accuracy of knowledge. Agreement may be complicity (in a joint decision), consensus (sharing a subjective view of the world), or corroboration (agreement that a fact is true). Posture is largely unconscious - agreement is usually accompanied by leaning sideways. Interactions without vision are more formal, more task-oriented, less personalised, and less spontaneous than face to face interactions. In non-vision negotiations the person with the stronger case always wins. (Argyle, 1990: 109-120). Agreement is often signaled by nonverbal behaviours associated with liking. There is a vast range of nonverbal signs of liking. These include proximity (closer or forward in seat), orientation (more direct or side by side), gaze (more and mutual gaze), facial expression (more smiles), gestures (head nods, lively movements), posture (open, arms outstretched), touch (more), and tone of voice (higher pitch, pure tone) (Argyle, 1990).

Agreement may be complicity (in a joint decision), consensus (sharing a subjective view of the world), or corroboration (agreement that a fact is true).

Understanding. Eye contact can give feedback on whether the listener has understood a crucial point. Understanding may include sympathy, forgiveness, indulgence, or routineness. A speaker wants others to show they are listening and attending and so looks up to elicit response gazes. An absence of back channeling (e.g. head nod or shake) will be taken as a negative reaction and will result in the speaker repeating or stopping (as a result there are fewer interruptions on the telephone – though see Patterson *et al.,* 1990: 362 for methods used by Space Shuttle controllers for gauging when to interrupt telephone conversations). Nonverbal communication plays a crucial role in conversation. This role complements verbal communication (Oliver *et al*., 1993) and may be part of the same psychological system (Argyle, 1990: 108). Speaker gaze is intermittent in glances of about 3 seconds. Speakers look more at the ends of utterances (turns) and look away at the beginning of them, especially if they have been asked a question. Yielding a turn to another speaker is achieved using six cues – two verbal (clause completion, ending tags such as "It only goes to show!"), three vocal (rising – falling pitch, drawl on final syllable, drop in loudness), and one visual (end of a gesture). When people are introducing a new topic into the conversation they have a tendency to gesture more than usual (Levy & McNeill, 1992) although what the gestures are will vary cross culturally: (Kendon, 1995; Morris *et al*., 1979). The mutually supporting role of language and nonverbal communication occurs even at the micro-level such as in interruptions, criticisms, propositions and phrases, of conversational turn taking, opening and closing. For example, while doctors and patients accomplish routine tasks preparatory to dealing with a patient's main complaint, doctors use gaze and body orientation to communicate that they are preparing but are not ready yet to deal with these complaints. In response, patients wait for their doctors to ask for their main complaint. Gaze and body orientation thus communicate levels of engagement and disengagement with course of action (Robinson, 1998). Experiments using video-tapes of conversations show that observers and participants judge the meaning of the nonverbal signals for intimacy, dominance, composure and informality in the same way (Burgeon & LePoire, 1999).

Promise. Eye contact and lack of pauses (Rutter, 1984: 129) can communicate intention, confident prediction, and satisfaction – all components of a sincere promissory gesture.

Orientation. Pointing enables shared orientation to an external object but is difficult to communicate to a remote partner because there is no shared sense of orientation. For example, "behind me" has a meaning only to collocated person; the point is subtler than at first it appears because "behind me" requires the listener's and speaker's shared understanding of three spatial references: speaker, listener, and speaker's orientation – a problem explored by Hindmarsh *et al.,* 1998).

Humour. Eye contact enables each person to share the joke – to show they understand and to know that the other understands the joke (Rutter, 1984: 41-42). Much of humour succeeds when it is partly implicit or unexplained, and nonverbal communication helps to achieve this, and so humour is both a device of exclusion and inclusion as well as an important relational language.

DRAMATURGICAL CONSTRUCTION OF VISIBILITY AND INVISIBILITY.

Symmetry cannot be assumed in communication. Partners may be and often are unequal. This inequality may vary along a number of different dimensions. These four dimensions are important and require adversarial discussion within any organisation. When there is an agreement to emphasise one pole of a dimension at the expense of the other pole, by means of some taboo, or because of the communication medium then they give rise to various types of exclusion, marginalisation, and invisibility (Star & Strauss, 1999).

The given versus the new. The given, when it is competently performed and negotiated, is associated with legitimacy and tradition, whereas the new, when it is competently performed and negotiated, is associated with the exciting and creative. When the given has prominence, the

new becomes invisible, and vice versa. In a work context, focussing on a continuing problem requiring satisfactory solution makes it visible as the given. Showing that the solution requires changing something (an artifact or a working practice) focuses on the new and makes it visible. Kress & van Leeuwen (1996) argue that on a Western alphabet page, the given-new dimension is arranged left-right. Schmidt & Bannon (1992) have argued that work that gets things 'back on track' in the face of the unexpected, modifying plans to accommodate unanticipated events, requires the development of a sophisticated politico-cultural analysis of the work context which distinguishes the routine from the exceptional. If the given-new dimension is denied open discussion then two extremes may exist. Suppression of the new-oriented dimension will create the expectation that communication only has a given-oriented meaning and will make new-oriented meanings invisible. For example, some may wish to introduce novel topics but will feel they are unable to pressure for change and so the change agenda is invisible. Suppression of the given-oriented dimension will create the expectation that communication only has a new-oriented meaning and will make given-oriented meanings invisible. For example, some wishing for change to stop so that stability can resume will feel overcome by irresistible change and will feel that the stability agenda has become invisible.

The ideal versus the real. The dimension represents the degree to which communication partners focus on the ideal (generalisation, title, distant in time, abstract, ideal in form, or wished for) versus the real (example, text body, concrete, here and now, true, imperfect). The ideal, when it is competently performed and negotiated, is associated with contextual validity and desirability, whereas the real is associated with immediate relevance and truthfulness. When the ideal is prominent as in a working model or an abstract theory, the real becomes invisible. When the real is prominent as in a mass of undigested data or uninterpreted pictures, the ideal in the form of theoretical significance becomes invisible. Kress & van Leeuwen (1996) argue that on a Western alphabet page, the ideal-real dimension is arranged top-bottom. This may influence where items are placed spatially upon a page, with the ideal placed further up the page than the real (Kress *et al*., 1997). Another is whether they are in the centre (powerful, informed, busy) or on the periphery. If the ideal-real dimension is denied open discussion then two extremes may exist. Suppression of the real-oriented dimension will create the expectation that communication only has an ideal-oriented meaning and will make real-oriented meanings invisible. If discussion is upon the distant past or the distant future, or upon ideal worlds, then those wishing to get things done here and now will feel unable to get decisions taken to make any progress. Suppression of the ideal-oriented dimension will create the expectation that communication only has a real-oriented meaning and will make ideal-oriented meanings invisible. If discussion always is on the here and now, or upon accuracy, it will be difficult to brainstorm new ideas, take risks or develop new initiatives, and ideas will become stale and predictable.

Centre versus periphery. This is the degree to which communication contains centre meanings associated with hierarchy, organisational structures of authority and power, and centralisation of control or whether it contains periphery meanings associated with pluralism and empowerment. In a centralised or controlled work setting issues of pluralism and empowerment may be invisible, as will issues of control in a very decentralised working environment. Kress & van Leeuwen (1996) argue that on the Western alphabet page the centre-periphery dimension is arranged foreground-background. If the centre-periphery relation is acknowledged (as it must be in an organisation where those in authority need to gain compliance in order to do their job properly) then this will influence the politeness behaviour used (Brown & Levinson, 1978). When the dimension is significant as a way of attributing the meanings of communication, those in the centre (the powerful, popular, strong etc) will use positive politeness to reduce social distance, and those on the periphery will use negative politeness to reduce imposing themselves. If the centre-periphery dimension is denied open discussion then two extremes may exist. Suppression of the periphery dimension will create the expectation that communication only has a centre meaning and will make periphery meanings invisible and the lack of participation will generate resentment. Suppression of the centre pole of the dimension will create the expectation that communication only has a periphery meaning and will make centre meanings invisible. If the centre is not acknowledged (as in an over-

democratic organisational culture) then participation may be demanded for discussion of every small detail, which will slow decision making and may lead to unnecessarilly high conflict.

Task versus social. This is the degree to which the communication is task-oriented (aimed at solving a problem) or socially or relationally oriented (aimed at fostering a friendship). This is influenced by the "cuelessness" of the communication medium (for example telephone conversations are brisker and more businesslike than face to face conversations and so are more task-oriented) (Argyle, 1990). This has led to media richness theory, which posits that "rich" media (face to face is rich, telephone is less rich, computer mediated communication is "lean") are used more by able managers for "equivocal" communications (ones where differences of opinion exist and require resolution) (Daft *et al.,* 1987). If the task-social dimension is denied open discussion then two extremes may exist. Suppression of the social dimension will create the expectation that communication only has a task meaning and will make social meanings invisible. When the task is over-emphasised then members will lose any sense of organisational identification or esprit de corps which may affect motivation and performance. This may occur due to the media used – computer mediated communication involves fewer cues and so emphasises task-orientation. Suppression of the task dimension leads to communication in which social meanings are expected, valued and attended to and where task meanings are invisible. If the task dimension is suppressed then performance will suffer, senior management sanctions will occur, and motivation will decline as the organisation member sees his/her contribution falling.

These four dimensions - given-new, ideal-real, centre-periphery, task-social - are enacted using nonverbal as well as verbal communication. Elements of both performance (the management of impressions) and negotiation (ensuring that the audience accepts the performance) are involved (Goffman, 1959). These dimensions are not an exhaustive list. For example, another potentially important dimension is the mobile-static. Mobility, when it is competently performed and negotiated, is associated with confidence and energy, whereas static behaviour is associated with caution and solemnity. When mobility is given prominence, the static becomes invisible. Stage-managed political/royal events often show the leader/sovereign moving through static supporters. Another important dimension is the formal-informal. Formality, when it is competently performed and negotiated, is associated with dignity and social distance, whereas informality is associated with friendliness and openness. State ceremonial occasions involving royalty and television chat shows are extreme examples of contexts where formal and informal nonverbal communication are appropriate. Another dimension is that of the group-individual. At a social function where membership and who knows who is significant, the group becomes visible.

In order to explore the importance of nonverbal communication within a computer-mediated setting, we shall discuss an illustrative example, based on a multi-site construction project.

THE ORGANISATIONAL SETTING

The workplace studies were carried out during work on the 'Collaborative Integrated Communications for Construction' (CICC), (ACTS No. 017) project on the development and use of interactive technology in the workplace. Several academic disciplines (linguists, computer scientists, sociologists) and practical disciplines (architects, structural engineers) were involved in the study. The rationale for the project was driven by the needs of people working in construction and manufacturing industries, where poor communication results in serious problems in day to day activities and requires cooperation and coordination. Industry insiders hope that interactive multimedia technology can improve communications. The potential is that technology can offer a richer information environment for the repair of breakdowns and misunderstandings between professionals. This is particularly useful in project teams which have a temporary and contingent existence, and whose members often come from several different organisations of origin. In the industry studied here, that of construction, the tendering process is competitive (between organisations of origin), yet this is followed by a period during

which cooperation between team members is vital. Induction meetings and seminars aim to overcome problems of lack of shared culture at the start of the project. This vital yet time consuming team building stage of the project is often undermined by teams joining projects at later stages with consequent integration problems (Rosenberg *et al*., 1997). Architectural and engineering design and construction project teams are characterised by high levels of uncertainty, tight time pressures, and a wide variety of high grade professional skills (Winch *et al*., 1997). So uncertainty exists in two ways – in creating the design object (a house, a road, a bridge) and in creating the team.

The study which yielded the results presented in this paper was focused on the use of multimedia communications technologies in collaborative design and utilised access to Stanford University - the 'Computer Integrated Architecture, Engineering, Construction' (A/E/C) course at the Civil and Environmental Engineering Department. A virtual learning environment was created using network and information technologies as mediators and facilitators for improved communication and co-operation (Fruchter 1997; Fruchter and Reiner, 1998, Perry et.al.1999). The Stanford course is multi-site, cross-disciplinary, project-based, and team-oriented (Fruchter 1998). The course was offered in a nation-wide pilot in 1997/98 at Stanford University, UC Berkeley, Cal Poly San Louis Obispo, and Georgia Tech.

The investigation of the verbal and non-verbal communication involved a team of A/E/C students working on the design of a construction project. They included an architect, at Georgia Tech., and an engineer, a construction manager, and an apprentice located at Stanford University. All were postgraduates, with between two and ten years of industrial experience with the exception of the apprentice. A building was to be collaboratively designed and this was to be owned by a 'client' (a staff member), and it was necessary to draw on the experience of consultants (industry based advisors with specialist skills). The team had access to email, web editors and workspaces, desktop video-conferencing and 3D modeling software together with a multi-party telephone and microphone.

The design project aimed to be as near to a real design task as possible. There were tight deadlines and constraints on budget, quality and completion time. Therefore the group which was studied was performing design activities: they had to collaborate to perform problem solving, and they faced typical industry constraints. The non-commercial setting meant that sensitive project related information was accessible.

The team members were engaged in multiple tasks, of which the design project was but one. Time management, task allocation and scheduling, and arranging meetings were necessary coordinating activities. Offices were in separate locations, although the three team members at Stanford had access to a well equipped computer room which is where the team meetings were observed and video-recorded a total of 52 hours, and those data will be analysed in this paper .

The study was carried out over nine weeks, as the Stanford and Georgia Tech teams were performing the second phase of the design - the detailed design phase. The members of the teams had been communicating for several weeks and so the data do not reflect problems of using unfamiliar technology.

ANALYSIS

The transcription extract (see Figure 1[1]) has been taken from video recordings of the communication link between the Stanford team of structural engineers and the Georgia Tech team of architects. The following notational conventions have been used. […] is indistinct speech; (p) is a slight pause ; EC is eye contact; bold shows **raised voice or slow for emphasis;** underlining shows smiling and / or laughing; italics show when participants are *using multi party telephone*; shading shows private Stanford conversation overheard by the Georgia Tech team; unshaded, non-italicised shows Stanford private conversation not overheard by the Georgia Tech team. In the extract shown here, the Stanford team comprised Renata (R) and

[1] Figure 1. is at the end of the paper.

Mike (M) (and for a time, David - D), and the Georgia Tech team comprised Umberto (U). The Stanford team was video-recorded and so its nonverbal communication has been included within Figure 1.

Both teams had sound but no visual contact. However, the Stanford team, which was video-recorded, was larger, making much of its communication local, face to face, within-team, and this to a large extent excluded the Georgia Tech team.

The distinction will be made between the public utterances (*147 italicised lines*) made across the link between the Georgia Tech team and the Stanford team, and private utterances (72 non-italicised lines) made within the Stanford team. Private utterances comprise those overheard by the Georgia Tech team (60 shaded lines), and those not overheard by the Georgia Tech team (12 unshaded lines).

The proportion of utterances is massively weighted in favour of the Stanford team. There are two reasons for this. Firstly the Stanford team includes the tutor, Renata who did a lot of the talking (586 words followed by Mike with 357 words followed a long way behind by the Georgia Tech collaborator, Umberto, with 55 words). Also the Stanford team had many more talking points and topics of conversation which were raised by visible cues. David's arrival prompted 67 words, "something weird" behind Renata prompted 11 words, and David dropping food twice on the lab floor prompted 8 and 6 words. Secondly, nonverbal communication (only visible within the Stanford team) were implicated in the generation of utterances: the majority of the 80 lines which are accompanied by nonverbal communication were private. The breakdown was 34 lines (or 56.7% of the 60 which were privately uttered within the Stanford team but overheard by Umberto), 6 lines (or 50% of the 12 which were privately uttered within the Stanford team but not overheard by Umberto) and 40 lines (or 27.2% of the 147 which were publicly uttered across the Georgia Tech-to-Stanford link).

In terms of power the Georgia Tech team (Umberto) is marginalised. The effect of collocation can be estimated by factoring out the project leader – the tutor Renata, and comparing the Georgia Tech team (Umberto) and the Stanford team (Mike). The advantage of being in someone's presence (compared with a telephone link) is quite marked. Umberto had only 12 turns i.e. taking the floor - (compared with Renata's 44 turns and Mike's 38 turns).

There are various ways in which individuals reduce the threat of loss of "face" – i.e. the extent that their presentation of self is accepted by others as a credible dramaturgical performance (Goffman, 1961). Negative politeness behaviour (Brown & Levinson, 1978), is used by those of lower status to protect the higher status, listener from being imposed on. It includes the making of elaborate apologies before making requests, and the use of indirect forms of language such as assertions disguised as questions. Such "powerless language" reduces the speaker's credibility and has been found to make court witness' evidence less convincing (Lind & O'Barr, 1979; O'Barr, 1982; Lakoff, 1975). People also look away: people gaze less when the topic is difficult, submissive people gaze less, and job candidates with low gaze rates are less likely to be given a job by interviewers (Argyle, 1990: 160-161).

The Georgia Tech team's (Umberto's) contributions do not use "powerful" language. Two of his turns were ignored (line 4 and 56), two were questions (31 and 82), four were acknowledgements (lines 35, 37, 58 and 86). A transcript excerpt illustrates the nature of the invisibility of the remote partner, Umberto:

Renata	 1 2 3	{Atlantic x 2, 2 Ridge, meetings 7,14, & 15 –00:36:00} *Do you have the* *architectural stuff* *available*	 R & M face computer/phone Finger raised
Umberto	4	*[..] some […]*	
Renata	5	*to show?*	

There were only two suggestions (lines 39 and 44) and only two agreements (lines 89 and 196). These two agreements are a response to direct and concrete commands by the project leader. An example of such an agreement is given below:

Renata	187 188 189 190 191 192 193	Your team has to get (p) your act (p) together and my suggestion is you should have a dry run on a preferably similar work for me on Tuesday and the second on Wednesday	EC (R & D) EC (R & D) R nods head down EC (R & D)
Mike	194	*Wednesday? OK?*	R nods
Umberto	195	*yes*	
Renata	196	*OK? and*	

His turns tend to be short and task-oriented – the average length of each turn is 4.6 words (compared to 13.3 words per turn for Renata and 9.4 words per turn for Mike). The most surprising thing in the whole extract is the fact that the remote team member, Umberto, after the long gap in talking from line 89 to line 195, immediately replies to Mike's "Wednesday, OK?" (line 194).

Positive politeness behaviour, on the other hand, seeks to reassure the listener that they are being taken seriously in the interaction. One of the contexts of its occurrence is when there is a difference of status. Those of higher status use language which is informal (e.g. "*Hi*" instead of "*Nice to meet you*"), unassuming (e.g. "*I hire people"* rather than "*I'm Personnel Director*"), self-mocking ("*I'm always to blame*" rather than "*It's my responsibility*") or inclusive ("*We*" instead of "*I*") in order to reduce social distance (Brown & Levinson, 1978). People also gaze more: people who are trying to be persuasive tend to gaze more, observers judge people with high gaze rates as more credible, superiors gaze more than their subordinates, in groups more gaze is directed at the leader, dominant people tend to gaze more, and teachers who gaze more at their pupils generate more work done (Argyle, 1990: 161-164).

The Stanford team demonstrated positive politeness toward the Georgia Tech team. Usually positive politeness is used by higher status people to reassure lower status people. In this case, instead of reducing social distance (by means of humour, inclusive language, warmth and informality) the Stanford team used other linguistic strategies. Firstly, a member of the Stanford team would act as spokesperson (Levinson, 1988) for the Georgia Tech team member to his/her Stanford team members, (lines 6, 48, 50). For example:

Renata	48 49	Hold on Ah just to make sure Umberto is on that meeting?	R turns to computer and uses mouse R nods repeatedly towards M
Mike	50	Umberto is a (p) maybe	
Renata	51	[…] yes here [..]	

Secondly, the Stanford team member would explain to the Georgia Tech team member what other members of his/her (Stanford) team were doing (lines 41, 52).

Mike	52 53	*She's going to share Netmeeting with you* *Umberto*	
Renata	54	*Ah Netscape*	
Mike	55	*In Netscape*	
Umberto	56	*[…] meetings […]*	
Renata	57	*Right so can you see your page?*	Looking at screen
Umberto	58	*OK the page […]*	
Renata	59	*Good*	

Thirdly, when a Stanford team member spoke directly to the Georgia Tech team member (line 90, 110) this topic did not endure for many turns. It did not became elaborated either – it was rather like a quick instruction or passing of information which then got interrupted by another Stanford team member's topic shift (line 99, 121).

Mike	99	*Will dry runs be important also?*	
Renata	100	*Ah we can **do** (p)*	EC R nods repeatedly to M
	101	*can organise a dry run and a second dry run*	
	102	*(p) because I don't believe at the first you*	
	103	*will be there Um*	EC (R & M)
Mike	104	***Won't be there in time***	

This was because the Georgia Tech team member had fewer conversational and nonverbal resources for making appeals for attention and for signalling to prevent interruption. Fourthly, there was a tendency to make explicit that which co-presence would make unnecessary (e.g. Umberto said "I hear that" in line 37) (see Hindmarsh *et al*., 1998: 221, and Patterson *et al.*, 1999: 360 for similar examples).

The extract illustrates the importance of the direct, mutually supportive relationship between verbal and non-verbal communication. Nonverbal communication becomes more agitated and energetic when breakdowns occur, or during periods of emotional talk. Nonverbal communication is used to add to the expressiveness of language, but also to read the signs on the listener's body, which are more necessary in problematic moments of talk than in non-problematic ones. Several examples exist of the way in which nonverbal communication aids the rhetorical work of language for co-present persons but hides the presence of remote persons and thus helps in the creation of invisibility. It is important to point out here that when a channel of communication (here visibility) is lacking for the support of a mode (here nonverbal communication) then although the mode is supported in face to face communication, it remains disadvantaged in communication with those who are remote. As Hindmarsh et. al. (op.cit.) point out, the interaction with remote partners takes place in a fragmented space where the links between verbal and non-verbal clues cannot be taken for granted.

Nonverbal communication in the video-recorded team.

Mimickry. The argument that things are included in a category - "Everything…has been this version.." (lines 6-8) - is mimicked by a hand raised open towards the speaker. Also, "layers can be imported" (line 17) is dramatised by a drag-action with the hand toward the body. Repetition is another movement-oriented gesture: "I needed to do my stuff and Umberto has been doing his stuff" (lines 12-13) and "the list" (line 176) are activities which generate the action of repeated processing, which is mimicked by moving the hands around in a water wheel action. Dramatically creating the expectation that a list will follow is achieved by placing a closed hand repeatedly perpendicular onto the table. The list is the tutor's important messages summarised: "all that I'm saying…your presentation … Friday … forty minutes" (lines 66-70).

Embarrassment. "That's what (p) I tried to (p) [communicate] yesterday" (lines 9-10) contains a mild criticism of the tutor which causes the speaker embarrassment and this is communicated by indistinct speech and unfilled pauses but also by the fingers of both hands together and touching the hair to emphasise the need to carefully choose his words.

Emphasis. Extracting the listener's agreement of the importance of something requires feedback: "you (p) have (p) ah **forty minutes**" (lines 69-70 and 78). The importance of not exceeding the allocated time limit is emphasised by the extra loudness, but also by eye contact between Renata and Mike – Renata wants to know that Mike has conceded the importance of time limits. De-emphasising or dismissing is just as important - the second dry run in the evening should not be regarded as too much work - "(p) that's kind of (p) late evening (p)" uses a flip of fingers away from the body to express unimportance. Shaking a hand repeatedly in the air adds emphasis to the advice to arrive early so "you will be able to experience" (lines 94-95) the seminar rooms beforehand. The emphasis during "Um (p) I (p) **revisit** all that I'm saying now" (line 64-65) by using eye contact and shaking a raised finger is pedagogical: the moment in the lesson has come when the teacher must restate ("revisit") the important messages. Emphasis can be used to break an expectation. In line 106 "the **second** dry run" the extra loudness (emphasis) and the eye contact (checking that the emphasis has been understood and accepted by the listener) is required to distinguish it from the first dry run (the immediately

prior subject of line 104). Another example is eye contact during "for questions" (line 74) which is a reason for the variation to "thirty minutes" (line 72-73) which is an unexpected elaboration of the "**forty minutes**" (line 70) so emphatically brought up earlier.

Recognition. This involves both requesting and getting recognition for effort put in (via the feedback provided by eye contact) - "to do my stuff and Umberto has been doing his stuff" (lines 13-14) requires eye contact as feedback to Mike that Renata has recognised that real work has been done.

Commitment. Mike wants to know that Renata is acknowledging that she has already seen a version of the drawing - "last Friday" (line 8) which can only be established through eye contact. Again, "I strongly also encourage you ah to come earlier" (line 90-91) which occasions eye contact and is followed by stumbling "ah so ah there is" (line 92) as the distracted speaker picks up feedback.

Agreement. Eye contact between Renata and Mike combined with head nodding by Renata serves to provide Renata with feedback on the accuracy of her knowledge: "there are classes in the afternoon" (line 93). Head nodding here performs the same function as using a rising, questioning intonation but is more positive (it expects a positive answer "yes") and assertive and thus more appropriate as a tutor's behaviour. The same applies to "at nine thirty we party" (line 165). On the other hand, "if we organise it in the evening?" (line 107-108) and "case study room in the law school?" (line 116) are questions but eye contact elicits a response of agreement.

Understanding. Eye contact can give feedback on whether the listener has understood a crucial point: "I mean you have to understand ah where you will give your presentation" (lines 96-97), "OK" (line 178), and "OK" (line 180).

Promise. Eye contact at the same time as "It will be fun" (line 174) enables Renata to communicate intention, confident prediction, and satisfaction – all components of a sincere promissory gesture. When Mike asks about dry runs, Renata says "Ah we can **do** (p) can organise a dry run" (lines 99-101) and uses eye contact and repeated nods to answer affirmatively and to signal a sincere promise to Mike.

Orientation. Pointing (line 81) effortlessly overcomes the difficulty of the negative answer (line 80) by enabling shared orientation to an external object (another room). But it is difficult to communicate to the Georgia Tech team because there is no shared sense of orientation ("behind me" has a meaning only to a Stanford person).

Humour. "Forty (p) forty minutes each? Wow!" (line 83) expresses amused surprise. The description of food as "**illegal stuff**" (line 132), although an amusing way of referring to food, is difficult for the Georgia Tech person (Umberto) to understand. Humour is both a device of exclusion (of Georgia Tech persons) and inclusion (of Stanford team members). The hidden nature of the humour and its excluding property comes out in several ways. Humour relies on the ability to express a range of emotions – for example, "I'm very tense now!" (line 160) is dramatised by a facial expression for mock fright as Renata uses irony.

The excluding of the Georgia Tech person (Umberto) is shown in the transcript by the fact that 33 of the 49 humorous lines contain private conversation which Umberto overheard but probably felt excluded by in spite of the verbal commentaries that were intended to "bring him in":

David	121 122	Can I eat? Shall I sit up? I won't come near (p) I'll sit wherever you	D holds dinner plate & stands looking at R
Mike	123	Don't come near the computer	
Renata	124	If you drop anything	Moves to let David into room
David	125	I'll buy a new carpet (p) why you	D sits
Renata	126 127	**You bet! You buy a new carpet!** *OK David showed up and we all had our initial*	
David	128	*Hey! Hey!*	M picks something from floor
Renata	129	*jokes*	
Mike	130	Why (p) you make jokes?	M to D
Renata	131 132 133	*He just brought some* ***illegal stuff*** *into the lab*	M laughs & EC (R & D)

All these dimensions of nonverbal communication are elements of "common ground for shared beliefs", which "recognise reciprocal expectations and accept rules for interaction which serve as necessary anchors in the development of conversation" (Mantovani, 1996: 91). They are therefore ways of sharing, and because of the disadvantageous asymmetry between the Stanford and the Georgia Tech teams these nonverbal communication dimensions are conversational resources which severely disable non-Stanford persons. The extract clearly shows the significance of cuelessness as a disadvantage to social interaction and the importance of nonverbal communication and of the need for etiquette, indulgence or "positive politeness" towards the disadvantaged, Georgia Tech team. Elements of this etiquette included actions which were easier to perform (inclusive behaviour) than others (expression of involuntary emotions). The etiquette surrounding overhearing is probably quite subtle in work situations: although A should not, in earshot of C, talk to B about a party to which C was not invited, "thinking out loud" and listening into other people's conversations may be a fundamental part of working life (Patterson *et al.,* 1999: 360 provides several examples).

Current theories of nonverbal communication are based upon face to face (mostly dyadic) settings, and are unable to deal with organisational settings when they are a mixture of computer mediated and face to face. Also previous research has focused on settings with one focus of attention (a task or a single conversation), whereas much work in organisations requires negotiated roles, overlapping responsibilities, rapid change to accommodate contingencies, and overhearing, monitoring, and polling other people's conversations. Also previous research has focused on mode (verbal, nonverbal) rather than communication network (who is defined as being "in" the team and thus who is chosen to be a communication partner).

There are a number of reasons why research has not addressed these issues in real-life communication. Metaphors about active participants, such as "reader-writer" and "sender-receiver" are misleading in organisational contexts. Questions of coherence and rhetorical effect with regard to writing or sending assume the text is planned to the end, and that a tension is eventually resolved by means of problem solution, conflict resolution, puzzle explanation, conclusion to an argument, means to an end, or answer to a question (Grimes, 1975, Kintsch & van Dijk, 1978). But conversation is unplanned, unresolved, interrupted, and chaotic, and attempts by participants to order and frame are more or less successful depending on their discourse resources (Edwards, 1997; Grant *et al.,* 1998; Potter & Wetherell, 1987), which, in an organisation, may be unequal. The "local complex of objects and artefacts provides a resource for making sense of the actions of others" (Hindmarsh *et al.,* 1998: 221). Visual information about coworkers' nonverbal communication provides a similarly powerful conversational resource. Kress *et al*., (1997) consider and reject a number of metaphors or semiotic models for considering multi-modality (including ideas from many-to-one technologies such as film, television and advertising).

Moreover, it is now accepted that both writer-speaker and reader-listener co-construct or interpret the text. Also organisational context is an important element: "to argue that the bulk of organizational life is captured by the metaphor of reading texts is to ignore most of the living that goes into life" (Weick, 1995: 15; also Czarbiawska-Joerges, 1992: 123).

Another problem is that language has enjoyed a central place in theories of communication. Even those who have attempted to provide an understanding of visual communication have used linguistic theories (e.g. Metz, 1971) or relied on language as the master code (e.g. Barthes, 1977). The primacy of language has been reinforced by the fact that it has been found that nonverbal communication closely parallels and complements verbal communication.

Types of visibility and invisibility in the two teams.

In our example, there was a stark difference between the communication within the Stanford team, which emphasised the given, ideal, centre, and social, and the communication between the Stanford team and the Georgia Tech team, which emphasised the new, real, periphery and task. The Stanford team emphasised the given because it was dominated by the tutor, Renata, who laid down the rules e.g. "you (p) have (p) Ah forty minutes" (Renata in lines 69-70). It emphasised the ideal by ranging backwards in time e.g. "Everything you saw last Friday" (Mike

in lines 6-8) and forwards in time e.g. “I kept my schedule for next week open” (Renata in line 213). It emphasised the centre by focussing on the tutor’s supervisory role in the project: e.g. “You were pleased with me” (Mike in line 203), “Your team has to get (p) your act together” (Renata in lines 187-189). It emphasised the social by often using humour e.g. “You buy a new carpet!” (Renata in line 126, and above extract), by discussing personal matters e.g. “Can I eat?” (David in line 121), “What about your new job?” (David in line 136), and by remarking on neighbouring events e.g. “Sorry I don’t know if you saw that” (Mike in line 152).

The communication between the Stanford team and the Georgia Tech team, emphasised the new by bringing up new questions: e.g. “Do you have the architectural stuff” (Renata in lines 1-2), “Mike do you have the drawings?” (Umberto in line 31). This was done mostly to establish the aspects of the common ground that are normally taken for granted in co-presence (as a matter of joint salience, Clark, 1996 p.69). It emphasised the real by referring to currently relevant artifacts e.g. “switch up the” (Umberto in line 39), “Right can you see your page?” (Renata in line 57). It emphasised the periphery by using positive politeness and indulgently explaining what was happening for the peripheral team's benefit e.g. “Renata is doing something right now in Netscape” (Mike in line 41-42), “David just showed up” (Renata in line 126-127) or by talking about the peripheral team as if it were not present e.g. “Umberto is on that meeting?” (Renata in line 48-49) or by taking trouble to explain things e.g. “It’s (p) a nice room Umberto” (Mike in line 112). It emphasised the task e.g. “architectural stuff” (Renata in line 2), “drawings” (Umberto in line 31), “Netscape” (Mike in line 42), “page” (Renata in line 57).

This difference between the two teams suggests that (a) the presence in the Stanford team of the tutor predisposed it to emphasising what she wanted for the project (the given) and (b) to emphasising her as the centre of decisions, (c) her supervisory role being occasional meant that talk would range back and forth in time (ideal), and (d) the fact that there were several members of the Stanford team in a face to face meeting predisposed it to emphasising social rather than task issues. The communication between the two teams however, because it was conducted in relatively “lean” media (shared text-based computer meeting system plus shared telephone) meant that (e) there would be plenty of unknown new questions arising requiring answers (the new), (f) an inability to communicate abstract ideas easily in this medium meant that communication concentrated upon concrete artifacts (the real), (g) the lack of cues plus what was mentioned above in (a) and (b) led to a predisposition to an emphasis on the centre versus periphery, and (h) the lack of cues for social interaction led to an emphasis on task.

DISCUSSION.

This consideration of nonverbal aspects of communication raises two problems. Firstly nonverbal communication supports social activities (for example, requesting and getting commitment) and does not support the concrete, instrumental activities (doing, orienting, manipulating, moving) of the task dimension. Yet it is the task dimension which the communication between the two teams emphasised and which “lean” media such as computer mediated communication lead people to emphasise (Rutter, 1984: 115-125). Current concern for making shared work more visible using the metaphor of the common artefact (Robinson, 1993; Berlage & Sohlenkamp, 1999) merely adds to this one sided preoccupation with task-orientation. It in fact overlooks the earlier definition of common ground by Clark & Shaefer (1989) which was based on the discourse strategies that enable a shared understanding to develop during conversation. Clark & Brennan (1991) have taken this idea further and argued that, instead of the principle of individual least effort (Grice, 1975) conversation should be understood in terms of the principle of the least collaborative effort, because so much of conversation is aimed at achieving shared understanding. We have shown (in the example above) that such strategies are embedded within a large number of social activities (for example, giving recognition for effort that others have put into work) which surround work, and are often communicated nonverbally. Secondly although the centre-periphery dimension is an important one for understanding the computer mediated communication between large, or powerful “in-groups” and remote, solitary or “invisible” individuals, the use of “lean” media which do not

enable nonverbal communication actually makes the centre-periphery gap worse. Six of the ten ways in which nonverbal communication supported work in our example involved the centre-periphery dimension. This suggests that technology-oriented studies of communication may contain an undemocratic bias against the remote, small organisational subunit. This makes more relevant the comment that its organisational benefit "heavily depends on the resolution of social questions about collaboration – questions about group norms and values, equitable role structuring, and shared task management – that organisations introducing new technology are usually not prepared to address" (Bickson *et al.*, 1989: 90).

It might be argued that better audiovisual communication systems will eventually enable people to remotely see each other as minutely as in face to face, thus rendering unnecessary any further recourse to such unnatural methods. A striking thing about the video-recorded data was that the Stanford group's visual attention was on group members rather than on the computer screen. Future technology may need to address the issue of creating hologram-like images of remote team members in the room, thus escaping from the confines of the computer screen and enabling the remote team members' full repertoire of nonverbal behaviours to shine through.

Even were this to happen, it might still be useful for computer systems to have models of nonverbal communication, because another motivation for developing emotion-body movement models is in order to enable interfaces to better understand human users' intentions. So far this extension from using English text to gauge intention towards making use of computer processing of sensor data of nonverbal behaviour is only a proposal rather than an implementation (McKevitt & Gammack, 1996). It should also be remembered that people adapt to new media: for example, distance learning students have lower expectations of nonverbal immediacy than on-site students (Witt & Wheeless, 1999).

With these and possibly other issues in mind, it is relevant to consider technological efforts to enable users to express emotions within a computer mediated environment. Towards this end, attempts have been made to relate models of 3D face, expression and emotion (Morishima, 1996). Such a model is able, given an emotion, to generate a realistic facial expression. Another approach is to look at the specific dialogue task being performed and to take careful note of the points at which nonverbal facilitation is needed, and to use simpler and easier to use methods of communicating such nonverbal signals (Noro *et al.*, 1996). However, such approaches depend upon firstly a user consciously deciding (even, being aware of) what emotion, speech act or intention to portray, secondly the user wanting that emotion to be expressed, and thirdly his/her being able to make the effort to press a button. All three questions show how very problematic such an approach is.

Taking the first one (awareness of what needs to be nonverbally communicated), it is clear that nonverbal communication is able to function even when cognitive resources are low and when effort is decreased (Patterson, 1995) so that any attempt to get the user to articulate such processes may be counter-productive.

The second one (preparedness to consciously communicate what would otherwise by unconscious and/or involuntary) raises the issues of deception and impression management. Face to face nonverbal behaviours have the unique features that they can be difficult to suppress (although the face is fairly controllable, the voice is less so, and the body below neck level is even less so), and they are more accessible to the people who observe them than to the people who produce them (Depaulo, 1992). For example, people's pupils dilate if they see another person's dilated pupils in a kind of sympathetic reflex action, without any conscious awareness (Argyle, 1990: 163).

Taking the third one (preparedness to make the effort to signal the emotion, action or intention), minimising the imposition on limited cognitive resources is accepted as an important function of collaborative technology design (Dourish & Bellotti, 1992) so that making explicit via interface formalisms "actually disrupts the flow and organisation of collaborative activities" (Hindmarsh *et al*., 1998: 221) so that "it necessarily interrupts the task" as well (Shipman & Marshall, 1999: 342).

Directions for future research in this area thus seem to involve moving away from direct application of empirical findings in the design of technology interfaces. Perhaps a more productive method can be based on our understanding of the interaction between verbal and

non-verbal clues and of the role that changes in dimensions of non-verbal communication have in this context. For example, emphasis enables powerful people to reinforce their communication and so supports the centre. Emphasis also reinforces the status quo (confident suggestion, nonverbal taboos about topics) and so supports the given. Mimickry provides visual support for shapes and movements and so supports the real and the task. Embarrassment being expressed enables negative politeness and thus supports the peripheral. Recognition being requested, received and acknowledged supports centre-periphery relations. Commitment being requested or offered, given and acknowledged arises from a wish for something in the future and so supports the ideal. Agreement being requested, given, received and acknowledged reinforces the powerful (the centre) and the status quo (the given). Promises are resources of the centre or are extracted from the periphery. Orientation is in the here and now and so supports the real and the task. Humour is an important element in social communication.

When a dimension or one pole of a dimension are suppressed, then the dramatisation of the dimension or pole using nonverbal communication will be missing. For example, in an organisation which stresses the centre such as the military, emphasis (salutes, parade ground communication, superior-subordinate communication) will be important, whereas it will be missing in a monastery or another kind of organisation which stresses the periphery.

In face-to-face communication, such shifts in suppression may be seen to have an enhancing role as they add richness to the media of communication. In mediated settings, however, such shifts may be seen to further amplify the "leanness" of the media. If this is adopted as a working hypothesis, then further evidence, possibly experimental, is needed to explicate the critical differences between the rich and the lean media that would in turn inform design.

REFERENCES

Argyle M. (1990). *Bodily communication*, Routledge, London.

Barthes R. (1977). *Image-music-text*, Fontana, London.

Berlage T., and Sohlenkamp M. (1999). 'Visualizing common artifacts to support awareness in computer mediated cooperation', *Computer Supported Cooperative Work*, 8, 207-238.

Bickson T.K., Eveland J.D., and Gutek B.A.. (1989). 'Flexible interactive technologies for multi person tasks: Current problems and future prospects', in Olson M.H. (ed) *Technological support for work group collaboration*, Erlbaum, Hillsdale NJ.

Brown P., & Levinson S. (1978). 'Universals in language usage: Politeness phenomena', 56-289 in Goody E.N., (ed) *Strategies in social interaction*, Cambridge University Press, Cambridge.

Buller D.B., Burgoon J.K., Buslig A.L.S., and Roiger J.F. (1994). 'Interpersonal deception: a further analysis of nonverbal and verbal correlates of equivocation from the Bavelas et al (1990) research', *Journal of Language and Social Psychology*, 13 (4), 396-417.

Burgoon J.K., and LePoire B.A. (1999). 'Nonverbal cues and interpersonal judgements: participant and observer perceptions of intimacy, dominance, composure, and formality', *Communication Monographs*, 66 (2), 105-124.

Burgoon J.K., and Buller D.B. (1994). 'Interpersonal deception. 3. Effects of deceit on perceived communication and nonverbal behavior dynamics', *Journal of Nonverbal Behavior*, 18 (2), 155-184.

Burgoon J.K., Buller D.B., Guerrero L.K., Afifi W.A., and Feldman C.M. (1996). 'Interpersonal deception: 12 information management dimensions underlying deceptive and truthful messages', *Communication Monographs*, 63 (1), 50-69.

Clark H. (1996). *Using Language*, Cambridge University Press.

Clark H., and Brennan S. (1991). 'Grounding in communication', 127-149 in Resnick L.B., Levine J.M., and Teasley S.D., (eds) *Perspectives on socially shared cognition*, American Psychological Association.

Clark H.H., and Schaeffer E.F., (1989). 'Contributing to discourse', *Cognitive Science*, 13, 259-294.

Czarniawska-Joerges B. (1992). *Exploring complex organizations – a cultural perspective*, Sage, Newbury Park CA.

Daft R.L., Lengel R.H., Trevino L.K. (1987). 'Message equivocality, media selection, and manager performance: implications for information systems', *MIS Quarterly*, September, 355-366.

Depaulo B.M. (1992). 'Nonverbal behaviour and self presentation', *Psychological Bulletin*, 111 (2), 203-243.

Dourish P., and Bellotti V. (1992). 'Awareness and coordination in shared workspaces', in *Proceedings of CSCW '92*, Toronto, Canada, ACM.

Ebesu A.S., and Miller M.D. (1994). 'Verbal and nonverbal behaviours as a function of deception type', *Journal of Language and Social Psychology*, 13 (4), 418-442.

Edwards D. (1997). *Discourse and cognition*, Sage, London.

Forrester M.A. (1996). *Psychology of language*, Sage, London.

Fruchter, R. (1997). The A/E/C Virtual Atelier: Experience and Future Directions. *Proc. ASCE 4th Congress of Computing in Civil Engineering*. Ed. Teresa Adams, Philadelphia, June 1997, p.395-402.

Fruchter, R. (1998). Roles of computing in P^5BL: problem-, project-, product-, process-, and people based learning. *Artificial Intelligence for Engineering Design and Manufacturing, 12*, p.65-67.

Fruchter, R. and Reiner, K.(1998). ProMem: Project Memory for Shared Design Evolution Capture. *Proc. of Structural Engineers World Congress*, San Francisco, July 1998. (published on CDROM).

Goffman E. (1959). *The presentation of self in everyday life*, Penguin, Harmondsworth.

Grant D., Keenoy T., and Oswick C., (eds), (1998). *Discourse and organization*, Sage, London.

Grice H.P., 1975, 'Logic and conversation', in Cole P., and Morgan J.L., (eds) *Syntacs and semantics, Vol 3: Speech acts*, Academic Press, New York.

Grimes J. (1975). *The thread of discourse*, Mouton, The Hague.

Hindmarsh J., Fraser M., Heath C., Benford S., and Greenhalgh C. (1998). 'Fragmented interaction: establishing mutual orientation in virtual environments', 217-225 in *Proceedings of CSCW 98* Seattle, Washington, ACM.

Kendon A. (1995). 'Gestures an illocutionary and discourse structure markers in southern Italian conversation', *Journal of Pragmatics*, 23, 247-279.

Kendon, A. (1999). *Conducting Interaction: patterns of behavior in focused encounters*, Studies in Interactional Sociolinguistics 7, Cambridge University Press.

Kintsch W., and van Dijk T.A. (1978). 'Toward a model of text comprehension and production', *Psychological Review*, 85, 363-394.

Kress G., and van Leeuwen T. (1996) *Reading images: a grammar of visual design*, Routledge, London.

Kress G., Leite-Garcia R., and van Leeuwen T. (1997). 'Discourse semiotics', 257-292 in van Dijk T.A., *Discourse as structure and process*, Sage, London.

Lackoff R. (1975). *Language and woman's place*, Harper & Row, New York.

Levinson S.C. (1988). 'Putting linguistics on a firmer footing: explorations in Goffman's concepts of participation', 161-227 in Drew P., and Wooton A., (eds) *Erving Goffman: Exploring the interaction order*, Polity Press, Cambridge.

Levy E.T., and McNeill D. (1992). 'Speech, gesture and discourse', *Discourse Processes*, 15, 277-301.

Lind E.A., & O'Barr W.M. (1979). 'The social significance of speeech in the courtroom', 66-87 in Giles H., & St.Clair R.N., (eds) *Language and social psychology*, University Park Press, Baltimore.

McKevitt P., and Gammack J.G. (1996). 'The sensitive interface', *Artificial Intelligence Review*, 10 (3-4), 275-298.

Mantovani G. (1996). *New communication environments: from everyday to virtual*, Taylor & Francis, London.

Metz C. (1971). *Language et cinema*, Larousse, Paris.

Morishima S. (1996). 'Modeling of facial expression and emotion for human communication system', *Displays*, 17 (1), 15-25.
Morris D., Collett P., Marsh P., and O'Shaughnessy M. (1979). *Gestures: their origins and distribution*, Jonathan Cape, London.
Noro K., Kawai T., and Takao H. (1996). 'The development of a dummy head for 3-D audiovisual recording for transmitting telepresence', *Ergonomics*, 39 (11), 1381-1389.
O'Barr W.M. (1982). *Linguistic evidence: language, power, and strategy in the courtroom*, Academic Press, New York.
Oliver R.L., Robertson T.S., and Mitchell D.J. (1993). 'Imaging and analyzing in response to new product advertising', *Journal of Advertising*, 22 (4), 35-50.
Patterson M.L. (1995). 'A parallel process model of nonverbal communication', *Journal of Nonverbal Behavior*, 19 (1), 3-29.
Patterson E.S., Watts-Perotti J., and Woods D.D. (1999). 'Voice loops as coordination aids in Space Shuttle Mission Control', *Computer Supported Cooperative Work*, 8, 353-371.
Perry M, Fruchter R, Rosenberg D. (1999). 'Co-ordinating Distributed Knowledge: a Study into the Use of an Organisational Memory', in Cognition, Technology and Work , An International Journal for the Analysis, Design and Use of Joint Cognitive Systems, Springer-Verlag 1:142-152.
Potter J., and Wetherell M. (1987). *Discourse and social psychology: beyond attitudes and behaviour*, Sage, London.
Robinson M. (1993). 'Keyracks and computers: an introduction to "common artefact" in Computer Supported Cooperative Work (CSCW)', *Wirtschaftsinformatik*, 35, 157-166.
Robinson J.D. (1998) 'Getting down to business – talk, gaze, and body orientation during openings of doctor-patient consultations', *Human Communication Research*, 25 (1), 97-123.
Rosenberg D., Perry M., Leevers D., Farrow N. (1997). 'People and Information Finder: informational perspectives', in Williams R. (ed) *The Social Shaping of Multimedia: Proceedings of International Conference COST-4*, European Commission DGXIII, Luxembourg.
Rutter D.R. (1984). *Looking and seeing: the role of visual communication in social interaction*, Wiley, Chichester.
Schmidt K., and Bannon L. (1992). 'Taking CSCW seriously: supporting articulation work', *Computer Supported Cooperative Work* , 1, 7-41.
Shipman F.M.III, and Marshall C.C. (1999). 'Formality considered harmful: experiences, emerging themes, and directions on the use of formal representations in interactive systems', *Computer Supported Cooperative Work*, 8, 33-352.
Star S.L., and Strauss A. (1999). 'Layers of silence, arenas of voice: the ecology of visible and invisible work', *Computer Supported Cooperative Work*, 8, 9-30.
Weick K. (1995). *Sensemaking in organizations*, Sage, Newbury Park CA.
Winch G.M., Usmani A., and Edkins A. (1997). 'Towards total project quality: a gap analysis approach', *Construction, Management and Economics*, 14. 1-24.
Witt P.L., and Wheeless L.R. (1999). 'Nonverbal communication expectancies about teachers and enrollment behavior in distance learning', *Communication Education*, 48 (2), 149-154.

Figure 1. Extract from video recording (verbal and nonverbal communication)

Speaker		Stanford and Georgia Tech team utterances	Stanford team nonverbal communication (from video recording)
		{Atlantic x 2, 2 Ridge, meetings 7,14, & 15 –00:36:00}	
Renata	1 2 3	*Do you have the* *architectural stuff* *available*	R & M face computer/phone Finger raised
Umberto	4	*[..] some […]*	
Renata	5	*to show?*	
Mike	6 7 8 9 10 11 12 13 14 15 16 17 18 19	Everything that you saw last Friday has been this version of the drawing that's what (p) I tried to (p) [communicate] yesterday. What I've been doing is I've been working with a version of the drawing that had everything I needed to do my stuff and Umberto has been doing his stuff in another file and (p) But they're all separate as layers can be imported and superimposed and then (p) and that's one thing that we need to do right away	 EC (R & M) Raises hand, open towards himself Fingers of both hands together Touch hair EC (R & M) Hands move in water mill action EC (R & M) Hands slot horizontally together Drag-action toward body with hand
Renata	20	Ah	
Mike	21 22 23 24 25 26 27 28 29	OK. Right away (p) I'm almost done I have about three more beams to put in And then the floors and Then I'm done with All of the structure of upgrade And then (p) then it becomes doing (p) putting drawings and stuff that isn't even in 3D	Palm towards R EC (R & M) Hands slot horizontally together EC (R & M) Palm upwards
Renata	30	OK	
Umberto	31 32 33	*Mike do you have the drawings? Ah (p) we* *can deal with the (p) to show the structure* *we have evolved?*	Relaxed bodies, eyes down
Mike	34	*Ah no I have that at home*	Looks away, pulls nose
Umberto	35	*OK fine*	
Mike	36	*Right unfortunately I can't access from here*	
Umberto	37	*[…] I hear that*	
Mike	38	*Yes I understand.* ***Hold on!*** *(p) That that*	
Umberto	39 40	*If you have the […] you can switch up the* *[…]*	
Mike	41 42 43	*Yes yes I will do that right now Renata is* *doing something right now in Netscape* What would you like to see?	 Leans toward R, quietly to R
Umberto	44 45	*Yes I think it [..] right (p) so (p) just for* *showing off and so*	
Mike	46 47	*Yes* What do I	
Renata	48 49	Hold on Ah just to make sure Umberto is on that meeting?	R turns to computer and uses mouse R nods repeatedly towards M
Mike	50	Umberto is a (p) maybe	
Renata	51	[…] yes here [..]	

Speaker		Stanford and Georgia Tech team utterances	Stanford team nonverbal communication (from video recording)
Mike	52	*She's going to share Netmeeting with you*	
	53	*Umberto*	
Renata	54	*Ah Netscape*	
Mike	55	*In Netscape*	
Umberto	56	*[…] meetings […]*	
Renata	57	*Right so can you see your page?*	Looking at screen
Umberto	58	*OK the page […]*	
Renata	59	*Good*	
Mike	60	What would you like to see?	
Renata	61	Well what I thought is (p) Ah (p) is let's	R turns away from computer
	62	look at your architecture	R faces M, head down, eyes up
	63	*so and since others are here (p)*	R turns to phone
	64	*Um (p) others are here (p) Um (p) I (p) I*	R looks at watch
	65	***revisit***	EC (R & M)
	66	*all that I'm saying now but Ah (p)*	R shakes raised finger in air
	67	*for your presentation (p) OK? (p)*	R's closed hand on table repeatedly
	68	*on Friday (p)*	R's closed hand down on table
	69	*you (p) have (p) Ah*	
	70	***forty minutes***	EC (R & M)
	71	*for your team*	
Mike	72	*Thirty minutes for presentation and [..]*	
Renata	73	*Thirty minutes and then*	R turns from phone
	74	*For questions*	EC (R & M)
	75	*but if*	R nods repeatedly to M
	76	*questions happen during the presentations*	R's hands move in water mill action
	77	*that's usually maybe more*	
	78	***You have about forty minutes***	EC (R & M)
Mike	79	Is that in […]?	
Renata	80	That's (p) no in (p)	
	81	Thorntons	R turns and points
Umberto	82	*forty minutes each?*	
Renata	83	*Forty (p)* ***forty minutes each? Wow! We***	R laughs & EC (R & M)
	84	***will be here till midnight!***	
Mike	85	*I hope not*	
Umberto	86	*OK fine*	
Renata	87	*OK everybody […] is coming to Stanford*	
	88	*(p) so plan to be here*	
Umberto	89	*yes*	
Renata	90	*I strongly also encourage you ah to come*	
	91	***earlier***	EC (R & M)
	92	*ah so ah there is*	
	93	*there are classes in the afternoon*	EC. R nods repeatedly to M
	94	*so you will be able*	EC (R & M)
	95	*to experience*	R shakes hand in air repeatedly
	96	*the space I mean you have to understand ah*	EC (R & M)
	97	*where you will give your presentation (p) the*	
	98	*location*	
Mike	99	*Will dry runs be important also?*	
Renata	100	*Ah we can* ***do*** *(p)*	EC R nods repeatedly to M
	101	*can organise a dry run and a second dry run*	
	102	*(p) because I don't believe at the first you*	
	103	*will be there Um*	EC (R & M)
Mike	104	*Won't be there in time*	

Speaker		Stanford and Georgia Tech team utterances	Stanford team nonverbal communication (from video recording)
Renata	105 106 107 108 109 110 111	*Yes but we can ah organise the dry runs the* ***second*** *dry run to be a sort of (p) if we organise* *it in the evening ?* *(p) that's kind of (p) late evening (p)* *we reserve for Friday Thornton hundred and* *ten (p) it's open*	 EC (R & M) EC (R & M) R flips fingers away from body
Mike	112 113	*It's (p) it's a nice room Umberto (p) it's very* *large and it um it's sort of*	
Renata	114 115 116 117 118 119 120	*It's like a case study (p) if you ever went to a* *case study room* *in the law school?* *The law school? It usually (p) it's like all the* *(p) ah ah (p)* *organised in a U shape (p) OK (p) so* *everybody*	 EC (R & M) R shrugs R & M nod to David entering room
David	121 122	Can I eat? Shall I sit up? I won't come near (p) I'll sit wherever you	D holds dinner plate & stands looking at R
Mike	123	Don't come near the computer	
Renata	124	If you drop anything	Moves to let David into room
David	125	I'll buy a new carpet (p) why you	D sits
Renata	126 127	**You bet! You buy a new carpet!** *OK David* *showed up and we all had our initial*	
David	128	*Hey! Hey!*	M picks something from floor
Renata	129	*jokes*	
Mike	130	Why (p) you make jokes?	M to D
Renata	131 132 133	*He just brought some* ***illegal stuff*** *into the lab*	 M laughs & EC (R & D)
Mike	134	***He's being nice!*** *Because*	
Renata	135	*And he said to me don't*	
David	136	What about your new job?	
Mike	137	Let's not talk about my [new job]	
Renata	138 139	*I had (p)* What new job?	
Mike	140	I had some spectral deposits confirmed	
David	141	**Oh! Oh!**	R puts hands over eyes and laughs
Mike	142	And um (p) this is (p)	
Renata	143	*We are going to be here […]*	
Mike	144	*Anyhow let's get on*	
Renata	145	*OK*	
Mike	146	[..] it isn't that important to you guys	
Renata	147 148 149 150	*So ah (p) there will be a message in your* *email ah with the location and the time ah* *(p) just for your information. We start at* *four forty five*	
David	151	Oh really? Doing?	M sees something behind R
Mike	152	Sorry I don't know if you saw that	M waves his head for R's benefit toward source of distraction
Renata	153	Yeah something weird	
Mike	154	*OK four forty five*	

Speaker		Stanford and Georgia Tech team utterances	Stanford team nonverbal communication (from video recording)
Renata	155	*In Thornton hundred and ten (p) and (p) will*	
	156	*I was fighting to get it (p) if (p) it's very*	
	157	*hard to get [Isaac]*	R pushes hand away from face
	158	*Off the […]*	
	159	**David watch out!**	D drops food on carpet
	160	**I'm very tense now! Ah!**	D laughs & EC (R & M)
Mike	161	I'm still wired from this morning so	To R
Renata	162	*Yes (p) so we have a nice (p)*	
	163	*and the presentations will be about seven*	Serious again
	164	*thirty and then until about nine*	
	165	*nine thirty we party*	EC & both nod heads (R & M)
Mike	166	*OK*	
Renata	167	*And everybody is coming to Stanford*	
	168	***as I said***	R counts with finger in air
	169	*the Georgia Tech people ah and also my*	
	170	*colleague from Georgia Tech*	EC & both nod heads (R & M)
	171	*[…] is coming here (p) the industry*	
	172	*managers are coming*	
Mike	173	*OK*	
Renata	174	*It will be fun*	EC (R & M)
	175	*And for your information I will also send out*	
	176	*the list*	R's hands move in water mill action
	177	*of guests so*	
Mike	178	*OK*	EC (R & M)
Renata	179	*You know a little bit who's there OK?*	
Mike	180	*OK […] dry run?*	
Renata	181	*You will have two dry runs OK?*	R raises finger in air
David	182	*What are dry runs?*	EC (R & D)
Renata	183	*Yes OK* **quick before your**	David drops some food on floor
David	184	Is that	
Renata	185	**No!**	EC (R & D)
David	186	[…] up there	
Renata	187	Your team	EC (R & D)
	188	has to get (p)	
	189	your act (p) together	EC (R & D)
	190	and my suggestion	R nods head down EC (R & D)
	191	is you should have a dry run on a preferably	
	192	similar work for me on Tuesday and the	
	193	second on Wednesday	
Mike	194	*Wednesday? OK?*	R nods
Umberto	195	*yes*	
Renata	196	*OK? and*	
Mike	197	It is better than last time we did a dry run	EC (R & M)
	198	one day and the next day there was still […]	
Renata	199	This (p) I suggested last time the same	EC (R & M)
	200	strategy	
David	201	Yeah but	
Renata	202	**Ah you were not listening!**	
Mike	203	**Now I know!** You were pleased with me (p)	M laughs & EC (R & M)
	204	now	
Renata	205	Now that you know I'm glad (p) so (p) any	
	206	time but not in the morning don't bring me	R laughs
	207	here at eight I get that day from my club (p)	EC (R & M)
	208	you are not a personal organiser OK	

Speaker		Stanford and Georgia Tech team utterances	Stanford team nonverbal communication (from video recording)
David	209	Where did it go	
Renata	210	Yes but (p) I don't know (p) you aren't […]	
David	211	good	
Renata	212 213	*Good (p) so (p) every time (p) ah (p) time (p)* *I kept my schedule for next week open*	
Mike	214 215	*Would it be better to work out the schedule now? (p) do it now?*	
Renata	216	*Do you drive? [..] it now*	
Mike	217	*I drive? […] in the afternoon?*	EC (R & M)
David	218	*Yes two to three*	
Mike	219	*OK how about one o'clock?*	