Computer Supported Co-operative Work: Cases and Concepts

M. Robinson
Sageforce Ltd.
61 Kings Road
Kingston-on-Thames
Surrey KT2 5JA, England

Abstract

CSCW is a new field of research in Europe, the USA, and Japan. Its original thrust was to develop software with groups of users to increase their competence in working together. It grew from some failures of, and problems inherited from Office Automation and Management Information Systems; from some sociological intuitions about ways people might work together; and from new interfacing and networking technologies. The content of the field is illustrated by some "first generation" CSCW applications: group authoring; calendar management and meeting scheduling; action co-ordination in organisations; nursing; wage bargaining; informal conversation; and large meetings. These applications had a mixed reception. Some CSCW specific concepts emerged that started to account for this experience, and to influence future CSCW design. These were: articulation work; situated action; unanticipated use; mutual influence; shared information space; shared material; double level language; equality; and "flipover". The implementation of these concepts forms a preliminary agenda for CSCW.

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1 Introduction

CSCW is a new field of research and development, involving increasing numbers of institutions in Europe, the USA, and Japan. It grew from fairly unsystematic attempts by various developers to generate software that would increase the competence of people working together. This in turn was partly a response to: failures of and problems inherited from Office Automation and Management Information Systems (See, for instance, [Sco78, FGHW88, Lyy89, Sch91]); some sociological intuitions about ways people might work together; and a search for uses of new interfacing, networking, and multi-media technologies.

The applications that emerged had a mixed reception. Some of them are reviewed in the first part of this chapter. A series of conferences and meetings between 1984 and 1991 considered them—and the nature of the common enterprise that was christened CSCW. Simultaneously, in papers and books, some "CSCW specific concepts" emerged. A selection of these will be summarised in the second part of this chapter.

In one sense these "CSCW specific concepts" are based on, and help account for past work in the field. In another, they form a preliminary agenda for research, design, and implementation of CSCW applications. The unique quality, and some of the excitement of CSCW is well summarised in the following quotation:

> ".... CSCW is neither solely a tool or technology business, nor just a new way to study computer impact on the work place. Instead, in CSCW, equal emphasis is put on *the distinctive qualities of co-operative work processes, and on questions of design: how to mould computer technology to fit into and support these work processes.* Due to the prominent role placed on the process of design, the issue in CSCW is not just how the work process is currently organised, but also how it *could* be organised." [Lyy89]

2 Some CSCW Applications

The full range of current CSCW applications is best understood from the published proceedings of the last four conferences [GS88, BB91, ACM90, BRS91], and the books of readings by Greif [Gre88] and Galegher et al., [GKE90]. Seven examples will be given here to illustrate the range of technology, and the negative as well as positive aspects of the learning process that is CSCW.[1]

2.1 GROVE (Group Authoring Software)

The GROVE system was developed at MCC, Texas, in 1988 [EGR91]. The need was for several researchers to write a joint paper under considerable time-pressures. This came together with an objective to explore "distributed meetings", where the participants are not in the same place at the same time.

GROVE is basically an "outliner" similar to those found in many word processors. The main difference was that it had a real-time group editor. Participants would connect to it and each other with computer and a voice links. The various co-authors remained in their own offices. The voice link was a loudspeaker phone. Everyone had their hands free, but could talk with anyone else in the group. Each had a personal workstation, running the outliner. Each could select any part of the outline to work on or develop. Thus one author could be developing the framework for say, a definition of shared databases in Section 3 of the paper; another could be working on "graphics" in Section 5; another on whether the Introduction would be too long if examples were included; and so on. All authors could see what the others were doing, and what progress was being made, by "paging up and down" the document.

Each workstation had a private and public window onto the underlying document. There was also the possibility of shared screens between group members. Entry was anonymous, although the verbal channel allowed people to ask who was doing what.

[1] With the exception of CRUISER, the applications considered in this section (GROVE, Electronic Meeting Scheduling, The CO-ORDINATOR™, The Florence Project, the "Wage Bargainer"; the Arizona Decision Room) are largely based on text taken from "Double Level Languages & Co-operative Working" [Rob91].

It is interesting to note that some of the usual software design problems were not solved in advance of trying out GROVE. For instance, there was no built-in "access contention" resolution method. This meant there was nothing to prevent any two authors attacking the same bit of text simultaneously:

> "It was a shock to find someone else wordsmithing a sentence I was in the middle of writing."

The automatic renumbering (when someone added or deleted a line) was also experienced as "abrupt".

> "You are working on a screen when there is a flash of renumbering as someone has changed something higher up. Or you suddenly see words jump around as a consequence of what someone else is doing. You don't actually see it coming as you would in a normal meeting...."

Despite this lack of polish, by September 1988, 11 out of the 12 groups that used GROVE loved it. There were many anecdotes and an enthusiasm to use it again. GROVE stands out as a CSCW application because of the spontaneous enthusiasm expressed by its users, and because of its fundamental simplicity.

2.2 Calendar Management

In an excellent review titled "Why CSCW Applications Fail", Grudin [Gru88] points out that many systems, applications, and features that support co-operative work share two characteristics: high cost and low success. He looks at the track record of electronic calendars to show how the dubious track record of many applications can be traced to a common dynamic—a "disparity between those who will benefit and those who must do the work." The point is clearly made, and is worth quoting at length.

> "Where electronic calendars are in use on a large or networked system, an automatic meeting scheduling feature is often provided [Ehr87a, Ehr87b]. The concept that underlies automatic meeting scheduling is simple: the person scheduling the meeting specifies a distribution list and the system checks the calendar for each person, finding a time convenient for all. The system then notifies all involved of the tentative schedule.
>
> For automatic meeting scheduling to work efficiently, everyone involved must maintain a personal calendar and be willing to let the computer schedule their free time more often than not. Data reported by Ehrlich (ibid) suggest that neither of these requirements are generally satisfied.
>
> Electronic calendars are *not* electronic versions of paper calendars. They serve communication functions, primarily for managers and executives with personal secretaries who maintain the calendars. An electronic calendar may be used simultaneously by the secretary for scheduling, the manager for reviewing, and other group members for locating or planning. Ehrlich describes the successful use of the electronic calendar in detail; a key point is that "the secretary's role is critical"; those who do not have a secretary are much less likely to maintain an electronic calendar. Another relevant finding is that for managers, "free time is never really free". Unauthorised scheduling of a manager's apparently open time "can be sufficient motivation for total rejection of the system by the manager."
>
> Thus, electronic calendars are voluntarily maintained primarily by managers and executives (or their secretaries). This has dire consequences for automatic meeting scheduling. If a manager wants to meet with non-management subordinates, few of the latter are likely to maintain electronic calendars. The scheduling program will find all times open, schedule a meeting, and conflicts will ensue. "In order to take full advantage of an electronic calendar, all members of a group must commit to using this medium,"

> [Ehr87b]. If managers or executives keeping online calendars wish to meet among themselves, automatic scheduling could work. But as noted above, free time is often not truly free for such managers; it would be wise to consult with their secretaries anyway. Thus automatic meeting scheduling may rarely be used in this situation either.
>
> The simple meeting scheduling feature previews the pattern that emerges from the major applications discussed later. Who would benefit from automatic meeting scheduling? The person who calls the meeting: in general, the manager would benefit. But who would have to do ***additional*** work to make the application succeed? The subordinates, who would have to maintain electronic calendars that they would not otherwise use. ....."

When an organisation introduces a comprehensive ***system*** it may be possible to dismiss or redeploy those that refuse to use it. When a CSCW ***application*** is introduced, these drastic options are not available. Applications in which some people benefit at the expense of extra work for others are unlikely to be successful.

The Electronic Calendar looks like a good idea. It meets many of the frustrations that are often voiced about scheduling meetings. It comes unstuck in most cases because it does not take the practical work processes of ***all*** staff members into account.

2.3 The CO-ORDINATOR™

This is probably the best known CSCW E-Mail application. Its function is "conversation management"—particularly it "reminds you when some action is asked or committed" [Act89]. It is based on the major ideas of Speech Act Theory [Aus62, Sea79, Flo82].

> "... language cannot be understood as the transmission of information.
>
> Language is a form of human social action, directed towards the creation of what Maturana calls 'mutual orientation'. This orientation is not grounded in a correspondence between language and the world, but exists as a consensual domain—as interlinked patterns of activity. The shift from language as description to language as action is the basis for speech act theory, which emphasises the ***act*** of language rather than its representational role." [WF86, page 76]

From this it follows that the most valuable role for the computer is to ***mediate*** communication between people—as opposed to participating or replacing people—a common perception in Artificial Intelligence projects. This idea is the deeper one that conversation (not description) is the fundamental organisational unit.

> "We ask 'Who makes requests and promises to whom, and how are those conversations carried to completion?'" (ibid p. 168)

and

> "We are not proposing that a computer can 'understand' speech acts by analysing natural language utterances. It is impossible to formulate a precise correspondence between combinations of words and the structure of the commitments listened to in a conversation. What we propose is to make the user aware of this structure and to provide tools for working with it explicitly." (ibid p. 159)

The CO-ORDINATOR™ was designed as a computer-based Electronic Mail system to facilitate exchange, clarification, and negotiation of commitment in organisations. There is little doubt that the CO-ORDINATOR™ was also intended to facilitate "co-operative working"; as a way of deepening realistic democracy and respect for people in organisations. Flores had been the Minister, in the Chilean Allende government, concerned with Project Cybersyn [Bee75, Bee81]. This is directly recognised as a predecessor of the CO-ORDINATOR™. Further, there is a recognition of skill (or the need for "reskilling" [Coo80]) that seems to place the project outside the Taylorist paradigm.

> "Anyone in a position to direct actions that affect the economic, political, or physical conditions of others is in some sense a manager. In all but the most routinized jobs, a worker functions in some ways as a manager, requesting and initiating actions that affect the work of others." (ibid p. 143)

While one report [JOW86] suggests user acceptance, many others do not, and take a highly critical position of the performance and nature of the CO-ORDINATOR™ [BBBG88, GC88]. Bowers and Churcher [BC88] raise important linguistic problems about "conversations for action", but the nub of the objections seems to be that the CO-ORDINATOR™ is experienced as excluding negotiation. This has led to the observation that it works in stable, hierarchical, authoritarian organisations, but not elsewhere. Those who defend the co-ordinator do little to dispel this impression.

> "Kent Hancock of EDS reported a more favourable experience with the CO-ORDINATOR™. EDS has a reputation as a company with strict rules and strong discipline. 'In our management structure we try to think of each other as equals all the way up and down the management chain' said Hancock. His verdict on the CO-ORDINATOR™: 'It is a good communication tool and it gets the job done by forcing compliance'." [Dur88]

With friends like this, the CO-ORDINATOR™ hardly needs its enemies to whisper about the "world's first fascist computer system". How has this unfortunate reversal of the original intentions come about? How did the adoption of radical speech act theory lead to this level of discontent?

Grantham & Carasik [GC88] provide some interesting evidence. The CO-ORDINATOR™ was introduced, for a six month trial, to 15 "technical professionals" at Pacific Bell who used frequent phone and E-mail communication with each other.

> "The basic finding was that the use of the software prompted expression of emotional, or affective states in almost all subjects. In most cases, these expressions were not solicited but occurred freely. The most cogent observation was simply the stoppage of use by a majority of subjects. In this sense their actions spoke louder than their words. When questioned, they stated that the format of their interaction pattern encouraged by the software was "unnatural", "uncomfortable", and "made no sense" to them.
>
> Subjects reported feeling overly restricted in "how they can talk to one another" in the speech act paradigm. Although, most admitted not understanding what the underlying language paradigm was; they felt that an intellectual understanding would not ally their felt emotional states. .....
>
> ..... it was revealed that a large part of the communication occurring during the trial period was designed to formulate new rules of group behaviour. .....
>
> Subjects openly expressed the need and desire for a communications medium which would augment their search for common understanding. Open ended, free flowing, almost serendipitous conversations were the norm for this group of individuals."

and

> "It is our conclusion therefore, that the CO-ORDINATOR™ failed to be incorporated into a normal workflow pattern because it, and its underlying paradigms of work, failed to acknowledge the experienced phenomenon of work. The CO-ORDINATOR™ makes explicit and textual a dimension of human communication which is otherwise contained in the overall context of interaction. It further makes the unsupported assumption that participants in the system will willingly share the designers' view that one ***should*** be extremely explicit about the nature of one's utterances.
>
> This assumption violates the phenomenology of work which embeds a process of negotiating the agreement of meaning among workgroup members. Pask's [Pas80] conversation theory gets to this point when he makes the distinction between communication and conversation. Communication is a process of transmission of information between, and among group members. Conversation is distinct, in that it implies a process of concept sharing and development of agreement of the interpretation of meaning events.

> In this sense the CO-ORDINATOR™ supports a process of communication, but does not necessarily support the process of conversation, or the negotiation of meaning interpretation among group members."

While it is too early to bring in a verdict on a system still under development, and on the basis of relatively few cases, it appears that the CO-ORDINATOR™ violates some basic CSCW concepts considered later.

2.4 Work Team Support—The Florence Project

Four researchers from the University of Oslo set out to:

> "... explore whether—and how—computer systems can be used in nurses' daily work rather than focusing on more administrative work tasks, carried out by head nurses and the like." [BB88]

The system was developed around a need identified by the nurses themselves:

> "I wish we (ie.. the nurses) could talk about computer systems which support co-operation with others—it would be beneficial to our work if the nurses stopped being the information network in hospitals." (ibid)

Another need was explicated in more detail on the cardiological ward, which often treated emergency heart attacks:

> "The patients stay in the ward for a rather short time, approximately 3 days. According to the nurses this means the patients are replaced so often that it is hard to get to know them. On the other hand, its impossible to increase the stay since this would require extra personal. Because the patients stay for a short time, and are emergency cases, it is difficult to organise the work according to primary nursing. This means the nurses have to give a rather detailed report every day." (ibid)

The nurses information function was complex. It involved at least passing all relevant information to the next shift, co-ordinating information with other nurses to have an overview of the state of the ward, arranging for different medical doctors to meet (or conveying information to them individually), and relaying the doctors' daily programmes for each patient back to the ward.

All these meetings cut into the time available for patient care. The CSCW supported competence would be a way of "packaging variety" [ZR89] so that everyone got the necessary information without all the meetings. The equality that was not recognised in the Electronic Calendar is found here:

> "Due to the project being a research project, the nurses were free to not use the system. As researchers and outsiders we could not force the nurses to use the system. The only possible reason for using it was the nurses' own motivation based on their own positive evaluation of the system." (ibid)

There was a sensitivity to the nurses own way of talking and acting:

> "We seldom talk about co-operation in our daily work, we just do it. One example of this "wordless" connection is the concept "overview". The nurses use "lack of overview" to explain the rejection of different suggestions for changes. Overview seems to relate to the nurses' "inner picture" of the ward. This inner picture has to be in common (to some extent) to the nurses in a ward, and it seems to be the basis for their co-operation. The nurses are not able to explicate what gives overview, but they are quick to tell if something is not useful for getting an overview." (ibid)

There was a sensitivity to the existing "system", which utilised "scraps of paper"

> "At the beginning of each shift, there is a meeting where one nurse from the preceding shift gives the new comers a status report. Each of them writes down the most important information on their own scraps (of paper). During the shift the nurses use the scraps to look up information, and to write down important observations and happenings. The sheets are "use-once-paper", ie. the sheets are out of date the next shift." (ibid)

and the computerised system was based on it.

> "The information in the Work Sheets is presented in a way that gives the nurses overview of the patients in the ward. It is this overview that is the basis for the decisions made by the nurses during a shift."
>
> "... the Work Sheets contain only the parts of the patient information which the nurses have in common. Compared to the nurses' scraps, the Work Sheet does not add structure to the information. And the process of using the information is not standardised. Like the scraps, the Work Sheet will support the non-formalised professional decision making." (ibid)

The formalised Work Sheets "fix" information that the nursing group has decided to be relevant, enabling their "non-formalised professional" evaluations and decision making to happen around them. The importance of the structure of the Work Sheets is highlighted by the fact that

> "... one of the kernel groups has refused to use the computer system. But they produce Work Sheets nevertheless. They know how to get "empty" Work Sheets, and then they fill in the information by hand." (ibid)

2.5 A Group Decision Support System—The "Wage Bargainer"

The "Wage Bargainer" was developed in 1987 by the Open University as part of the WISDOM Project to explore collective uses of new technology [Rob89, Rob90]. The context was a "real co-operative" (enterprise owned and controlled by its workers). The problem was two hundred people in a dozen or so workgroups, with a wage structure that had "evolved" over 19 years. During this time, the organisation had increased in size sixfold, and many new specialisms and functions had developed. The wage structure had become so complicated that it was almost incomprehensible. Anomalies abounded, as did the discontent that they gave rise to.

Since the organisation was a co-operative, there was no external owner, or separate management to bargain with. No single group could ***impose*** a new structure. In practice, and in some way, the workers had to bargain with each other. This situation had been evaded in previous years by acceptance of National Agreements reached by various appropriate unions. The glaring anomalies now meant some other way had to be found.

The Open University team provided a spreadsheet. Each group had its "own" screen. This showed their salary and salary range, in figures and as "points" on the wage scale; overtime rates, and overtime actually paid; number of workers in the group; extra costs of insurance contributions; etc. Each group screen was driven by an underlying table of wage scales and actual salaries. Each screen also showed the consequences of the current situation, and of any changes, to the co-operative as a whole.

Each group could change any of the factors that directly affected it (wage scale range, increments, overtime rate, number of workers, etc.). Although ***any*** group could make ***any*** change, what the co-op ***could*** pay was determined by the relation of all the "claims" taken together to its total (budgeted) income. Each group had to evaluate its claim in the light of other claims. Negotiations were reflected in the "groups screens" but took place directly. Negotiation was not a part of the computer system.

The "Wage Bargainer" was well received. A great deal of experimentation took place, as well as some fantasy realisation. One group claimed parity with Civil Service Grades, and awarded themselves an appropriate increase that ate up the surplus for the whole organisation. There was also considerable interest in what others were actually paid. Although this information had

previously been available in theory, in practice it had been too difficult to get. Finally it was agreed that the reality of the budget income was such that a 3% across-the-board increase was the minimum everyone would accept, and the most that could be paid. The anomalies remain, but the problem the anomalies were causing was resolved.

The "Wage Bargainer" was a simple and obvious application that was received with enthusiasm as a useful tool. It enabled the co-operative to achieve a satisfactory resolution of the wage question. Most people did not get as much as they would have liked—but they understood why, and accepted it. The final result could not have been deduced (or algorithmically derived) from the original claims. The mutual adaptations, the ability to take new positions, allowed by iteration and discussion were a necessary part of the process.

It was recognised that individual viewpoints always have a context. Contexts—especially when the context is people in co-operating groups—are mobile. Meanings are not ***and cannot be*** divorced from context. "Freezing" viewpoints is the best way of rendering them meaningless. CSCW applications cannot rely on participants having fixed positions—or on frozen representations of fixed positions. Rather they should support a process of mutual influence.

2.6 Computer Supported Spontaneous Interaction—CRUISER

At first sight, CRUISER [Roo88] appears to be a typical hi-tech, high cost system suited only to luxurious offices in the US. Computer support for gossip appears to be a decadent luxury! Or does it?

First, what is informal interaction?

> "... the fact that people move around the workplace in the course of their daily activities. They go to lunch, get coffee, visit colleagues, make copies, and so on. During the course of these excursions they are likely to bump into other people on similar errands, or to pass by people working in their offices." (ibid)

And why is this of any significance?

> "[All84] states that social interactions and resulting personal relationships are critical to the success and effectiveness of the organization: they foster the development of mutual understanding, define the channels though which information flows into and throughout the organization, and increase the effectiveness of communications among technical employees. Workplace social relationships are also known to be important elements of job satisfaction and sources of social support [Loc76]
>
> ..... Kraut, Galegher and Egido [KGE88] have observed that collaborations actually operate on two "inextricably intertwined" levels of activity—personal relationships and research tasks. They argue that the major facilitator of processes at both levels is good communication, ie. frequent, low-cost face-to-face interaction, especially the brief unplanned encounters where important bits of technical and personal information can be exchanged "on the fly". They conclude the simple effects of physical proximity and frequency of interaction probably directly affect the success of collaborations....." (ibid)

This raises the question of how to most effectively support work between colleagues and collaborators when they are necessarily separated by large offices or different workplaces. CRUISER attempts to tackle this problem. It takes its name from "cruising"—the teenage practice of the '50's of piling into someone's car to visit coffee bars in search of social encounters.

Technically, the design assumes the availability of desktop full-motion video communications; high quality full duplex audio; a switched multimedia network under the control of a local computer; and integration of video images and computer-generated graphics. Root [Roo88] says of it:

> "CRUISER is designed round the concept of virtual personal communities which can exist only in a virtual world, a place in which proximity is rendered irrelevant by providing instant access to anyone anywhere. CRUISER derives much of its power from two ideas: first that users can have a variety of mechanisms for browsing the virtual world in search of social encounters. and second, that the virtual world is independent

> of the physical world, and can be organised and populated according to the needs of the user".

In practice, CRUISER provides a 2D map of the office building (which may or may not be veridical). The user can wander the corridors, look into other peoples offices, visit the common area or the printer, and so on. Communication is by microphones and video cameras placed in every office and common area.

CRUISER is taking on a real problem of project and team work support. It recognises a subtlety that is often missed—the importance of informal communication. It has some sensitive features, by analogy with workplace practice, to allow several levels of privacy. But there remains a very serious question. Who would want a video camera watching them, and a microphone listening to them in their office? There is a very long history of resistance to any form of monitoring (eg. the tachograph). Is it even desirable that "resistance to change" should be overcome? Bannon et al. [BBD88] raise the spectre of the "Panopticon"—Bentham's prison where the warder sees into every cell—as a very real potential for abuse of CSCW. Computer support has to be sensitive, not just to people's working practices, but to their culture and their politics. It is unlikely that CRUISER will clear this hurdle. Technical excellence is not the prime hallmark of a CSCW application.

2.7 The Arizona Groups Decision Support System (GDSS)

The problem addressed here is the large meeting. Small meetings are familiar to most people. They are rich and flexible. While it is true that fruitful meetings depend on skills that can be taught and learned [OU86], this learning takes place on a strong base of existing experience.

Large meetings are a different problem. They

> "... are time consuming and expensive. They are often seen as boring or irrelevant. They may be ill-attended or unrepresentative. They may be dominated by a few people. They may go round in circles without reaching a decision. Decisions may have more to do with how much time there is left than with the issue in hand. Complex issues may be oversimplified, or presented in a lop-sided way. Important alternatives may be suppressed in setting the agenda. And so on." [Rob89]

The ability to have a real say in a large meeting concerned with a complex issue would be a new competence. This possibility has been explored at the Management Information Systems Department of the University of Arizona.

The research has concentrated on the development of a Group Decision Support System (GDSS) which is embodied in a Meeting Environment, sometimes also called a "Decision Room".

> "A large U-shaped table is equipped with up to 16 networked micro-computers that are recessed into the table to facilitate interaction among participants. A microcomputer attached to a large screen projection system is also on the network, which permits display of work done at individual workstations, or of aggregated information from the total group. Break-out rooms are equipped with microcomputers that are networked to the microcomputers at the main conference table. The output from these small group sessions can be displayed on the large screen projector for small group presentations and can be updated and integrated with planning session results." [VNAK]

The system supports a variety of software, including Electronic Brainstorming, Assumption Surfacing, Issue Analysis, Stakeholder Identification and Analysis, etc. These are intended to support a wide variety of group tasks, demands, and styles in a flexible way.

Unusually, the work at Arizona has concentrated on supporting large groups of more than 8 people. The current Environment will support up to 32 people. A new facility is under construction that will support 64 people in one meeting. Some results to date are:

> "Efficiency considerations of Group Decision Support Systems become increasingly apparent as group size increases. It is difficult to demonstrate that GDSS promotes efficiency for small groups (eg. of size 3 to 5). For larger groups (eg. of size 8 and up)

> the GDSS enhances group efficiency by facilitating input from all group members in a relatively simultaneous fashion. Members need not "wait their turn" to contribute to the question or problem before the group. ...
>
> Group effectiveness when using decision support systems is enhanced as group size increased. For groups of six to eight or more, the effectiveness of GDSS becomes particularly apparent in facilitating and co-ordination of large numbers of issues associated with a complex question. Small groups, by contrast, often find that while the GDSS is interesting, it is difficult to suggest that any striking measure of increased effectiveness has been attained.
>
> Member satisfaction with the group process is better when the groups are larger. For larger groups, the reduction of equivocality on issues associated with complex problems or questions that exceed the capabilities of individual members or small groups to address is more readily apparent. Larger groups appreciate the structuring inherent with the GDSS to keep the group from becoming "bogged down" or subject to domination by member personalities. Small groups are more frustrated by GDSS constraints, and are less likely to conclude that GDSS is more effective or efficient than an unstructured face-to-face meeting for the relatively less complex questions typically addressed by small groups."
>
> (ibid)

In summary, we can say that systems designed for, or used in support of small groups have had patchy results [RE88]. Usually they were attempting to "improve" an activity people could do reasonably well unaided. In such circumstances, people can afford to be "picky", and the software provided has to be very good indeed.

There is a clear organisational need in industry, in national and local government [GLC85, Coc88], for large meetings to deal with complex or controversial projects [BU88]. Without the involvement of relatively large numbers of people, much necessary expertise and even crucial viewpoints are left out of the decision making process. Unfortunately, to date, large meetings have usually been found to be impracticable and/or ineffective.

The evidence suggests that computer support for things people couldn't do without it (like large meetings) is likely to be appreciated if it works at all. This is re-enforced by the Arizona experience. Although the overall project is ambitious and sophisticated, some of the tools are less so. The microcomputers involved, for instance, are IBM PC's—which are certainly not the most user-friendly machines available. Response times in some applications would be unacceptable in other contexts—for instance, the mean time spent waiting for the screen[2] during Electronic Brainstorming was half a minute! [NAK87] Yet the Meeting Environment provides a way of doing what could not be done without it , and this is appreciated by the users. Again we see that the design concept may be more important than the technical excellence of a CSCW product.

3 Some "CSCW Specific" Concepts

In one sense, CSCW is a new attempt at old problems. In addition to the problems of Office Automation and Management Information Systems mentioned earlier, it is worth mentioning the failures of planning (see [Suc87]) and of participatory democracy in the workplace. (see [BBS79, Rob83, Sal79, RW86])

The central problem lies in the nature of the reality that has to be dealt with. This is best illustrated in a comment by Sheil [She83].

> "I had approached those offices convinced (with the confidence of not having realised that there might be an alternative) that office procedures were, at least in principle, clearly defined methods of processing information. Programs, in other words. Things that could be transcribed, analysed, maybe even reprogrammed for a different "machine". But, above all, *I assumed that they existed, independently of my enquiries.* And that is fantasy."
>
> (ibid Emphasis added)

[2] [Mar89] reports that the original version of Electronic Brainstorming took one minute to send and recover files, but that the current version has a response time of under 12 seconds even with groups of 24.

This section will outline ten concepts that seem to be basic to CSCW. They are not mutually exclusive, and there are many overlaps. They are not a checklist, or taxonomy, against which applications can be measured—although it is interesting to notice their absence or presence in particular applications, and to consider how this relates to their usefulness or otherwise. These "CSCW specific concepts" are based on, and help account for past work in the field. They also form a preliminary agenda for research, design, and implementation of second generation CSCW applications.

"Articulation Work"

> "No representation of the world is either complete or permanent. Rather, any description is a snapshot of historical processes in which differing viewpoints, local contingencies, and multiple interests have been temporarily reconciled.
>
> ..... even apparently simple pieces of information such as entries on fixed forms are the result of many negotiations and struggles. These may include ad hoc decisions by clerks, responses to patron complaints, the organisations policy decisions, the rules of regulatory bodies, and the limits of the local database management systems. In order to create adequate representations, then, office workers must somehow reconcile multiple viewpoints with inconsistent and evolving knowledge bases. Since no centralized authority can possibly anticipate all the contingencies that might arise locally, *office workers always have some discretion* in deciding how this reconciliation is to be accomplished. .....
>
> ***Without an understanding of articulation, the gap between requirements and the actual work process in the office will remain inaccessible to analysis. ..... When the articulation of the work is deleted in representations of that work, the resulting task descriptions can only be uneasily superimposed on the flow of work.***
>
> It will always be the case that in any local situation actors "fiddle" or shift requirements in order to get their work done in the face of local contingencies. We argue here that *such articulation* is not extraneous to requirements analysis, but *central to it.*" [GS86]

The calendar management problems that we considered earlier seem to exclude the possibility of articulation work. Entries on fixed forms are kept, if at all, by many people for many diverse reasons. These disparate entries are then unproblematically aggregated to produce a meeting date and time. This procedure seems to ignore Gerson and Star's observation that "even apparently simple pieces of information such as entries on fixed forms are the result of many negotiations and struggles". The experience with automatic meeting scheduling seems to confirm their remark "When the articulation of the work is deleted in representations of that work, the resulting task descriptions can only be uneasily superimposed on the flow of work." The challenge for CSCW is to find ways of supporting work that are negotiable, and do not marginalise the articulation work that lies at the centre of "orderliness" in the office.

"Situated Action"

> "There are few physical activities that are a necessary part of performing the action of turning on a light. Depending on the context, vastly different patterns of behavior can be classified as the same action. For example, turning on a light usually involves flipping a light switch, but in some circumstances it may involve tightening the light bulb (in the basement) or hitting the wall (in an old house). Although we have knowledge about how the action can be performed, this does not define what the action is. The key defining characteristic of turning on the light seems to be that the agent is performing some activity which will cause the light, which was off when the action started, to become on when the action ends. An important side effect of this definition is that we could recognize an observed pattern of activity as "turning on the light" even if we had never seen or thought about that pattern previously." ([All84] cited in [Suc87])

On which Suchman [Suc87] comments:

> "Allen's point is twofold. First, the "same" action as a matter of intended effect can be achieved in any number of ways, where the ways are contingent on circumstance rather than on definitional properties of the action. And secondly, while an action can be accounted for post hoc with reference to its intended effect, an action's course cannot be predicted from knowledge of the actor's intent, nor can the course be inferred from the observation of the outcome." (p. 34)

She makes a similar observation earlier

> ".... the problem of meaningful action turns on the observation that behavior is inherently subject to indefinitely many ascriptions of meaning or intent, while meaning and intent are expressible through an indefinite number of possible behaviors." (p. 3)

And remarks that this is useful and desirable state of affairs.

> "It is precisely because our plans are inherently vague—because we can state our intentions without having to describe the actual course that our actions will take—that an intentional vocabulary is so useful for our everyday affairs." (p. 38)

In effect, Suchman has advanced an impossibility theorem; a conclusive and straightforward argument that there can be no a priori or algorithmic connection between any particular plan and any specific action. This insight underpins the "failure of planning" and has important implications for the design of CSCW applications: they should beware of trying to anticipate too much about any work situation.

The idea of situated action is remarkably similar to the idea of articulation work, yet there is a difference of emphasis which is valuable for an understanding of CSCW. Gerson and Star stress the distinction and yet the connectedness of representation with action. Suchman, on the other hand, stresses the autonomy of plan and action. This is illustrated by the Florence Project. There obviously is an overall plan for dealing with cardiac patients. But this has nothing to do with the nurses' "overview" of the ward—the crucial aspect "discovered" by CSCW analysis. The "overview" is an aid to understanding constantly changing context. It is the best way of situating action—realising the agenda set out in the plan—within this flux of context.

"Mutual Influence"

> "Participants should be able to retract, restate, change, or take a totally different position in the light of views and feelings expressed by others." [Rob91]

A central problem of co-operative working is that people usually do not know the thoughts, intentions, and feelings of, or "facts" available to others with respect to a particular issue. These are discovered in the course of conversations and discussions in formal meetings and informal encounters.

A bad CSCW application can hinder this process in a variety of ways. It can attempt to substitute for meetings, while excluding the emotive and meta-linguistic nuances. It can block informal conversation. The latter is cited by Egido [Egi88] as a major reason for the confinement of videoconferencing to small market niches. Bad systems can also "freeze" viewpoints. A frozen viewpoint is then an "object" that has to be reconnected to other "objects" in some way—whereas in a real conversation, utterances are often integral parts of other utterances. They take their meaning from their immediate context. They are temporary placemarkers in a fluid whole.

A central property of conversation and discussion is that people change their minds (preferences, choices, viewpoints) in the light of the whole discussion, including their own previous expressions. CSCW applications should reflect this. Apart from the problems of inequality noted by Grudin with Electronic Meeting Scheduling, such applications also violate the desideratum of mutual influence. Choices about free time and its meaning (if people can be persuaded to make them) are frozen. The choices are algorithmically put together again as a "conclusion" to the question "when should we meet?". An iterative procedure—assisting rather than automating meeting scheduling—might be an improvement. "Tuesday at 10 looks good for most people. Are you still available?"

> "The ability to retract, restate, change, or express different views in the light of the whole conversation means that participants must have access, in some way, to the whole conversation. Nevertheless, applications that support this are not required to be intelligent, or even particularly sophisticated." [Rob91]

The idea of mutual influence has much in common with both situated action and articulation work. This time the stress is on the social context of actions, plans, and representations; on the process of articulation and negotiation, rather than the plans or actions that flow from it. The Open University "Wage Bargainer", considered earlier, was an explicit and reasonably successful attempt to explore the potential of computer support in the exercise of mutual influence.

"Shared Information Space"

> "The computer ... as a medium that could be used dynamically ... to help people to share their view of the world with others through joint manipulation of each person's personal models of the situation.
>
> The emphasis on the need to share models ... is echoed in the work of Thompson [Tho84]. He has put forward the concept of an increase in the shared information space of the communicating parties as the key feature of radical innovations in communications technology. In his view, the move from speech, to writing, to print effected three significant changes in the surrounding culture—a change in the ease with which stored human experience can be accessed, an increase in the size of the common information space shared by the communicants, and an increase in the ease with which new ideas can be propagated throughout society. As these features are difficult to measure directly, he proposes a "test of significance" for each as follows:
>
> 1. Must affect the way in which people index information;
> 2. Must increase the range of strategies open to the communicants for the interrupt act;
> 3. Must increase the probability of transmitting or receiving an interesting but unexpected message.
>
> If we turn out attention to computer communication, we find that most of the available facilities do not provide a very rich information space—especially if the focus is on "real time" facilities." [Ban89]

Shared information space is one of the few ideas unconditionally endorsed by Bannon, who is often rightly more sensitive to the implicit dangers than the potential benefits of CSCW applications. In this context, shared information space is obviously necessary as the context in which articulation work, situated action, and mutual influence fit together. But it provides further and deeper cues. It indicates that the shared information space must include the subjectivities of the participants. More than this, the space is "co-constructed" [FIT] and constantly re-constructed by the participants, even if it appears to have "objective" status.

Finally, shared information space shows how the technological elements and the social matrix may fit symbiotically together. The computer may provide an infrastructure for action. In the best cases, this can be thought of as a backdrop against with the traffic of conversation [Atk79] can realize new potentials and innovative structures by building on human action whose significance had previously been unseen and taken for granted—such as the "interrupt act". Currently we are able to "interrupt"—question and clarify—only in face to face situations. The most revolutionary property of the "shared information space" currently in the process of being born may be the ability to "interrupt"—which is really the ability to participate—in a much larger social space.

Projects such as CRUISER illustrate both the potential and the dangers of such a march into the unknown. In addition to the technology, major new forms of politeness, a much amplified sense of respect for other human beings, will be necessary. Fortunately, the precepts of CSCW—as counterposed to those of "Scientific Management" [Tay47]—give us a reasonable start in this endeavour.

"Shared Material"

> "Two ways of co-ordinating co-operative work can be identified. One is by explicit communication about how the work is to be performed. Another is less explicit, mediated by the **shared material** used in the work **process**. A simple example is the way two people carry a table. A part of the co-ordination may take place as explicit communication, for example in a discussion of how to get a table through a door. When the table is carried, however, the two people can follow each others actions because the actions get mediated through the shared material. This co-ordination is not necessarily explicit. Also it has been learned. There is a big difference between two persons first attempt at carrying something together, and the way people with experience do it. The learning is both on the part of the individual, and on the part of the team. ..... The pattern of co-operation is not fixed, it is often defined by the actors." [Sør89]

Pål Sørgaard's notion of "shared material" is orthogonal to the ideas considered so far, but vital for their realisation. Situated action, mutual influence, etc. all need to be grounded in shared material—else the actions may pass each other meaninglessly like ships in the night. Participants need to share a "world" as well as a "space". But the idea of shared material goes further. In the same paper, Sørgaard proposes that it has a programmatic function. Effective computer support for work processes should support dialogue and joint manipulation of shared objects, because, to anticipate the next section, dialogue is always dialogue about something. GROVE, The "Wage Bargainer", the Florence Project, and the Arizona GDSS all provide shared and manipulable material. Sørgaard himself proposed a railway booking system, where the booking clerks have access to iconic, shared, and manipulable models of the trains and their current seating arrangements. He also proposed that object oriented programming provides a crucial tool in the production of such shared materials.

"Double Level Language"

> "In general, it can be said that any non-trivial collective activity requires effective communication that allows both ambiguity and clarity. These ideas of ambiguity and clarity can be developed as the "cultural" and "formal" aspects of language as used by participants in projects and organisations. "Computer support" is valuable insofar as it facilitates the separation and interaction between the "formal" and the "cultural". Applications and restrictions that support one level at the expense of the other tend to fail.
>
> The "formal" level is essential as it provides a common reference point for participants. A sort of "external world" that can be pointed at, and whose behaviour is rule governed and predictable.
>
> The "cultural" level is a different type of "world". It is an interweaving of subjectivities in which the possible and the counterfactual [Els78] are as significant as the "given"..... interpretation and viewpoint take the place of rules and predictability.....
>
> The formal level is meaningless without interpretation, and the cultural level is vacuous without being grounded.[3]" [Rob91]

[3] This distinction has been pursued in a more formal way by Lofgren [Lof89].

> "*The linguistic complementarity.* Every language that can naturally be considered a language contains descriptions and interpretations that are complementary within the language. That is, as long as we stay within a language L, we cannot completely describe L only in terms of its own sentences. Both description and interpretation processes (both sentences and interpretation processes; both models and description processes) are needed in interaction for a full account of L. However, there may be a metalanguage, with a higher describability than that of L, allowing a complete description of L. In that case, we say that the complementarity is *transcendable*. If no such metalanguage can exist, the complementarity is *nontranscendable*."

The distinction between "formal" and "cultural" levels of language is considered nontranscendable. One implication of importance is that it is not possible to change (or improve!) both levels simultaneously.

Seymour Papert once said that "learning to learn is always learning to learn about something". The idea of "double level language" is similar to this. Conversation (even conversation about conversation) is always conversation about something.

The living conversation, with changes of perspective, mood, intention, and interpretation, with its constant search for the right words[4], is the "cultural" level. Papert's "something" is the "formal" level as captured in the conversation. If we ***move*** tables, as in Sørgaard's example, we are moving things with particular physical and aesthetic properties and relations. If we ***talk*** about tables, then we experience the object (the "something") of our conversation as having formal properties and relations[5]. We may conceptualise this experience as "having a model" or "knowing the logic of ..." or as simply "understanding". We may conceptualise it as the ***talking***, and the ***something*** the talking is about.

Many conversations come unstuck because this distinction cannot be established (perhaps for reasons of time-pressure, or numbers of people involved) or cannot be maintained (perhaps for reasons of complexity or conflict). Laing [Lai76] and Bateson [Bat73] have both explored the pathologies that follow from such breakdowns. The enormous potential value of "computer support" in CSCW is that it may allow the distinction to be maintained with larger numbers of people for more complex problems. Issues that were intractable in "unsupported" dialogue may become amenable to mutual learning. Management of complexity may start to supplant "chop" solutions[6].

The two levels of language are brought together in a "shared information space". The models at the formal level are what we index. The conversation or dialogue at the cultural level is where we need to be able to interrupt unpredictably, and where interesting and unexpected messages happen. Unsatisfying, unco-operative work happens where one or the other level of language is excluded from the shared information space.

The "formal level", in the examples, is the Outliner in GROVE; the Meeting Scheduler layout; the Message Structure in the CO-ORDINATOR™; the Work Sheets in the Florence Project; the spreadsheet in the "Wage Bargainer"; and Electronic Brainstorming (or other menu items) in the Arizona Meeting Environment.

The "cultural level" is absent with the Meeting Scheduler and CO-ORDINATOR™, and this resulted in observable problems. The "cultural level" takes the form of direct talking in the "Wage Bargainer", Florence, and the Meeting Environment; and takes place over the phone in GROVE. Members of the groups could talk to each other about the situation ***and the representation of the situation*** they were dealing with. They were not barred from interpretation, ambiguity, "feints", questions, comment, conditional suggestions, and all the other things that are possible in conversations.

The elimination of either the cultural or the formal level of language would have resulted in unusable systems. With GROVE, the group needed to know (or to be able to ask) why someone was making changes—not just that they were making changes. Here the "cultural level" was necessary to interpret the "formal level". With the "Wage Bargainer", it was important to know how committed other groups were to their claims—not just that they had made them. Conversely, it would have been difficult and confusing to know about the motive and commitment to a claim without knowing exactly what was being proposed—which was the situation before the introduction of the "Wage Bargainer". Here the "formal level" was necessary to ground the "cultural level". It was important that precision and ambiguity were separated out, and that they could interact, each helping to define, and providing a reference point for the other.

Equality

In the section on "Calendar Management", Grudin's analysis of the problems of automatic meeting scheduling was examined. It seems to point the way for another, different basic concept for CSCW. Grudin [Gru88] repeats the problem in two bullet points:

[4] T.S. Elliot's Four Quartets catch this elusive idea best in poetry. He speaks of words bending and breaking under the stain of communication—of finally only having the right words for the things we no longer wish to say.

[5] It it does not, we are not talking about tables, we are defining them.

[6] For instance, the "guillotine", the majority vote, the dictate—the general Arthurian approach of cutting the Gordian Knot.

- "The application fails because it requires that some people do additional work, while those people are not the ones who perceive a direct benefit from the use of the application.
- The design process fails because our intuitions are poor for multi-user applications—decision makers see the potential benefits for people similar to themselves, but don't see the implications of the fact that extra work will be required of others."

Grudin suggests that this is not an insurmountable problem.

> "Computer support for the activities of individuals in their group and organisational contexts will unquestionably change the way people live in significant ways. It is difficult to imagine anything more important of fascinating than trying to understand and guide that change. .....
>
> We need to have a better understanding of how groups and organisations function and evolve than is reflected in most of the systems that have been developed. At the same time, we also need to know more about individual differences in responding to technology if we are to develop systems that can support entire groups. One approach may be the contextual research of John Whiteside and his colleagues [WBH87]. Another is that used at Aarhus University in Denmark: "The Aarhus people start out with a problem situation defined by workers, and work beside them a long time in order to develop a new system that is "owned" by the workers ..... This is different from traditional systems development, as you can imagine, and you can't simply package a set of techniques to do the job ... see Ehn and Kyng [EK87]" (Liam Bannon, personal communication)" [Gru88]

Equality, in the complex sense of sensitivity to feelings, intuitions, and perspectives which are not necessarily articulated, and not usually considered part of the work process at all, is a necessary condition for "understanding and guiding that change". Understanding the distribution of benefit and work in different contexts is an important first step in this area—as is the transformation suggested by Bannon of the concept of "ownership".

4 A Last Note

There is an implicit difficulty with most of the concepts considered to far. Distinctions have been made between "representation of work" and "articulation of work"; between "plan" and "situated action"; between "shared space" and "shared material"; between "formal" and "cultural" levels of language; and between "who will do the work" and "who will benefit from it". This was inevitable. Conversations have fixed points and flowing movements. Contexts, assumptions, and much else has to be "taken-for-granted" in order to concentrate on some particular aspect, action, topic, or objective (as in this chapter). Any dialogue makes distinctions, and the distinctions depend on an uncountable number of assumptions.

This is essentially Suchman's [Suc87] point about a "continually receding horizon of understandings". Citing an experiment by Garfinkel [Gar72], she says that his aim

> "was to press the common sense notion that background knowledge is a body of things, thought but unsaid, that stands behind behaviour and makes it intelligible. His request was that the students provide a complete description of what was communicated, in one particular conversation, as a matter of participants' shared knowledge. Students were asked to report a simple conversation by writing on the left hand side of a piece of paper what was said, and on the right hand side what it was that they and their partners actually understood was being talked about.
>
> ..... they gave up with the complaint that the task was impossible.
>
> The students' dilemma was not simply that they were being asked to write "everything" that was said, where that consisted of some bounded, albeit vast, content. It was rather

> that the task of enumerating what was talked about itself extended what was talked about, providing a continually receding horizon of understandings to be accounted for. The assignment, it turned out, was not to describe some existing content, but to generate it." (ibid p. 46)

And again,

> "Actual attempt to include the background assumptions of a statement as part of its semantic content, however, run up against the fact that there is no fixed set of assumptions that underlie a given statement. As a consequence, the elaboration of background assumptions is fundamentally ***ad hoc*** and arbitrary, and each elaboration of assumptions in principle introduces further assumptions to be elaborated, ***ad infinitum***." (ibid p. 60)

To rephrase: conversations and distinctions rely on assumptions that are not only uncountable—they may not exist until they are generated. To paraphrase Bateson, this chapter has talked about CSCW distinctions as if they were somethings, and somethings that could be counted. But of course thats all nonsense. Distinctions cannot be counted any more than the bats in a psychiatrists inkblot—because there are none.

What are the implications for CSCW?

- Firstly, reflectively, it must never take itself too seriously.
- Second, empirically, it must anticipate the collapse of distinctions as a conversation refocuses.
- Third, methodologically, it will be unpredictable when and if context or assumption will become salient, and what impact it will have on the distinctions in the conversation. de Zeeuw & Robinson [ZR89] have pointed to the "***flipover***" phenomenon in the context of "double level language". The "formal" level may become the interpretation, and the previous interpretation its object, suddenly fixed, formalised. This has of course long been recognised as a component of innovation. Its salience here is its ubiquity in the most ordinary of everyday exchanges. Similar remarks can be made about the "flipover" possibilities of "representation/articulation", "plan/situated action", "benefit/work", and so on. Which is which depends on local circumstances, local actors, and local "closures". "Flipover" is also why the subject matter of CSCW is not amenable to the formalism of prediction (and hence classical experimental method). The possibility of prediction assumes a causality that is not present in local closures: in re-interpretation and situated action.
- Fourth, for design, the implication is that "flipover" can be anticipated, but not predicted. It is the essence of human, as opposed to machine, activity systems. The question is whether design will support or try to block the possibility of "flipover". Both the CO-ORDINATOR™ and Meeting Schedulers assume that the processes embodied in their formalisms will be concluded, should be concluded, and will be the same processes at the end as they were at the beginning. GROVE and the "Wage Bargainer" make no such assumptions about use, and consequently integrate smoothly into human activities. They allow for "conversational repair"; for ***re-establishing*** the distinction between the talking and the somethings we are talking about. From the point of view of a systems designer, this will look like "unanticipated use"—artifacts may be used in conversational ways and conversations may at times be regarded as artifacts. From a full CSCW point of view, this is "redesign in use", and should be allowed and supported by the application. In conclusion, it may be said that ***CSCW applications should support the process of making distinctions, not the distinctions themselves.***

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