

# CSCW, Or What's In A Name?\*

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The topic of Computer-Supported Cooperative Work (CSCW) has attracted much attention in the last few years. While the field is obviously still in the process of development, there is a marked ambiguity about exactly what is or is not included under its rubric. The lack of a commonly accepted view on the nature of the field may hinder its further development and lead to fractionation. In this paper we set out an approach to CSCW which would provide a more coherent conceptual framework for this area. This paper develops a framework for CSCW suggesting that it should be concerned with the *support requirements of cooperative work forms*. Other conceptualizations of the field are briefly contrasted in the context of how they view cooperative work. The paper then presents and enlarges on some important issues that we see as vital to the development of usable CSCW systems including support for articulation work and support for cooperation via the construction of a common information space.

The emerging field of Computer Supported Cooperative Work, or CSCW as it is commonly abbreviated and referred to, appears to present new challenges to computer professionals and others involved in the development of computer-based information systems. However, the intense interest in CSCW is not matched by clear conceptualizations concerning the exact nature of the field. In a recent seminar, Irene Greif (1988), one of the originators of the term 'Computer Supported Cooperative Work' (together with Paul Cashman), noted that the term was coined as a shorthand way of referring to a set of concerns about supporting multiple individuals working together with computer systems. The meaning of the individual words in the term was not especially highlighted. With the subsequent

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abbreviation of the term Computer Supported Cooperative Work to that of CSCW, attention to the individual words was expected to be even further reduced, as the field would come to be represented simply by the acronym. This has not occurred. This may be in part due to the fact that the boundaries of the field are difficult to circumscribe and that a core definition of the field does not exist, - other than the very descriptive one of CSCW being a field which covers anything to do with computer support for activities in which more than one person is involved.

If we take this extremely broad categorization of the field, it is hard to see how anything in the form of a coherent research area can emerge from such a loose description. However, as noted by Bannon et al. (1988), having CSCW simply as an “umbrella term” could be advantageous:

“What at first sight might appear to be a weakness of the field, having such a diversity of backgrounds and perspectives, is seen by us as a potential strength, if utilized properly. We believe that for the moment the name CSCW simply serves as a useful forum for a variety of researchers with different backgrounds and techniques to discuss their work, and allows for the cross-fertilization of ideas, for the fostering of multi-disciplinary perspectives on the field that is essential if we are to produce applications that really are useful.”

Granted that this interdisciplinary commingling has occurred by now, the time is ripe for a more incisive probe of what the conceptual underpinnings of the field are. Already at the 1988 CSCW Conference one could sense a certain tension among the participants, which we believe was generated by the lack of a shared perspective on the field.

Within the field of CSCW, loosely construed, a number of different groupings have been discerned by commentators. Howard (1988) gives a succinct account of these differences. He coined the term “strict constructionists” to describe those in the field focused on the development of computer systems to support group work, who tend to use themselves as objects of analysis in the provision of support tools. These people, mainly implementers, are interested in building widgets, and they see the area of CSCW as a possible leverage point for creating novel applications. Most of these people equate the CSCW field with Groupware, the pros and cons of which we will discuss in a later section.

Howard (1988) has labelled those who make up the remainder of the CSCW field, the larger part, as “loose constructionists,” a heterogeneous collection of people, some of whom are drawn to the area by their dissatisfaction with current uses of technology to support work processes, others because they see in this area a chance for communities who traditionally have not had a voice in the design of computer systems to have one. Some wish to make the design of computing systems more democratic, so that the resulting systems will actually support cooperative forms of working, rather than hinder it, where the word ‘cooperative’ has a positive value associated with it, connected with workplace democracy. Part of the rationale here is that for work to be truly ‘cooperative,’ in their sense, one should design systems in a cooperative manner, and ways of achieving this therefore need to be investigated, and developed. The focus is on alternatives to

traditional systems and systems design, alternative ways of doing design, of involving users, etc. (see, e.g., Ehn and Kyng, 1987; Kyng, 1988; Bødker et al., 1988).

Developing a coherent discipline of CSCW that will be acceptable to these different groupings of interests and disciplinary backgrounds is not an easy task. For Howard, the key problem is understanding the ongoing nature of the computer-induced “collectivization” of work. This approach emphasizes the need for empirical case studies. Others emphasize technological factors in providing multiple user access to facilities. The augmentation of high performance teams is seen as the core issue for another group. The issue of exactly what is the object of enquiry in the CSCW field is clearly not settled. Let us pursue this question a little further, as we develop our own conceptualization of the field.

## 1. A Conceptualization of CSCW

According to the British sociologist of science, Richard Whitley, a research area is defined by a *problem situation*: “A research area can be said to exist when scientists concur on the nature of the uncertainty common to a set of problem situations” (Whitley, 1974). Applying this criterion to our topic, we may ask what are the problem situations addressed by researchers working under the CSCW label? Are the problem situations in fact related? Do scientists in the area actually concur on the uncertainty common to this set of problem situations? Are they exploring the same basic issues? This is questionable when one notes that the CSCW label seems to be applied to just about any application, such as: face-to-face meeting facilitation, desk-top presentation, project management, multi-user applications, text-filtering software, electronic mail, computer conferencing, hypertext, etc. Also studies formerly appearing under the rubric of Office Information Systems or Computer Mediated Communication now appear regularly under the CSCW banner.

### 1.1. The Approach of CSCW: Computer Support

#### 1.1.1. The Concept of Support

What's in the name CSCW? By virtue of the first part of its name, the ‘CS’ part, the professed objective of CSCW is to *support* a specific category of work - cooperative work. Thus the term *computer support* seems to convey a commitment to focus on the actual needs and requirements of people engaged in cooperative work. Of course, new technologies of communication and interaction

necessarily transform the way people cooperate and CSCW systems are likely to have tremendous impact on existing cooperative work practices. Nonetheless, *cooperative work* can be conceived as a specific category or aspect of human work with certain fundamental characteristics common to all cooperative work arrangements, irrespective of the technical facilities available now or in the future (see Schmidt, 1990, for an initial elaboration).

By virtue of its commitment to *support* cooperative work, CSCW cannot be defined in terms of the *techniques* being applied. CSCW is a research area aimed at the design of application systems for a specific category of work - cooperative work, in all its forms. Like any other application area, CSCW, in its search for applicable techniques, potentially draws upon the whole field of computer science and information technology. Accordingly, a technology-driven approach to CSCW will inevitably dilute the field. To some extent, the current lack of unity of the CSCW field bears witness to that.

CSCW should be conceived as *an endeavor to understand the nature and requirements of cooperative work with the objective of designing computer-based technologies for cooperative work settings*. The fact that multiple individuals, situated in different work settings and situations, with different responsibilities, perspectives and propensities, interact and are mutually dependent in the conduct of their work has important implications for the design of computer systems intended to support them in this effort.

Thus, CSCW is a research area addressing questions such as the following: What are the characteristics and hence the *general* support requirements of cooperative work as opposed to work performed solely by individuals? Why do people enter into cooperative work arrangements and how can computer-based technologies be applied to enhance their ability to do whatever it is they strive to do by cooperating? How can the coordination requirements of cooperative work arrangements be accomplished more easily, rapidly, flexibly, comprehensively, etc.? How can the overhead costs of coordinating cooperative work be reduced with technology? Etc.

Turning to the problems of designing *particular* systems for specific cooperative work settings, further questions can be posed: How can designers unravel the essential functions of the cooperative work relations to be supported as opposed to ephemeral cooperative work practices that may safely be discarded? How should designers approach the complex and delicate problem of designing systems that will change existing cooperative work patterns? The focus of these questions is to *understand*, so as to better *support*, cooperative work.

While this conceptualization of the general approach does recommend the CSCW field to focus on understanding the nature of cooperative work so as to better support people in their cooperative efforts, it does not prescribe a particular research strategy. Of course, field studies of cooperative work in diverse domains with the objective of identifying the research requirements of various kinds and aspects of cooperative work is much needed, but the design and application of

experimental CSCW systems may also yield deep and valid insights into the nature and requirements of cooperative work.

### 1.1.2. Why Groupware is not a synonym for CSCW

The terms Groupware and CSCW are used interchangeably in much of the discussions about the new field. What is Groupware? It is often defined quite simply as software that in some fashion supports 'groups' in performing their activities (e.g., Johansen, 1988). While the concept of a group is itself worth examination (see Section 1.2.2), its use in software engineering is quite loose. This need not be problematic however, in so far as the Groupware field is focused on solving the technical problems of extending the software to cater for multiple users - from networking software to shared databases to enhanced communication facilities. With such a technical focus, the Groupware field does not need to understand the specific needs and requirements of people engaged in cooperative work relations and may thus use the notion of 'the group' as a simple way of referring to multiple users.

Thus the general push evident in most of the R&D work under the Groupware label is to explore and elaborate a set of techniques. The direction of this approach is quite different to the approach to CSCW that we are proposing. Thus, if we simply collapse the field of CSCW into that of Groupware we risk to dilute both fields. This does not exclude, of course, the possibility that Groupware will contribute to CSCW, for example, by developing artifacts that users may appropriate and use in unforeseen ways that might throw new light on the needs and requirements of people engaged in cooperative work.<sup>1</sup> In fact, the two approaches can be viewed as complementary in the sense that while they pursue incommensurable approaches they may mutually benefit from each other.

As an example of the distinction, one can examine some of the recent discussion about the nature of certain software applications, and whether they should be considered as properly Groupware, or as CSCW applications (see Grudin, ms, for this discussion). Concerning electronic mail, for example, some view it as an instance - and indeed, as one of the few successes in the field so far - of Groupware (Kraut in Ensor, 1990). Others argue that applications that are not "group-aware" (Rein, in Ensor, 1990) or "collaboration-aware" (Lauwers & Lantz, 1990) are not Groupware. In our view (and that of Grudin, ms), this debate about inclusion or exclusion of a particular technology under a CSCW label seems somewhat beside the point. While such distinctions might be of interest to the Groupware field, in terms of developing a taxonomy, our approach to CSCW would lay stress on the work accomplished with the application, rather than defining something as being a CSCW application or not purely due to its technical form. To reiterate, CSCW is not defined in terms of the technology being applied. As artifacts, CSCW applications cannot be distinguished from

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<sup>1</sup> See Mackay (1990) for an example of how this occurred with a prototype of INFORMATION LENS.

Groupware applications, and vice versa. The difference between CSCW and Groupware is not in the result but in the approach.<sup>2</sup>

However, we concur with the drive of Groupware enthusiasts to actually *construct* working artifacts to support cooperative work processes. CSCW should be a *design oriented discipline*. Thus, the objective of social science contributions to CSCW should be to explore exactly how insights springing from studies of cooperative work relations (with or without mediating technologies) might be useful in the design of useful CSCW systems. The basic approach of CSCW research should not be descriptive but constructive. This requires that technologists extend out from a strict technical focus and investigate how their artifacts are, or could be, used and appropriated in actual settings, while behavioral and social scientists must move beyond simple evaluation and analysis of systems and begin to explore how their insights might be utilized to influence the design process, in collaboration with software engineers and practitioners from actual work domains. In short, the drive of CSCW should be directed towards designing systems embodying an ever deepening understanding of the nature of cooperative work forms and practices. CSCW is problem driven as opposed to technology driven, and is constructive as opposed to simply descriptive in its approach. It is as a stimulus to this interdisciplinary commingling and potential for mutual learning that makes us resist the substitution of the more open-ended CSCW term with the software engineering term - Groupware.

## 1.2. The Scope of CSCW: Cooperative Work

### 1.2.1. The Nature of Cooperative Work

Turning now to the second pair of characters in CSCW - "CW" or "Cooperative Work", the first thing we notice is rampant confusion. There are many forms of cooperative work, and distinctions between such terms as cooperative work, collaborative work, collective work, and group work, are not well established in the CSCW community. Without wishing to impose a formal taxonomy on a set of terms that have loosely defined everyday connotations, we believe that analyzing the meaning of the term cooperative work is necessary due to the wildly disparate

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<sup>2</sup> In any event, we would argue that a focus on email in the study of CSCW applications is not the most enlightening. This is because electronic mail is a CSCW application that merely supports interaction at the level of exchange of information objects *qua* objects, as packaged text strings. At the very best, formatting instructions, graphics etc. are retained. Few current email systems support cooperative activities at higher semantic levels, for instance, by providing facilities for annotating text, commenting text, linking text across messages, indexing messages, etc. In studying email, the attention of CSCW is directed towards computer support for cooperative work at the lowest semantic level while the real challenges to CSCW are the support requirements of the higher semantic levels of cooperative work. In fact, for some years, the main thrust of CSCW work has been attempts to build more specific and functionally richer applications on top of electronic mail that provide higher level support for a focused range of activities, as has been done for example in the case of the COORDINATOR (Flores, 1988) and INFORMATION LENS (Malone et al., 1987a, 1987b).

uses of the term in the field at present. For instance, for Ehn (1988) *all work* is essentially cooperative, in that it depends upon others for its successful performance. While this is assuredly the case at some level, we would hope that a more specific definition of cooperative work can help us in understanding more clearly different forms of work activity. At another extreme, Sørgaard (1988) has enumerated a very specific set of criteria for what would count as cooperative work, for instance, that it is non-hierarchical, relatively autonomous, etc. From yet another perspective, e.g. that of Howard (1987), the term 'cooperative work' is inappropriate because of the ideology he believes is inherent in the term. For Howard, and many others, there is a connotation to the term "cooperative" that assumes compliancy, shared sentiments, etc., which he regards as inappropriate for the realities of everyday work situations. He prefers the allegedly more open term, 'collective work,' which he sees as being induced in a variety of ways through the use of computers in general. Kling (1988) concurs in this criticism of the "cooperative" label, arguing in favor of the term 'coordinated work.'

'Cooperative work,' the term chosen by Greif and Cashman to designate the area to be addressed by the new field, happens to be a term with a long history in the social sciences and one which is quite appropriate to the current context of CSCW. It was used as early as the first half of the 19th century by economists as the general and neutral designation of work involving multiple actors (e.g., Ure, 1835; Wakefield, 1849) and was picked up and defined formally by Marx (1867) as "multiple individuals working together in a deliberate way in the same production process or in different but connected production processes." In this century, the term has been used extensively with the same general meaning by various authors, especially in the German tradition of the sociology of work (e.g., Popitz et al., 1957; Bahrtdt, 1958; Dahrendorf, 1959; Kern and Schumann, 1970; Mickler et al., 1976), as well as by other authors (e.g., Miller and Form, 1964; Thompson, 1967).

### 1.2.2. The Problem with the "Group" label

Greif (1988a) equates CSCW with "an identifiable research field focused on the role of the computer in group work." However, replacing the term 'cooperative work' with that of 'group work' or defining the former by the latter hides certain problems. The term 'group' is quite blurred. On the one hand it is often used to designate almost any kind of social interaction between individuals. For instance, in his book on *Groupware*, Johansen (1988) mentions "teams, projects, meetings, committees, task forces" etc. as examples of "groups" and even includes interaction among workers, supervisors and management in manufacturing operations, "often across both distances and work shifts," under the same notion.

At the same time, however, the term 'group' is usually used in a more limited way to designate a relatively closed and fixed aggregation of people sharing the same 'goal' and engaged in continual and direct communication. Again, this notion of group seems inappropriate for our purposes as it is permeated with

untenable assumptions. First, the very notion of a 'shared goal' is murky and dubious. The cooperative process of decision making in a group is a very differentiated process involving the interaction of multiple goals of different scope and nature as well as different heuristics, conceptual frameworks, etc. Second, while in some cases groups do have a closed and fixed character such as project teams, in other cases they are formed spontaneously in response to the requirements of the situation. For example, in a hospital groups ('task forces') are formed on an *ad hoc* basis to deal with emergency situations whereupon they dissolve again.

By defining the term 'group' simply and informally as multiple people perceiving themselves as a 'we,' Bahrtdt (1984) suggests a definition that does not subscribe to these assumptions and yet is in accord with daily usage of the word 'group.' Even with this, more relaxed, definition of 'group,' however, the notion of group work does not encompass the rich and complex reality of cooperative work.

As pointed out by Popitz and associates in their classic study (1957), the group is not the typical unit of cooperation in modern industrial plants. Here, cooperation is typically mediated by complex machine systems and often does not involve direct communication between agents. The workers operating a rolling mill in a steel plant, for example, cooperate by monitoring and adjusting the state of the machine system. They are often not constituted as a 'group' and they typically interact without communicating in the sense of directly or indirectly exchanging messages. Likewise, in various domains, for instance administrative work, engineering design, and scientific research, actors often cooperate at 'arm's length,' without direct communication and without necessarily knowing each other. A major thrust of current practical efforts to apply computer based technologies to cooperative work settings is directed at the problems of supporting indirect and distributed cooperative work relationships. Let us briefly mention some examples from specific domains.

In advanced manufacturing enterprises cooperative work relations are not limited to the group or team responsible for a particular shop. Cooperative work relations span the entire enterprise, from Marketing to Shipping, from Design to Final Assembly. For a manufacturing enterprise to be able to adapt diligently and dynamically to emerging dynamic markets, the entire enterprise must react "simultaneously and cooperatively" (Harrington, 1979). In fact, this is the very essence of advanced manufacturing systems. The Just-In-Time principle of production control should be conceived as a semi-horizontal coordination mechanism for rapid adaptation of manufacturing operations in complex environments, thus embracing all functions from Marketing to Shipping (Aoki, 1988). Likewise, the objective of the concept of Company Wide Quality Control is to make the 'voice of the customer' audible throughout the company so as to ensure that distributed decision making (e.g., to handle local disturbances) is guided by pertinent knowledge of customers' needs and requirements. The ambition of the efforts of the Computer Integrated Manufacturing (CIM) field is to link and fuse

the diverse information processing activities of the various manufacturing functions such as design and process engineering, production planning and control, process planning and control, purchasing, sales, distribution, accounting, etc. into a unitary information system (Harrington, 1979; Harrington, 1984; Gunn, 1987). A CIM system embracing these information processing activities on a company-wide scale should be seen as a unified database system facilitating and supporting the horizontal and hierarchical, indirect and direct, distributed and collective cooperation of a heterogeneous ensemble of distributed decision makers throughout all functions of manufacturing.<sup>3</sup>

Likewise, the Office Information Systems (OIS) field aims at meeting the need of organizations for exploiting their information assets more effectively by designing information systems incorporating the mass of documents handled by the organization. By recording, indexing and providing access to the multitude of information objects in a large organization, office information systems should be seen as computer based systems that also support the indirect and distributed cooperation of an ensemble of workers.

In sum, we certainly do want CSCW to address the aspects of computer support for cooperative work in CIM and OIS. And we do not want to restrict the scope of CSCW to those special settings where the responsibility of accomplishing a task has been allocated to or assumed by a relatively closed and stable collective. The concepts of 'group' and 'group work,' however, invariably connote special types of cooperative relations characterized by shared responsibilities. This conceptualization of CSCW will tend to ignore or even dismiss the major challenges posed by ongoing practical efforts to design systems that mediate the indirect and distributed cooperation of multiple people.

### 1.2.3. An Expansive View of Cooperative Work

We do not want to restrict the scope of CSCW to cooperative work relations that are defined and bounded in terms of the formal organization. Cooperative work is constituted by *work processes that are related as to content*, that is, processes pertaining to the production of a specific product or service.<sup>4</sup> Thus, the boundaries of cooperative work networks are defined by actual cooperative behavior and are *not necessarily congruent with the boundaries of formal organizations*. A corporation may have multiple cooperative work processes with no mutual interaction, and a cooperative work process may cross corporate boundaries and may involve partners in different companies at different sites, each of the partners producing but a component of the finished product. For example, in response to the emerging dynamic business environment

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<sup>3</sup> It is interesting to note that despite the large amount of work on CIM, and its obvious pertinence to the CSCW field, this domain is almost totally absent in the work of the CSCW community! In our view, this is a loss to the field.

<sup>4</sup> This focus on content of work processes does not imply that we exclude social interaction in the workplace as part and parcel of these activities.

manufacturing enterprises are establishing stable cooperative networks incorporating multiple companies by involving supplier companies in 'just-in-time' and 'total quality control' arrangements. (For examples of CSCW work that begins to address this issue, see Estrin, 1985, and Suomi, 1989).

The term 'cooperation' has multiple connotations in everyday usage. Apart from the neutral and general meaning adopted in the economic and sociological literature, 'cooperation' may designate a process of give-and-take in a spirit of compromise (Bowers, 1991). In political science, the term is naturally used in the latter meaning. In CSCW, however, we should stick to the neutral and general meaning. What we are arguing for here is an interpretation of "cooperative work" that goes beyond its everyday meaning, yet which we earlier showed has an excellent sociological pedigree. The objectives of CSCW are quite ambitious as it is, so there is no reason to claim that computer-based systems will be instrumental in eliminating social, ideological, ethnic etc. enmity or animosity. Thus, in the context of CSCW, the concept of cooperative work does not imply a particular degree of participation or self-determination on the part of the workers, nor a particularly democratic management style. Actually, the concept has historically been developed and used in analyses of the harsh realities of industrial life (e.g., Ure, 1835; Marx, 1867; Popitz et al., 1957). Nor are we saying, "Thou shalt cooperate!" Cooperative work is not necessarily preferable to individual work; nor is it inferior to individual work. In our context, cooperative work relations are seen as emerging in response to technical necessities or economic requirements in certain work environments.

#### 1.2.4. Summary

Our argument is that the CSCW field should not artificially and inadvertently exclude specific forms of cooperative work from the scope of research. Rather, the conceptualization of CSCW should allow us to embrace the rich diversity of forms of cooperative work. We thus argue that the term "cooperative work" should be taken as the general and neutral designation of multiple persons working together to produce a product or service. The concept does not imply specific forms of interaction or organization such as mode and frequency of communication, comradely feelings, equality of status, formation of a distinct group identity etc. Likewise, in place of the "group" term which we have seen is ambiguous, an alternative term used by Sartre (1960) is "ensemble" which denotes an, as yet, unstructured aggregation of people. This more general and neutral term for a cooperating set of people does not imply any specific organizational form.

Work having multifarious facets, it is no wonder that multiple, more or less synonymous terms abound: collective work, collaborative work, coordination work, articulation work etc. We do not have to abstain from using any of these terms. They all have different connotations and may be used to designate different types or facets of cooperative work, but we will not delve into these distinctions

here.<sup>5</sup> We have seen that cooperative work can comprise indirect as well as direct and distributed as well as collective modes of interaction. Work conducted collectively, by a group, is merely one specific mode of cooperative work. Cooperative work may also be conducted in a distributed manner, i.e., by an ensemble of semi-autonomous workers changing their behavior as circumstances require and planning their own strategies. Furthermore, cooperative work may be conducted indirectly, i.e., mediated by the changing state of the particular production process, or directly, i.e. by means of interpersonal communication. Also, cooperative work processes may take place at one point in time, or extend over some considerable period.

The key point in the above definitional discourse is that the concept of cooperative work underlying and determining the scope of CSCW research, should not preclude specific forms of cooperative work but rather allow us to embrace the rich diversity of forms of cooperative work. We have shown that the very concept of the 'group' is poorly defined and that the term 'cooperative work' has a historical meaning suitable for its use in the CSCW context, in spite of the danger of the word 'cooperative' being misinterpreted because of its everyday connotations.

### 1.3. Why CSCW Now?

Why CSCW now? For many people working in the information systems field, it is difficult to comprehend the recent surge of interest in CSCW issues as if these issues were totally new, and deserving of a distinct field within information systems research. Even from the earliest days, the cooperative nature of human work has been taken into account in the design of some information systems. In other words, just as, for example, a simple accounting system could be viewed as a simple and special case of office information systems, an airline reservation system could be viewed as a simple and special case of CSCW applications.

Thus, one could certainly argue that the emergence of CSCW as a field was anticipated by many commercial transaction-oriented applications for cooperative work settings, e.g., airline reservation systems, that could, in a primitive sense, be viewed as CSCW applications. Airline reservation systems actually do support a primitive form of cooperative work in the broad sense posited above. The shared database of an airline reservation system can be viewed as an information space through which people interact in an indirect fashion. However, the anonymity of those interacting via the system, and thus the limited ability to track changes and communicate between those involved, make the range of support provided by

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<sup>5</sup> The term 'collective work,' for instance, designates cooperative work where the cooperating ensemble is sharing the responsibility for accomplishing the task. The emphasis of the concept is the fusion of the members of the ensemble into a whole, a 'collective.' That is, the term is conceptually close to 'group' and 'team' work. The term 'collaborative work,' on the other hand, gives special stress to a particular 'collaborative' or complying spirit among the cooperators, as evident, for example, in the connotation usually associated with the phrase "collaborating with the enemy."

many of these systems for cooperative work rudimentary. So, although people using these systems do engage in cooperative problem solving and discretionary decision-making, the technology itself provides little support for these cooperative processes - these aspects of their cooperative efforts take place outside or around rather than through the system.

The novel development that gives rise to CSCW as a field is the introduction of information technology to support work environments and work processes characterized by a high degree of complexity and uncertainty, and involving multiple actors whose activity must be coordinated, often semi-autonomously. In these complex environments, cooperative work exhibits specific characteristics, e.g., dynamic patterns of interaction, multiple decision making strategies, incompatible conceptualizations, etc. that are of little import in conventional transaction-oriented applications. These characteristics pose challenging problems to the development of CSCW applications. While the scope of CSCW is broad in the sense that no particular form of cooperation is presumed, and CSCW is not confined to narrow domains, the primary concern of CSCW as a field is focused on work processes involving problem solving, discretionary decision making, etc.

The commitment of CSCW to focus on the actual needs and requirements of people engaged in cooperative work is quite appropriate. Part of the reason for the rise in interest in CSCW is because information systems developers are becoming aware of the complexity of the cooperative work processes that need to be supported by the system. All too often computer-based systems are introduced in cooperative work settings with disruptive effects due to an insufficient appreciation of this complexity. Harper, Hughes & Shapiro (1991) provide an excellent description of how systems designers can get it - the nature of the work process and how the computer could assist - wrong. The point is not to laugh at the mistakes but to learn about the complexity of the issues. Thus CSCW is urgently called for.

## 2. Key Issues for CSCW

In order to develop our understanding of CSCW there is room for further work in clarifying and deepening the distinctions and conceptualizations just mentioned. In what follows, we make a start on this large task, by looking in more depth at just two issues, chosen because of their important role in the development of successful CSCW applications for cooperative work in complex environments:

- the need to provide flexible support for the 'articulation work' necessary to renegotiate the dynamic patterns of interaction of cooperative work in complex work environments - Supporting Articulation Work;

- the need to explicate the nature of shared understanding in view of the multiple decision making strategies and incompatible conceptualizations involved and how the negotiation of a shared understanding can be supported via system architectures - Supporting Construction of a Common Information Space.

## 2.1. Supporting Articulation Work

Any cooperative effort involves a number of secondary activities of mediating and controlling the cooperative relationships. First, tasks are to be allocated to different members of the cooperating ensemble: which worker is to do what, where, when? Second, by assigning a task to a worker, that worker is rendered accountable for accomplishing that task according to certain criteria: when, where, how, how soon, what level of quality, etc.? Finally, in the terminology suggested by Strauss (1985), cooperative work requires 'articulation work': The numerous tasks, clusters of tasks, and segments of the trajectory of tasks need to be meshed. Likewise, the efforts of individuals and ensembles need to be coordinated and integrated. In the words of Gerson and Star (1986), articulation work consists of all the tasks needed "to coordinate a particular task, including scheduling subtasks, recovering from errors, and assembling resources."

According to the traditional 'bureaucratic' conception of organizational work, people perform a number of tasks according to a set of well-specified 'procedures' that have been developed by management as efficient and effective means to certain ends, and the traditional formal organization chart is presumed to show the actual lines of authority and the correct' pattern of information flow and communication. However, the conception has been proved highly idealized and grossly inadequate for analyzing and modelling the articulation of real world cooperative work arrangements.

Due to the dynamic and contradictory demands posed on a social system of work by the environment, task allocation and articulation are renegotiated more or less continuously. This has been documented thoroughly in the domain of 'office work' and many other arenas.<sup>6</sup> For example, a number of studies of office work, conducted by anthropologists and sociologists, have emphasized the rich nature of many allegedly 'routine' activities and the complex pattern of cooperative decision-making and negotiation engaged in by co-workers, even at relatively 'low' positions within the organization (Wynn, 1979; Suchman, 1983; Gerson and Star, 1986). Suchman (1983) gives a concise account of this discrepancy between the office procedures that supposedly govern office work and the practical action carried out by office workers. She notes: "the procedural structure of organizational activities is the product of the orderly work of the office, rather than the reflection of some enduring structure that stands behind that work." It is

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<sup>6</sup> See, e.g., Strauss et al., 1964; Wynn, 1979; Sheil, 1983; Suchman, 1983; Strauss et al., 1985; Gasser, 1986; Gerson and Star, 1986.

not that office procedures are irrelevant, it is just that these procedures require problem solving activities and negotiation with co-workers, the result of which can be interpreted as performance according to procedures. The 'informal' interactions that take place in the office thus not only serve important psychological functions in terms of acting as a human support network for people, for example, providing companionship and emotional support, but are crucial to the actual conduct of the work process itself. Evidence for this is apparent when workers 'work-to-rule,' i.e. perform exactly as specified by the office procedures, no more and no less. The result is usually that the office grinds to a halt very quickly!

Still, the early computer systems developed to 'automate the office' were built by designers who implicitly assumed much of the traditional procedural conception of office work.<sup>7</sup> Designers were "automating a fiction" as Beau Sheil (1983) so aptly put it. Such systems have now been admitted as failures:

"In all these systems information is treated as something on which office actions operate producing information that is passed on for further actions or is stored in repositories for later retrieval. These types of systems are suitable for describing office work that is structured around actions (e.g. sending a message, approving, filing) ; where the sequence of activities is the same except for minor variations and few exceptions. None of the above systems explicitly describe the goals of office work and how each action is related to the accomplishment of the overall goal of the work. Thus it becomes difficult to describe work where the goal can be achieved via several different methods or where the actions necessary to accomplish the goal cannot be known ahead of time. These systems do not deal well with unanticipated conditions." (Barber, de Jong, and Hewitt, 1983, p. 562).

So, what does this imply for the design of CSCW systems? Building computer systems where work is seen as simply being concerned with 'information flow,' and neglecting the articulation work needed to make the 'flow' possible, can lead to serious problems. Computer support of cooperative work should aim at supporting self-organization of cooperative ensembles as opposed to disrupting cooperative work by computerizing formal procedures. A number of researchers within the office information systems field have accepted the rich view of office work provided by social scientists and attempt to develop systems that support office workers in their activities.<sup>8 9</sup> For example, Woo and Lochovsky (1986) explicitly note how much earlier work on office automation tended to view office work as a sequence of activities by autonomous actors rather than requiring the simultaneous participation of several people. They also critique the rush to formalize and the treatment of office systems as closed systems, noting that in many real situations allowance should be made for *inconsistent* office procedures, as "these inconsistencies represent different opinions on common tasks."

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<sup>7</sup> E.g., Zisman, 1977; Hammer and Sirbu, 1980; Hammer and Kunin, 1980; Ellis, 1982; Ellis and Bernal, 1982.

<sup>8</sup> E.g., Fikes and Henderson, 1980; Barber and Hewitt, 1982; Ellis, 1983; Barber, 1983; Barber, de Jong, and Hewitt, 1983; Gasser, 1986; Woo and Lochovsky, 1986; Hewitt, 1986; Croft and Lefkovitz (#).

<sup>9</sup> Much of this new work can also be critiqued re. their concept of goals and how they are represented, but this critique will not be pursued here.

Surprisingly, however, in the CSCW arena, it appears that some of the work on office information systems still maintains a more rigid 'office automation' view of office procedures and their "execution" (See, e.g., Victor and Sommer, 1991). Also, take the early CSCW project management support tool XCP. In the words of its designers,

"XCP is an experimental coordinator tool which assists an organization in implementing and maintaining its procedures. Its goal is to reduce the costs of communicating, coordinating and deciding by carrying out formal plans of cooperative activity in partnership with its users. It tracks, prods, and manages the relational complexity as captured in the formal plan, so that human resources are available for more productive tasks. [...] An important effect is that XCP encourages an organization to clearly define formal procedural obligations and relationships." (Sluizer and Cashman, 1984)

It would appear that XCP assumes that what people do in many work settings is to follow procedures. No wonder the authors note the difficulty involved in developing and "debugging" the formal protocol. The generalization of such an approach to a wide range of office situations seems unrealistic. It appears to exclude the dimension of task articulation.

In the same vein, Robinson (1989), in his analysis of the COORDINATOR mail system developed by Flores and Winograd (Winograd, 1986), notes that some reviewers have criticized the system because it forces people to be explicit about their commitments in their messages. But, he comments, and we concur: "There is no objection to making 'explicit and textual' a dimension of communication. [...] The Co-ordinator falls down, not because it has a formalised ('textual') dimension, but because it has excluded, marginalised, and even illegitimised" alternative channels of conversation to facilitate the negotiation of task allocation and articulation. "Unless these two levels interact, fruitful co-operation will not happen."

In response to the need for interminable task allocation and articulation, Robinson (1989) takes this contention even further and propounds a general design principle stating that a CSCW application should support at least two interacting "levels of language." In addition to the naked functionality of the CSCW application, the system should have facilities that allow users to freely negotiate task allocation and articulation. That is, the system should provide multiple alternative channels of interaction. As an example of a system providing a simple, yet effective, alternative channel for cooperative task articulation, Robinson cites the GROVE system developed by MCC (Austin, Texas) in 1988. Basically, GROVE is a multi-user outline processor, allowing multiple users to cooperate on drafting a common text. In addition to the interactions visible through the ongoing online textual modifications, the users could talk to each other about what was going on, and why, by means of a voice link. In the terminology suggested by Robinson, the voice link provided "the second level of language." Robinson's insightful remarks are worth quoting here:

"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 'formal' and 'cultural' aspects of language as used by participants in projects and

organizations. '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 behavior 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 are as significant as the 'given.' The formal level is meaningless without interpretation, and the cultural level is vacuous without being grounded."

While we have a number of reservations with Robinson's use of the terms 'formal' and 'cultural' — for example, the 'formal' level can quite legitimately also be viewed as a 'cultural' construct, — his distinction between the level of the primary work content and the level of task articulation and his contention that any CSCW system should provide alternative channels of conversation seems fruitful.

Taking the point even further, we would argue that the 'procedural' approach to the design of CSCW applications is deeply problematic. While systems that constrain the articulation work by imposing a prescriptive or empirical model of interaction such as a set of formal procedures or a recurrent pattern of conversation are in principle at variance with the nature and requirements of articulation work and will ultimately have a disruptive effect on cooperative work, a CSCW application based on a model of prescribed or established patterns of cooperation might be tolerable - and perhaps even useful - if, and only if, the system treats and presents *procedures as resources*<sup>10</sup> for capable and responsible workers.

A CSCW application will always be based on a model of a social world. Some CSCW applications have the system prescribe canonical patterns of interaction among humans, defined according to structural languages, e.g., the COSMOS Structure Description Language for "Communication Structures" (COSMOS, 1989; Bowers et al., 1988; Dollimore and Wilbur, 1991). But even in systems that do not prescribe 'procedures' for human interaction, but rather provide facilities for a community to cooperate via a common information space, the conceptual structure of that space is in itself a model of a social phenomenon. No representation is complete, however (Gerson and Star, 1986). As any other model, a model of a social system has an application area within which it is a valid (abstract) representation of the world. The validity of a model is of a local and temporary nature. That is, there is a boundary beyond which the model is invalid. Since any CSCW system will embody a model of a social world, the critical question is what happens to the cooperating ensemble using this system when the underlying model of cooperative relations is beyond its bounds?

This problem is of vital importance for the future direction of CSCW research and development and raises a number of crucial questions, which need to be investigated in future research programmes: Which aspects of social systems are suitable for being modelled in CSCW systems? Roles, procedures, rules of conduct? Is it possible to formulate general principles regarding the design of the

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<sup>10</sup> This argument is built on the insightful work of Suchman (1983, 1987).

functional allocation between human actors and a CSCW artifact so that the human actors are in control when the underlying model is used beyond its bounds? If yes, how? Should users be allowed to circumvent the procedural constraints of the system? All users? All procedures? Is it possible to design CSCW systems that provide a given community with a model of procedures as a heuristic resource? If yes, how? Is it possible to represent and present the boundary of the model embedded in a CSCW application so that the cooperating ensemble will be able to 'see' when the system is beyond its bounds? If yes, how? And so forth.

## 2.2. Supporting Construction of a Common Information Space

An alternative approach to the design of CSCW applications, other than the procedural approach, is to allow the members of a cooperating ensemble to interact freely, i.e. without being constrained by prescribed procedures or established conversational conventions, by providing facilities enabling them to cooperate via the joint construction of a *common information space*. They perceive, access, and manipulate the same set of information, for example in a shared database, but access to common objects does not ensure a shared interpretation of the meanings of the objects. Let us examine this idea more closely.

### 2.2.1. The Role of Interpretation Work

A common database is not a common information space. Objects in a database are perceived and manipulated at different semantic levels. They can be manipulated *qua* objects, but are more usually perceived and manipulated as *carriers* of representations. Their importance lies in the interpretation human actors place on the meaning of the representational object. The distinction between the material carrier of information - the object - and its meaning is crucial. The material representation of information in the common space (e.g., a letter, memo, drawing, file) exists as an objective phenomenon and can be manipulated as an artefact. The semantics of the information carried by the artefact, however, is, put crudely, 'in the mind' of the beholder, and the acquisition of information conveyed by the artefacts requires an interpretive activity on the part of the recipient. Thus, a common information space encompasses the artefacts that are accessible to a cooperative ensemble *as well as* the meaning attributed to these artefacts by the actors.

In the - unlikely but simple - case of an individual working totally on his or her own, the recipient of an information object is identical with the originator. Since the actor has produced, organized, indexed etc. the potentially relevant information himself, the interpretation of the information does not pose much of a

problem (although even here there can be problems, faulty memory, etc.). Likewise, the boundary of the information space - that is, the extension of the set of information relevant to the particular problem situation at hand - is constituted in the particular situation by the agent. If we picture several of these actors or agents, each with their own *personal information space* working totally independently we can view them as having several quite independent, i.e. *multiple personal information spaces*.

Now, what happens if the information object accessed by one actor is produced by another and vice versa, that is, if the set of information objects are produced and accessed by multiple actors? At the level of the objects themselves, shareability may not be a problem, but in terms of their interpretation, the actors must attempt to jointly construct a common information space which goes beyond their individual personal information spaces. A nice example of how this is a problem has been given by Savage (1987) :

“. each functional department has its own set of meanings for key terms. Key terms such as *part, project, subassembly, tolerance* are understood differently in different parts of the company. “

Of course, in order for work to be accomplished, these personal, or local information spaces must cohere, at least temporarily. But the important point is to realize that one cannot just produce a common information space, that it does not automatically appear as the result of developing a common dictionary of terms and objects, as the meanings of these terms and objects must still be determined locally and temporally. The common information space is negotiated and established by the actors involved.<sup>11</sup>

As an example, imagine a situation where a cooperating ensemble is working together in a meeting room, using a whiteboard, for instance. The material objects carrying the information are the inscriptions on the whiteboard and, fleetingly, the sound waves permeating the air. Again, the meaning of it all is ‘in the minds’ of the participants. Each of the participants contributes to the common information space by drawing and writing on the board or changing what has been drawn and written, by defining or questioning the meaning of a particular object, etc. Being together in a room, they are able to mobilize all the communicative resources of face-to-face interaction (cf. Suchman, 1987) to negotiate a shared understanding of what is said and written and of the boundary of the common information space. A person entering the room after the meeting, however, is able to perceive the remnants of the cooperative construction of a common information space in the form of more or less legible inscriptions, erasures etc., and may be able to infer - more or less cursorily - on the evidence of the remainders what has been going on

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<sup>11</sup> In this context, the following comment is *apropos* : "There are many actors; they each have different perspectives (often, multiple incommensurate ones); the points at which they come together are typically only a small cross-section of the activities of each. I think we need models which represent multiple ‘information spaces’ and then concern themselves with the specifics of cooperation among actors who don’t necessarily agree on anything, or whose cooperation is strictly bounded in time, location, and scope." (Elihu Gerson, personal communication, August 1989).

at the meeting. But with the actors absent, the latecomer is unable to negotiate and thus corroborate or modify this interpretation.

**Shared view.** The concept of a 'common information space,' as used here, should be distinguished from the 'shared view' approach in CSCW.<sup>12</sup> The core of the notion of a 'shared view' is that multiple actors perceive the same object - text, drawing, etc. - in the same state and perceive any changes in the state of the object concurrently. Any changes to the object effected by one actor will be immediately perceptible to the other actors. This approach has been implemented in a number of systems. For example, Engelbart, in his early NLS/AUGMENT system, implemented a "shared view" concept where two participants could perceive the same (code or graphic items) on their respective displays and could alternate control of the objects between them at will (Engelbart & English, 1968; Engelbart, 1984). In the work on Xerox PARC's COLAB, this approach was developed further to provide different participants with a WYSIWIS or 'What You See Is What I See' facility (Stefik et al., 1986)

What is 'shared' in the perspective of this approach is the object as such, as opposed to its meaning to the actors. The latter requires an interpretive activity on the part of the recipients, as discussed earlier. In these systems, this happens either via face-to-face discussion or over an audio channel while the actors are jointly viewing the "shared view". Thus, this work is primarily addressing the needs of small teams solving a common task of limited scope and duration by supplementing media such as the whiteboard as means of communication and recording or by supporting face-to-face type interaction among geographically distributed actors: for example, a couple of authors writing a joint paper by means of a multi-user document processor (note the reference to the GROVE system earlier) or a group of engineers observing and examining the behavior of a computer simulation of some phenomenon.

While such work is of interest to CSCW, it occupies a relatively small niche in the space of cooperative work activities. Certainly, the work of small groups involves multiple decision makers, in so far as all cooperative work involves distributed decision making (that is, decision making conducted by multiple, semi-autonomous actors). However, a - sufficiently - shared understanding of the organization and the boundary of the information space of the group can be *negotiated on the spot* due to the limited scope and duration of the task and the intensity of face-to-face interaction in small groups (and the emulation of face-to-face interaction by means of audio-visual media). In terms of design of support systems for this kind of cooperative work (meeting rooms, multi-user applications, etc.), the *distributed nature of cooperative decision making* is of minor import, yet it is precisely the latter that accounts for the bulk of cooperative work activities. We now move to consider the additional problems which this causes in the construction of a common information space.

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<sup>12</sup> See Greenberg, 1990, for a concise and articulate overview of issues in this area.

**Cooperation at arm's length.** In real world settings, semi-autonomous knowledge workers typically cooperate 'at arm's length' by adding to, modifying, linking, searching, and retrieving items from a common set of information objects, centralized or decentralized, but accessible to some or all members of the given community.

An example would be the common information space of a particular research community, that is, the 'content' of the body of literature (reports, books, journals, preprints, proceedings, etc.), the concomitant verbal contributions (presentations, objections, gossip etc.), and the conceptual frameworks and assumptions applied by the participating scientists in interpretive work. Another example would be the common information space of an organization, that is, the 'content' of the mass of memos, letters, forms, documents, files, agendas, minutes, drawings, photos, etc., the verbal arguments of organizational life, and the beliefs and semantic structures of the staff involved.

Computer systems meant to support cooperative work in real world settings must support cooperation through the joint construction of a common information space in such settings. In our view, this constitutes one of the core problems for the CSCW field.

This problem has been recognized by several authors. For example, in contrast to the 'group work' oriented paradigms, Engelbart and Lehtman (1988) discuss a set of facilities necessary for a "system designed to support collaboration in a community of knowledge workers." First, in addition to services facilitating the creation, modification, transmission etc. of messages such a system should provide services supporting the cross-referencing, cataloging and indexing of the accumulating stock of messages. Second, the services for cataloging and indexing items generated internally, i.e. by means of the system, "should also support managing externally generated items." Having identified the basic technical requirements of such a system, Engelbart and Lehtman chalk out a grandiose vision of an information system supporting collective as well as distributed cooperative work in a community:

"With centrally supplied (and hence uniformly available) services such as these, a community can maintain a dynamic and highly useful 'intelligence' database..." And they propose extending this facility toward "the coordinated handling of a very large and complex body of documentation and its associated external references. This material, when integrated into a monolithic whole, may be considered a 'superdocument.' Tools for the responsive development and evolution of such a superdocument by many (distributed) individuals within a discipline- or project-oriented community could lead to the maintenance of a 'community handbook,' a uniform, complete, consistent, up-to-date integration of the special knowledge representing the current status of the community.

The handbook would include principles, working hypotheses, practices, glossaries of special terms, standards, goals, goal status, supportive arguments, techniques, observations, how-to-do-it items, and so forth. An active community would be constantly involved in dialogue concerning the contents of its handbook. Constant updating would provide a 'certified community position structure' about which the real evolutionary work would swarm."

While this magnificent scheme effectively addresses the need of supporting cooperation via a common information space, in that it provides levels of interpretation and context around the information objects in the database, the notion of “a uniform, complete, consistent, up-to-date integration” of the knowledge in a community handbook is hardly realistic. As we shall show, interpretive work remains to be done by actors accessing the community handbook. It too can be a valuable *resource* for developing a common information space with other actors, but due to the distributed nature of cooperative work the handbook will be necessarily incomplete and partial.

### 2.2.2. The Distributed Nature of Cooperative Work

If the decision making process (1) involves a large and indefinite number of people, (2) requires the integration of a number of different perspectives or domains, and (3) continues for a protracted period of time or even indefinitely, the interpretation of the objects in a common database and hence the construction of a common information space is hampered by the fact that the other originators and recipients are not co-present. A shared understanding cannot be negotiated on the spot and “on the fly.” Here, then, the distributed nature of cooperative work is of paramount importance.

In this case, A - as a relatively autonomous decision maker - applies a particular strategy in a local context to a particular problem. The resultant documents are then, at least to some extent, transferred to the ‘public domain’ in the sense that it may be found, retrieved, used, trusted, neglected, rejected etc. by B, C, D, etc. in other local contexts, working on other problems with different strategies. The information objects are produced and accessed in a distributed manner, by multiple, semi-autonomous decision makers. The meaning of the various information objects, their interrelationship, and their potential relevance have to be re-established by multiple agents whose shared understanding is incomplete. There is no central omniscient agent to ensure a consistent and comprehensive organization of the content of the information space and any negotiated understanding that may be established is a “local and temporary closure” (Gerson & Star, 1986).

As Woo and Lochovsky (1986) note, “Supporting distributed, yet cooperative, office activities by providing a logically centralized office system (i.e. gathering the knowledge of all the office workers involved in performing a task into a global and consistent knowledge base) creates a number of problems.” First, cooperative work in complex environments involves integration of specialized conceptualizations, and “converting specialized, yet cooperative, office procedures to fit an integrated environment will not be easy since it requires the integrator to have knowledge of all the different kinds of specialization.” And second, “In a logically centralized office system, inconsistent office procedures, specified by different office workers, are not allowed.”

Thus, while requirements of 'uniformity' and 'consistency' and even 'up-to-dateness' of a 'community handbook' to support the construction of a common information space in cooperative work at 'arm's length' can be relaxed, the concept of a 'community handbook' raises a plethora of new issues to be addressed if the practical utility of the "community handbook" is to materialize.

**(1) Identifying the Producer of the Information.** Different people prefer different problem solving strategies or heuristics. Accordingly, information bears the stamp of the strategy applied in generating it. It is the result of biased reasoning. In cooperative decision making, then, which we regard as the norm in even supposedly 'routine' office work, people discount for the biases of their colleagues. This point was brought home very eloquently by Cyert and March in their classic study (1963) :

"For the bulk of our subjects in both experiments, the idea that estimates communicated from other individuals should be taken at face value (or that their own estimates would be so taken) was not really viewed as reasonable. For every bias, there was a bias discount."

Thus cooperative decision making involves a continuous process of assessing, and re-assessing, the validity of the information produced by the participants. In cooperative work settings involving discretionary decision making, the exercise of mutual critique of the decisions arrived at by colleagues is mandatory for all participants. In order to be able to assess information generated by discretionary decision making, each participant must be able to access the identity of the originator of a given unit of information.

The fact that information produced by discretionary decision making cannot be conveyed anonymously has important implications for CSCW systems design. Naturally, such information must be accompanied by the identity of the source. But how to represent and present the identity of the source? It probably depends on the nature of the information and the context, but how? Name, picture, position? Which identity properties are pertinent in which situation? If the source is unknown to the recipient, the name or the picture may be of no use. That is, there may be a limit beyond which exchange of (discretionary) information is not feasible, a kind of absolute limit to the scope of information systems, like the speed of light. To which kind of information does this apply? On closer inspection, we will probably come across a spectrum of categories of information - from factual to discretionary. Which categories of information can be disseminated with different kinds of identifiers? Is it possible to circumvent the identifier problem by providing 'depersonalized' contextual information (see below) that would provide a basis for critical assessment of anonymous information? Is it possible to record and convey the heuristics applied by a decision maker so as to enable the recipient of information to assess the validity etc. of the information? Can a computer system elicit or acquire the relevant background information, the decisional criteria applied etc.? Alternatively, how can a computer system support the originator in expressing pertinent background information? Etc.

**(2) Identifying the Context of the Information.** Information is always generated within a specific conceptual framework, as answers to specific questions. Thus knowledge of the perspective applied by the person in reaching a decision and producing information is indispensable to colleagues supposed to act intelligently on information conveyed to them. Accordingly, in addition to the task-related information being conveyed (the message itself, so to speak), a CSCW system supporting the construction of a common information space must provide contextual knowledge of the conceptual frame of reference of the originator. Thus, a computer-based system supporting cooperative work involving decision making should enhance the ability of cooperating workers to interrelate their partial and parochial domain knowledge and facilitate the expression and communication of alternative perspectives on a given problem. This requires a representation of the problem domain as a whole as well as a representation, in some form, of the mappings between perspectives on that problem domain. Again, we are not very far along in understanding how to build in such properties into our systems, despite the converging evidence that these kinds of supports are required by people. However, some encouraging experimental systems that provide features of this kind are coming forward.

For example, Storrs (1989) describes a system - The Policy Application - which provides computer support for cooperative work in a policy making agency. Describing the characteristics of policy making on the basis of four years of field studies of cooperative work patterns in the target agency, Storrs notes: "The particularly odd thing about it is that the 'group' is widely dispersed in space and time. Yet it is a problem which calls for the bringing together of a great many people with a wide range of expertise and with widely differing perspectives." In order to cater for these characteristics, the system provides a 'logical model' of the domain, in this case the social security legislation, in order to facilitate enquiries about the effects of legislation, to model changes to the legislation so as to assess their efficacy as solutions to policy problems, and to check for unexpected interactions with other parts of the legislation. In conjunction with this decision support facility, the system provides a hypertext-like argumentation structure for policy documents that allows policy makers to retrieve the 'hidden' argumentation substructure behind policy documents. The Policy Application is an interesting example of a new brand of CSCW systems that allows participants, old or new, to be able to assess some of the notions and opinions of the different parties involved in producing a piece of information. A similar approach has been advocated by Conklin (1989) in order to record the design decisions and assumptions that occur during the process of system design. Normally, the careful deliberation and much of the domain learning that went into resolving key design issues are not documented and therefore wasted, thus increasing overall system cost, especially the cost of system maintenance later on in the system's lifetime. In order to preserve the design rationale Conklin proposes a hypertext network that integrates all of the documents, artifacts, notes, ideas, decisions, etc. of the design process. One can see some overlap here with

the ideas in Engelbart's "Community Handbook" described earlier. To summarize, then, data-bases for cooperative work must make visible the identity of the originator of information and the strategies and perspectives applied in producing the information.

**(3) Identifying the Politics of the Information.** Yet a third problem, albeit one that has had some public discussion, has been the presupposition among many designers of information systems that information is something innocent and neutral. This view implies that to design an information system for a company one need only to consider the data flows and files existing in that company. Consequently, a common data base containing all the relevant data from different parts of the organization, providing managers with a unified data model of the organization, is seen as attainable. In the words of Ciborra (1985), hard reality has condemned this idea to the reign of utopia. In fact, the conventional notion of organizations as being monolithic entities is quite naive. Organizations are not perfectly collaborative systems. Rather, the perspective on organizations that views them as a mixture of collaboration and conflict, overt and covert, appears to be more illuminating and have greater explanatory potential than the traditional 'rationalistic' account (See Kling's (1982) classic survey paper). We view organizations as a coalition of individuals motivated by individual interests and aspirations and pursuing individual goals (Cyert and March, 1963). Accordingly, in organizational settings information is used daily for misrepresentation purposes. Most of the information generated and processed in organizations is subject to misrepresentation because it has been generated, gathered and communicated in a context of goal incongruence and discord of interests and motives.

On the one hand, the visibility requirement is amplified by this divergence. That is, knowledge of the identity of the originator and the situational context motivating the production and dissemination of the information is required so as to enable any user of the information to interpret the likely motives of the originator. On the other hand, however, the visibility requirement is moderated by the divergence of interests and motives. A certain degree of opaqueness is required for discretionary decision making to be conducted in an environment charged with colliding interests. Hence, *visibility must be bounded*. The idea of a comprehensive, fully exposed and accessible database is not realistic. A worker engaged in cooperative decision making must be able to control the dissemination of information pertaining to his or her work: what is to be revealed, when, to whom, in which form? Deprive workers of that capability, and they will exercise it covertly.

That is, a common information space must be 'peopled' by actors who are responsible for the information in the system. Problems of information-ownership and the responsibility for its upkeep and dissemination to others, have been neglected in much of the information systems literature, though the work of Nurminen and his colleagues on Human-Scale Information Systems partly

addresses this important issue (see Hellman, 1989, for some information on this framework).

These realities of organizational life must be investigated seriously if CSCW is to be turned from a laboratory research activity into an activity producing useful real world systems. By ignoring the diversity and discord of the 'goals' of the participants involved, the differentiation of strategies, and the incongruence of the conceptual frames of reference within a cooperating ensemble, much of the current CSCW research evades the problem of how to provide computer support for people cooperating through the establishment of a common information space.

### 3. Designing Socio-technical Systems

When we are addressing the task of designing computer-based systems to support cooperative work we need to understand and control far better the interaction between technical system and work organization than has heretofore been the case (see also Bødker et al., 1988). The issue of changes in organizational life caused by technological developments has a long history. By changing the allocation of functions between humans and their implements, changes in technology involve changes in the work organization. Hargreaves' 'Spinning Jenny' of 1765 and Crompton's 'Mule' of 1779, for instance, performed the functions of directly controlling the spinning operations. Because of that, the skilled spinners could be removed from cotton manufacturing and replaced by semi-skilled operators. The 'Jenny' induced the transition to the work organization of the modern factory.

Because of its intrinsic flexibility, the computer is an agent of organizational change *par excellence* and, hence, designing computer-based systems for cooperative work settings is like writing in water. By careful analysis and design, the information system may be designed to match the current social structure of the labor processes. But this change of the technical system, in turn, induces a change of the social structure of the labor processes. This has been the bitter experience of a plethora of 'office automation' projects and installations, designed to match the traditional allocation of tasks in the office. The 'office automation' experience has unequivocally demonstrated that the potentials in terms of productivity, flexibility, product quality, etc. of information technology in the office cannot be realized without a corresponding change in the allocation of tasks among staff. (Hammer, 1984; Skousen, 1986; Hedberg et al., 1987; Schmidt, 1987).

A computer-based system acts as an organizational change agent. Any software application project involves the design not just of a technical system, but it also embodies - implicitly if not explicitly - assumptions about the work

organization (task allocation, job design, etc.) to which the technical system is adapted. That is, knowingly or unknowingly, the designer does not merely design a computer system. What is being designed is a socio-technical system. Many researchers and designers acknowledge this. For instance, Winograd (1986) notes:

“Every time a computer-based system is built and introduced into a work setting, the work is redesigned - either consciously or unconsciously. We cannot choose to have no impact, just as we cannot choose to be outside of a perspective. We can make conscious choices as to which ones to follow and what consequences we anticipate.”

The old problems of fitting technical systems into the workplace have become acute for CSCW:

First, when we move from narrow domains and start to discuss computer support for the coordination and control of a large portion of everyday workplace activities, the *assumptions about the use situation* surface as more and more important variables. An adequate understanding of what is really going on in the workplace (see sections 2.1 and 2.2) becomes crucial to acceptance and use of these systems.

Second, if we are to design really usable systems to support cooperative work we need to develop a theoretical framework that will help us understand the complex interactions between the technical subsystem, the work organization, and the requirements of the task environment. To design specific CSCW systems, designers must analyze the target organizations in order to come up with answers to such questions as: What are the reasons for this particular task allocation? Can it be attributed to customary privileges or prejudices? Is it imposed by labor market agreements? Is it required by law? Or is it required by the customer, e.g., to ensure specific quality requirements? Can it be attributed to the technical resources at hand in the given case. Can it be attributed to the available facilities for information retrieval or communication, for instance? And so forth. In short, can and should the current task allocation be changed by design?

Such analyses go far beyond current conceptions of what is involved in performing psychological and information systems task analyses of work activities. Thus, we believe that in the design of specific CSCW applications one must be aware of the multitude of forms of social interaction that play a part in shaping work organizations in any real world work setting, for example:

- The forms of interaction in the labor process itself as determined by the cognitive and technical resources available.
- The impact of the function of the enterprise vis-a-vis the wider socio-economic system.
- The characteristics of the domain in question (stability or variability, homogeneity or heterogeneity, etc.).
- The organizational setting of the interaction.
- The customary privileges and prejudices of task allocation.
- Institutional forms of expressing and regulating conflicts of interest, etc.

- The forms of social control and allocation of power and authority in the workplace.
- The impact of the structure and state of the labor market, etc.

The empirical and theoretical work conducted within the 'socio-technical' approach,<sup>13</sup> provides a significant contribution to the development of the required theoretical framework. The conceptual framework of the 'socio-technical' approach is still fairly coarse, however, and an operational framework that would help analysts and designers to deal with these issues in an effective and differentiated manner is not imminent (see Schmidt, 1990, and Rasmussen, 1991, for a 'cognitive engineering' approach to the problem).

More specifically, CSCW as a field must be able to handle and, to that end, understand the evolving and reciprocal relationship of CSCW systems and work organization. Mackay (1990) provides an interesting example of the introduction of a CSCW application into an organization and shows the complex interplay between technology, individuals and institutions. Just for illustration, we can note how the introduction of the same technology will be different in different organizations, due to established procedures re. the introduction of technological change, the consultation with workers, the amount of training given, the expectations generated, individual preferences etc. People do not passively "accept" the technology but can reject it outright or appropriate it in ways meaningful to them, often in the process using it in ways unintended by the design team. Also the introduction of a technology is rarely a "one-shot" process but occurs over time, with changing organizational procedures and changing technologies and a changing workforce which mutually determine each other. Teasing out these interrelationships and developing a model useful to explicate them is no easy matter. Perspectives based on dialectics (Mathiassen, 1987) and on Giddens structuration theory (e.g. Orlikowski (in press) which emphasize the fluidity and malleability of structure and process may provide a richer analytical framework for discussing these issues than the socio-technical framework referred to earlier. What is certainly required is more case study material to understand exactly what is going on, as grist for the conceptual mill. However, as pointed out by Howard (1988) the CSCW field is in short supply of detailed studies on the effects of current generation CSCW systems on the nature of work processes. This is beginning to be rectified, a further case studies emerge. Such studies should be used proactively in the design of the next generation of CSCW systems.

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<sup>13</sup> Developed by Woodward (1965), Emery and Trist (1965), Thompson (1967), Perrow (1967), Cummings and Huse (1975; rev. ed. 1989), Mintzberg (1979), and others.

## 4. Conclusion

In this paper we have sought to uncover a more fundamental basis and develop a more coherent framework for understanding the concept of Computer Supported Cooperative Work than has heretofore been available. Our emphasis has been on the nature of work, and cooperative work in particular. Rather than focus on the technology per se that supports multiple individuals, as in much of the debates concerning Groupware, we argue for conceiving of CSCW as a discipline focussed on understanding basic cooperative work forms and how cooperative work practices that instantiate these forms can be changed, augmented, supplemented, replaced through the new technologies. The goals of CSCW and Groupware are thus somewhat different, but they need not be seen as antagonistic. In our view, Groupware appeals to those in product development pushing technological feasibility and new market niches, while our more encompassing view of what the CSCW field is about may appeal more to those in organizations pushing for a better fit between user needs and new technology.

We have not focused on the role of specific disciplines - software engineering, psychology, sociology, anthropology, organizational science - in CSCW in this paper, although this is a topic that would be worth some attention. We have argued for more emphasis in CSCW to be placed on the support requirements of cooperative work itself - not on the nature of the technology employed, nor on the primacy of the 'group' entity per se as exemplified in some of the Groupware discussions. Our object of focus is to understand the needs and requirements of people engaged in cooperative work. Thus successful CSCW will be rooted in this understanding of the use situation and not determined solely by the techniques applied. As we have noted, CSCW is not a really new concept, examples of successful applications go back to the dawn of computer applications themselves. However, with the increasing penetration of computer-based information systems into work processes, the need for these systems to be designed with a better appreciation of how work actually gets done becomes more crucial. Failure to understand the nature of cooperative work will lead to yet further catalogues of computer systems that fail due to disruption of the very work process they were designed to support. Our hope is that further attention to the nature of cooperative work in particular settings - along the lines we develop in this paper - will provide a more solid basis for the development of truly supportive work technology - CSCW.

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