Taking CSCW Seriously: Supporting Articulation Work*

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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 the exact focus of the field. This lack of focus may hinder its further development and lead to its dissipation. In this paper we set out an approach to CSCW as a field of research which we believe provides a coherent conceptual framework for this area, suggesting that it should be concerned with the *support requirements of cooperative work arrangements.* This provides a more principled, comprehensive, and, in our opinion, more useful conception of the field than that provided by the conception of CSCW as being focused on computer support for groups. We then investigate the consequences of taking this alternative conception seriously, in terms of research directions for the field. As an indication of the fruits of this approach, we discuss the concept of 'articulation work' and its relevance to CSCW. This raises a host of interesting problems that are marginalized in the work on small group support but critical to the success of CSCW systems 'in the large', i. e., that are designed to meet current work requirements in the everyday world.

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* This paper has had a lengthy gestation period, and aspects of the arguments have appeared elsewhere. Some of the points made here first surfaced in a short polemic by the authors entitled "CSCW: Four Characters in Search of a Context," appearing in the *Proceedings of the First European Conference on Computer Supported Cooperative Work, September 1989, Gatwick, UK.* (Subsequently published in Bowers and Benford (1991)). Major revisions of this paper, under the title "CSCW, or What's in a Name?" were made in 1990, and again in 1991, and copies of these manuscripts were distributed and discussed widely. The present paper is completely re-written with substantively new argumentation and material.

** The ordering of authors for this, as for earlier joint work by the authors, is arbitrary.

"As a research field, CSCW is distinct from any of the fields on which it draws."

Irene Greif (1988b)

While the area of Computer Supported Cooperative Work, or CSCW, appears to have established itself as a research field in its own right over the last few years, judging from the wealth of conferences and papers devoted to the topic, confusions concerning the very nature of the field continue to surface. Differences abound, for example, as to the centrality of the 'group' in CSCW, as to what is or is not regarded as a CSCW system, the relation between CSCW and what has been termed Groupware, etc. Indeed, at times, it appears that there is no coherent conception of the area at all!

In this paper, we put forward our own conceptualization of CSCW, firmly anchored in a framework that pays attention to the computer support requirements of cooperative work, and briefly discuss how this view relates to other popular conceptions of the field. However, it is important to note that the paper is not intended as an introduction or overview of the field per se. Rather it is aimed at readers who already are interested or involved in the area, yet concerned about its focus and direction. The paper is thus programmatic, in that it lays out a set of arguments as to how to conceive of the CSCW field, and the consequences of taking this conception seriously, in terms of a research agenda. Our intent is not to contribute to sterile definitional debates prescribing what is or is not CSCW, but to construct a conception of the field that allows us, i.e. those active within CSCW, to have some common reference point, and some understanding of what are important questions for the field.[1] We then pursue the consequences of our approach in the remainder of the paper, discussing a number of important research issues for the field of CSCW which emerge from the particular framework outlined here.

The paper is organized as follows. As context for our discussion, some background information on the CSCW field is presented in Section 1. This is not intended as a comprehensive account of the field, and readers interested in more descriptive accounts should look elsewhere.[2] We then proceed to formulate our conceptualization of the field in Section 2, focusing on the nature of cooperative work, the need for computer support, and how the field or arena of CSCW could be viewed as a timely response to these concerns. Following this, we investigate

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1 On occasion, readers of the draft ms. have complained of an overly prescriptive tone to the paper. It is true that at times we take the liberty of saying that "the field of CSCW should" - focus on certain issues, or take certain directions. However, our intent with these remarks is simply to highlight issues in the field that we believe are important, indeed, which we are currently investigating, and arise out of the underlying conceptualization of CSCW that we argue for here. Our intent is not to police the field, but to provide some rationale for why a certain agenda for the area makes sense. We welcome debate with those who hold other conceptualizations of the field that lead them to formulate alternative research programmes to that presented here.

2 See, for example, (Bannon and Schmidt, 1989), Grudin (1991), and Wilson (1991).

aspects of an important issue - support for articulation work - that emerge as a core concern for the field as we have conceptualized it.

1. Some background

The term “Computer-Supported Cooperative Work” was first used by two researchers (Irene Greif and Paul Cashman) back in 1984, to describe the topic of an interdisciplinary workshop they were organizing on how to support people in their work arrangements with computers (Greif, 1988a). The meaning of the individual words in the term was not especially highlighted. Subsequently the term was abbreviated to CSCW, and discussion on the meaning of this somewhat unwieldy label describing the field was expected to disappear. This has not occurred. This may be in part due to the fact that both the boundaries of the field and its focus are still somewhat unclear, despite numerous attempts to clarify the nature and breadth of the field (Bannon et al., 1988; Greif, 1988a; Bannon and Schmidt, 1989; Ellis et al., 1991; Grudin, 1991). Indeed, at one point it appeared as if the label CSCW was simply being used as a umbrella term under which a variety of people from different disciplinary perspectives could discuss aspects of computer system design and use by people (Bannon et al., 1988). It is hard to see how anything in the form of a coherent research area could emerge from such a loose description. At the same time, it is not surprising that in the early stages of the emergence of a new field, which is actively being constituted by a variety of groups with quite different disciplinary perspectives, there is some difficulty in agreeing on what are the core issues for the new field, and how they should be handled. Indeed, any such development must also take into account the politics of the situation, as the emerging field becomes an arena where different conceptualizations of the area are fought over.

Attempts at a more coherent definition of the field have also appeared over the years. In the introduction to an important collection of readings in CSCW, Greif (Greif, 1988b: 5) defines CSCW as “… an identifiable research field focused on the role of the computer in group work”. This focus on the ‘group’ as the unit of analysis for CSCW will be subjected to some scrutiny later in the paper (Section 2.2.2). An alternative formulation of the field, that has since been adopted by many researchers, is that proposed in Bannon and Schmidt (1989): “CSCW should be conceived as an endeavor to understand the nature and characteristics of cooperative work with the objective of designing adequate computer-based technologies”. This definition focuses on understanding the nature of cooperative work as a foundation to designing information systems to support the work. Suchman (1989: 1) provides a somewhat related but weaker definition of CSCW: “… the design of computer-based technologies with explicit concern for the socially organized practices of their intended users.” The focus here is more loosely on the sociality of work, rather

than on specific characteristics of cooperative work as a distinct category of work (see Section 2.2 for an elaboration).[3]

Many in the field of CSCW simply refer to the area by the term Groupware. This term is often used by people who focus on the design of software that supports group work.[4] For a period in the development of the field, the wisdom of substituting one term for the other was debated, with concern being expressed that the Groupware label connoted too narrow a view of the field of CSCW, with the former's emphasis solely on developing software for 'group' processes (Bannon and Schmidt, 1989). The issue no longer stirs much controversy, with both terms still popular, and most proponents of Groupware quite aware of the multiplicity of cooperative work arrangements besides that of the 'group'. While many commercial reports still refer to the Groupware field, the term CSCW has come to be preferred in the research community due to its more comprehensive remit, despite its admitted awkwardness (Greenberg, 1991).

2. A conceptualization of CSCW

According to the British sociologist of science, Richard Whitley, a research area is constituted 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.

2.1. The approach of CSCW: Computer Support

By virtue of the first part of its name, the 'CS' part, the professed objective of CSCW is to *support via computers* a specific category of work - cooperative work.

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3 Given this work, Kling's claim that CSCW embodies "a 'worldview' that emphasizes convivial work relations" is surprisingly off the mark (Kling, 1991: 83).

4 The original usage of the term (Johnson-Lenz and Johnson-Lenz, 1982) differs somewhat from its prototypical use.

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 should not 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 of as *an endeavor to understand the nature and requirements of cooperative work with the objective of designing computer-based technologies for cooperative work arrangements.* 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 and development 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. with information technology? What are the implications of these requirements for the architectures of the underlying systems and services? All in all, the thrust of these questions is to *understand*, so as to better *support*, cooperative work.

As a research effort that involves a large number of established disciplines, research areas, and communities, CSCW is an arena of discordant views, incommensurate perspectives, and incompatible agendas. However, in the conception of CSCW proposed here - as a research area devoted to exploring and meeting the support requirements of cooperative work arrangements, CSCW is basically a *design oriented research area*. This is the common ground. Enter, and you must change.

Thus, the objective of social science contributions to CSCW should not be to cash in on the new wave and do what they have always done but rather to explore

exactly how insights springing from studies of cooperative work relations might be applied and exploited in the design of useful CSCW systems. This demand not only raises the issue of how to utilize insights already achieved in related fields to influence the design process. It raises more fundamental issues such as: Which are the pertinent questions being pursued in field studies and evaluations for the findings to be of utility to designers? And how are the findings to be conceptualized? If CSCW is to be taken seriously, the basic approach of CSCW research should not be descriptive but constructive.

On the other hand, as a research area devoted to exploring and meeting the support requirements of real world cooperative work arrangements, CSCW 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.

Likewise, designing systems for specific cooperative work settings raises new issues for requirements analysis: How can designers unravel the essential functions of the cooperative work relations to be supported as opposed to ephemeral or accidental cooperative work practices that may be observed? What are the reasons for this particular task allocation or practice? 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? How should designers approach the complex and delicate problem of designing systems that will inevitably change existing cooperative work patterns?

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.

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. We thus concur with the drive of Groupware enthusiasts to actually *construct* working artifacts to support cooperative work processes.

2.2. The scope of CSCW: 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. For instance, Hughes, Randall, and Shapiro (1991) contest the validity of the very concept of 'cooperative work' as a distinct category on the grounds that "all work is […] socially organized". 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 (1987) 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 compliance, 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. Concurring in this criticism of the allegedly strong positive connotations of the "happy terms" 'cooperation' and 'collaboration', Kling (1991) prefers the term 'coordination' in stead. Given this confusion, a closer examination of the concept of cooperative work is required.

2.2.1. The nature of cooperative 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) and Wakefield (1849)) and developed by Marx (1867) who defined it as "multiple individuals working together in a conscious 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), Bahrdt (1958), Dahrendorf (1959), Kern and Schumann (1970), and Mickler et al. (1976)). At the core of this conception of cooperative work is the notion of *interdependence in work*.

Work is, of course, always immediately *social* in the sense that the object and the subject, the ends and the means, the motives and the needs, the implements and the competencies, are socially mediated. However, people engage in *cooperative work* when they are *mutually dependent* in their work and therefore are required to cooperate in order to get the work done (Schmidt, 1991b). The notion of mutual dependence *in work* does not refer to the interdependence that arises by simply having to share the same resource. In this case people certainly have to coordinate their activities but to each of them the existence of the others is a mere nuisance and the less their own work is affected by others the better. For example, time-sharing

systems cater for just that by making the presence of other users imperceptible. Being mutually dependent *in work* means that 'A' relies positively on the quality and timeliness of 'B's work and vice versa and should primarily be conceived of as a positive, though by no means necessarily harmonious, interdependence.[5]

Because of this interdependence, any cooperative effort thus involves a number of secondary activities of mediating and controlling these cooperative relationships. Tasks have to be allocated to different members of the cooperative work arrangement: which worker is to do what, where, when? And in assigning a task to a worker, that worker is then rendered accountable for accomplishing that task according to certain criteria: when, where, how, how soon, what level of quality, etc.? Furthermore, the cooperating workers have to *articulate* (divide, allocate, coordinate, schedule, mesh, interrelate, etc.) their distributed individual activities (Strauss et al., 1985; Gerson and Star, 1986; Strauss, 1988). Thus, by entering into cooperative work relations, the participants must engage in activities that are, in a sense, extraneous to the activities that contribute directly to fashioning the product or service and meeting requirements. That is, compared with individual work, cooperative work implies an overhead cost in terms of labor, resources, time, etc. The obvious justification for incurring this overhead cost and thus the reason for the emergence of cooperative work formations is, of course, that workers could not accomplish the task in question if they were to do it individually (Schmidt, 1990).

True, all work is complexly social. We are indeed social animals, but we are not *all* of us *always* and in *every* respect mutually dependent in our work. Thus, in spite of its intrinsically social nature, work is not intrinsically *cooperative* in the sense that workers are mutually dependent in their work. Cooperative work is thus distinct from individual work, in theory as well as in practice. In so far as cooperating workers have to articulate their distributed individual activities and, thus, must engage in activities that are extraneous to the activities that contribute directly to fashioning the product or service and meeting requirements, cooperative work has characteristics distinctly different from individual work.

In our view, this conception of cooperative work is quite appropriate for CSCW for several reasons.

2.2.2. The rich diversity of cooperative work

It is crucial that the CSCW field does not artificially and inadvertently exclude specific forms of cooperative work from the scope of research. Rather, the conceptualization of cooperative work in CSCW should allow us to embrace the rich diversity of forms of cooperative work.

(1) In a large part of the literature on CSCW, cooperative work is simply defined as group work. Greif (Greif, 1988b), for instance, defines CSCW as "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

5 This conception of interdependence in work as constitutive of cooperative work is related to Thompson's concept of 'reciprocal interdependence' (Thompson, 1967: 54-55).

defining the former by the latter does not bring clarity to the scope of the field. To the contrary, it entails a host of problems of its own.

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, and so on" 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 (Johansen, 1988: 1). On the other hand, the term 'group' is quite often used to designate a relatively closed and fixed aggregation of people sharing the same 'goal' and engaged in continual and direct communication. The very notion of a 'shared goal' is itself murky and dubious, however (Bannon and Schmidt, 1989). The 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, motives, etc.

It has - implicitly or explicitly - been the underlying assumption in most of the CSCW oriented research thus far that the cooperative work arrangement to be supported by a computer artifact is a small, stable, egalitarian, homogeneous, and harmonious ensemble[6] of people, - a 'group'. However, in general cooperative work in real world settings has a number of characteristics that must be taken into account if CSCW systems are to be acceptable to users and, hence, commercially viable:

- Cooperative ensembles are either large, or they are embedded within larger ensembles.
- Cooperative ensembles are often transient formations, emerging to handle a particular situation after which they dissolve again.
- Membership of cooperative ensembles is not stable and often even non-determinable. Cooperative ensembles typically intersect.
- The pattern of interaction in cooperative work changes dynamically with the requirements and constraints of the situation.
- Cooperative work is distributed physically, in time and space.
- Cooperative work is distributed logically, in terms of control, in the sense that agents are semi-autonomous in their partial work. Cooperative work involves incommensurate perspectives (professions, specialties, work functions, responsibilities) as well as incongruent strategies and discordant motives.
- There are no omniscient agents in cooperative work in natural settings.

(2) 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 term 'cooperation', of course, has multiple connotations in everyday usage.

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6 The terms 'ensemble' is used by Sartre (1960) to denote an, as yet, unstructured aggregation of people. It is used here to denote a *cooperative work arrangement* irrespective of its specific organizational form - whether it is a group, a team, a network, a department, or a company.

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 should not be taken to 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), and 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.

(3) More generally, the conception of cooperative work suggested here does not assume or entail specific forms of interaction such as mode and frequency of communication, comradely feelings, equality of status, formation of a distinct group identity, etc. or even specific organizational settings. Indeed, we do not want to restrict the scope of CSCW to cooperative work relations that are defined and bounded in legal terms, i.e. in terms of formal organizational structures. Cooperative work is constituted by interdependence in work, that is, by work activities that are related as to content in the sense that they pertain to the production of a specific product or service. 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 business 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 manufacturing enterprises are establishing stable cooperative networks incorporating multiple companies by involving supplier companies in 'just-in-time' and 'total quality control' arrangements.

Actually, 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, - for instance in administrative work, engineering design, and scientific research, where actors often cooperate at 'arm's length,' without direct communication and without necessarily knowing each other. 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. For example, 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. CIM is thus faced with issues that are crucial to CSCW (Schmidt, 1991a). However, 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.

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 want CSCW to address the aspects of computer support for cooperative work *wherever* they occur. In this sense, established research and development fields such as, for example, Computer Integrated Manufacturing (CIM), Office Information Systems (OIS), Computer-Aided Design (CAD), and Computer-Aided Software Engineering (CASE) are all legitimate and indeed necessary fields for CSCW as domains of inquiry. Also, 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 the design of systems that support cooperative work arrangements that are characterized by a large and maybe indeterminate number of participants, incommensurate conceptualizations, incompatible strategies, conflicting goals and motives, etc. These challenges are not merely academic. They are the challenges posed by ongoing practical efforts in CIM, OIS, CAD, CASE etc.

2.2.3. Articulation work

The conception of cooperative work as outlined above points to a set of key issues for CSCW that can be subsumed under the notion of supporting the articulation of distributed activities.

A cooperative work arrangement arises simply because there is no omniscient and omnipotent agent. Specifically, a cooperative work arrangement may emerge in response to different requirements (Schmidt, 1990):

- A cooperative work arrangement may simply *augment* the mechanical and information processing capacities of human individuals and thus enable the cooperating ensemble to accomplish a task that would have been infeasible for the workers individually.
- A cooperative work arrangement may *combine the specialized activities* of multiple workers devoted to the operation of different specialized tools, techniques, or routines.
- A cooperative work arrangement may facilitate the application of multiple problem solving *strategies and heuristics* to a given problem and may thus serve the function of balancing the individual biases ('bias discount', in the words of Cyert and March (1963)).
- A cooperative work arrangement may facilitate the application of multiple *perspectives and conceptions* on a given problem so as to match the multifarious nature of the work environment.

Therefore, cooperative work is, in principle, distributed in the sense that decision making agents are semi-autonomous in their work in terms of the unique situations and contingencies they are faced with locally as well as in terms of goals, criteria, perspectives, heuristics, and interests and motives.

However, due to the very interdependence in work that gave rise to the cooperative work arrangement in the first place, the distributed nature of the arrangement must be kept in check, managed. The distributed activities must be articulated. Articulation work arises as a integral part of cooperative work as a set of activities required to manage the distributed nature of cooperative work.[7] In the words of Strauss (1985: 8), articulation work is "a kind of supra-type of work in any division of labor, done by the various actors":

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7 The concept of 'working division of labour' developed by Anderson, Sharrock, and Hughes (1987) is related to the concept of 'articulation work' as developed by Strauss, Gerson, Star, and others.

> Articulation work amounts to the following: First, the meshing of the often numerous tasks, clusters of tasks, and segments of the total arc. Second, the meshing of efforts of various unit-workers (individuals, departments, etc.). Third, the meshing of actors with their various types of work and implicated tasks.

In order to be able to articulate the distributed activities of a cooperative work arrangement, the participants need access to appropriate means of communication. By providing communication facilities in the form of file sharing, shared view, email, computer conferencing, and video conferencing that increase the bandwith and reduce the turnaround time of communication, CSCW systems can enable small and relatively stable cooperating ensembles to exploit the powerful repertoire of everyday social interaction in spite of distance and thus augment the capacity of the ensembles in articulating their distributed activities.

However, in 'real world' cooperative work settings - characterized by dispersed, distributed, and dynamic cooperative work arrangements and involving a large, varying, or indeterminate number of participants, - the various forms of everyday social interaction are quite insufficient. Hence, articulation work becomes extremely complex and demanding. In these settings, people apply various *mechanisms of interaction* so as to reduce the complexity and, hence, the overhead cost of articulation work, e.g.:

- Organizational structures in the form of formal (explicit, statutory, legally enforceable) and less formal (implicit, traditional, customary) allocation of resources, rights, and responsibilities within the cooperating ensemble.
- Plans, schedules, e.g. master schedules and kanban systems in manufacturing enterprises (Schmidt, 1991a).
- Standard operating procedures (Suchman, 1983; Suchman and Wynn, 1984).
- Conceptual schemes (e.g., thesauruses, taxonomies) for indexation or classification of information objects so as to organize distributed inclusion and retrieval of objects in 'public' repositories, archives, libraries, databases etc. maintained by multiple persons (Star and Griesemer, 1989; Bowker and Star, 1991).

These protocols, formal structures, plans, procedures, and schemes can be conceived of as *mechanisms* in the sense that they (1) are objectified in some way (explicitly stated, represented in material form), and (2) are deterministic or at least give reasonably predictable results if applied properly. And they are *mechanisms of interaction* in the sense that they reduce the complexity of articulating cooperative work.

However, as observed by Gerson and Star (1986: 266), being nothing but local and temporary closures, these mechanisms themselves require articulation work:

> Reconciling incommensurate assumptions and procedures in the absence of enforceable standards is the essence of articulation. Articulation consists of all the tasks involved in assembling, scheduling, monitoring, and coordinating all of the steps necessary to complete a production task. This means carrying trough a course of action despite local contingencies, unanticipated glitches, incommensurate opinions and beliefs, or inadequate knowledge of local circumstances.

> Every real world system is an open system: It is impossible, both in practice and in theory, to anticipate and provide for every contingency which might arise in carrying out a series of tasks. No formal description of a system (or plan for its work) can thus be complete. Moreover, there is no way of guaranteeing that some contingency arising in the world will not be inconsistent with a formal description or plan for the system. […] Every real world system thus requires articulation to deal with the unanticipated contingencies that arise. Articulation resolves these inconsistencies by packaging a compromise that 'gets the job done,' that is closes the system locally and temporarily so that work can go on.

Major research efforts in CSCW have been directed at incorporating such mechanisms of interaction in CSCW applications, e.g. AMIGO and COSMOS (Danielsen et al., 1986; Benford, 1988; Bowers et al., 1988; COSMOS, 1989), THE COORDINATOR (FLORES ET AL., 1988), DOMINO (Kreifelts et al., 1991), and the Community Handbook proposed by Engelbart and Lehtman (Engelbart and Lehtman, 1988).

However, in these CSCW research activities, a set of related issues are encountered recurrently, namely the problem of how to support the ongoing dynamic articulation of distributed activities and the cooperative management of the mechanisms of interaction themselves. This issue, we posit, is the key issue in CSCW.

2.3. Why CSCW now?

Why CSCW now? There are, of course, a multitude of answers to that question (Bannon et al., 1988; Grudin, 1991; Hughes et al., 1991). In a cynical interpretation, for example, CSCW could be seen as the answer to the silent prayers of researchers from HCI who feel that their field has done it duty by developing the graphical user interface, researchers from AI who feel that their field no longer offers the exciting opportunities it used to, or researchers from social science who feel that it is now their turn to get funded! All of these stories are probably relevant to some extent. But there are other - more material - developments involved.

First, however, we need to establish what is so new about CSCW. 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 information systems. For example, 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 rudimentary form of cooperative work in the broad sense posited above. The multi-user database of an airline reservation system can be viewed as a 'shared object' by means of which people interact in an indirect fashion. However, the limited ability to track changes and communicate between those involved make the range of support provided rudimentary. So,

although people using these systems may engage in cooperative problem solving and discretionary decision-making, the technology itself provides little or no support for these cooperative processes - these aspects of their cooperative efforts take place outside or around rather than through the system. 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.

Now, a major development that gives impetus to the rise to CSCW *as a field* is the current transformation of the organization of work. Comprehensive changes in the societal environment permeate the realm of work with a whole new regime of demands and constraints. The turbulent character of modern business environments and the demands of an educated and critical populace, compel industrial enterprises, administrative agencies, health and service organizations, etc. to drastically improve their innovative skills, operational flexibility, and product quality (Gunn, 1987). To meet these demands, work organizations must be able to adapt rapidly and to coordinate, in a comprehensive and integrated way, their distributed activities across functions and professional boundaries within the organization or within a network of organizations. In short, the full resources of cooperative work must be unleashed: horizontal coordination, local control, mutual adjustment, critique and debate, self-organization. Work organizations thus require support from advanced information systems that can facilitate the coordination of distributed decision making. Simultaneously, the proliferation of powerful workstations in cooperative work settings and their interconnection in comprehensive high-capacity networks provide the technological foundation to meet this need.

Such developments are illustrated in the area of Computer Integrated Manufacturing by the efforts to integrate formerly separated functions such as design and process planning, marketing and production planning, etc., and by the similar efforts in the area of Office Information Systems to facilitate and enhance the exchange of information across organizational and professional boundaries.

In emerging complex work 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. Thus, while the dynamic and distributed nature of cooperative work arrangements could be ignored (for all practical purposes) in the design of conventional information systems for cooperative work settings, these characteristics pose challenging problems to the development of computer-based systems to support cooperative work in the newly emerging organization of work.

These developments have often been encountered by unsuspecting systems designers who thus become aware of the complexity of the cooperative work processes the hard way. All too often computer-based systems are introduced in cooperative work settings with disruptive effects due to an insufficient appreciation of this complexity (Grudin, 1989; Harper et al., 1989).

3. Supporting articulation work

If we take our conceptualization of CSCW seriously, one issue that looms large is how to support the "articulation work" that people must engage in, in order to make the cooperative mechanisms developed to support different aspects of work in complex environments fit together and fit to local circumstances.

In this Section of the paper we broach two aspects of this articulation issue, one focusing on the management of workflow, the other on the construction and management of what we term a "common information space". The former concept has been the subject of discussion for some time, in the guise of such terms as office automation and more recently, workflow automation. The latter concept has, in our view, been somewhat neglected, despite its critical importance for the accomplishment of many distributed work activities. Here the focus is on how people in a distributed setting can work cooperatively in a common information space - i.e. by maintaining a central archive of organizational information with some level of 'shared' agreement as to the meaning of this information (locally constructed), despite the marked differences concerning the origins and context of these information items. The space is constituted and maintained by different actors employing different conceptualizations and multiple decision making strategies, supported by technology.

3.1. Supporting the management of workflows

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. 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. 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 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" (Suchman, 1983: 321). It is 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 (Zisman, 1977; Ellis and Nutt, 1980; Hammer and Kunin, 1980; Hammer and Sirbu, 1980; Ellis and Bernal, 1982). Designers were "automating a fiction" as Beau Sheil (1983) so aptly put it. Such systems have now been admitted as failures (Barber, 1983: 562):

> In all these systems [i.e., *inter alia*, Zisman's "Office Procedure Specification Language", Ellis' "Information Control Net" and Hammer and Kunin's "Office Specification Language"] 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. […] These systems do not deal well with unanticipated conditions.

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 (Fikes and Henderson, 1980; Barber et al., 1983; Ellis, 1983; Croft and Lefkowitz, 1984; Hewitt, 1986).[8] For example, Woo and Lochovsky (1986) 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."

Some early CSCW systems did not seem to take note of these issues. For instance, take the early CSCW project management support tool XCP. In the words of its designers (Sluizer and Cashman, 1984):

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8 Much of this new work can also be critiqued with respect to their concept of 'goals' and how they are represented, but this critique will not be pursued here.

> 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.

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.

A similar, rather rigid, view of office procedures as a series of directly executable steps can be found in the initial work on the office procedure system DOMINO. It was meant to incorporate a model of a procedure in the form of "a formalized exchange of messages" serving as "a fixed regulation in an organization" (Victor and Sommer, 1991: 119-120). However, after initial testing of a prototype, designers have noted the need for a more flexible interpretation of such 'procedures' and have begun work on a more open-ended version of the system (Kreifelts et al., 1991).

Thus it can be argued that, in addition to the naked functionality of the specific CSCW application, the system should also have facilities that allow users to freely negotiate task allocation and articulation. Robinson (1991) has argued for such a position forcibly, stating that a CSCW application should support at least two interacting "levels of language" as a general design principle, as "unless these two levels interact, fruitful co-operation will not happen." (Robinson, 1991: 48). He cites the COORDINATOR system developed by Flores, Winograd and others (Flores et al., 1988) as an example of a system that is problematic not because it requires people to be explicit about their communication but because, in his view, it has "excluded, marginalised, and even illegitimised" alternative channels of conversation to facilitate the negotiation of task allocation and articulation.[9] As an example of a system providing a simple, yet effective, alternative channel for cooperative task articulation, Robinson cites the GROVE system (Ellis et al., 1991). 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, users can 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:

> 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 'formal' and 'cultural' aspects of language as used by participants in projects and organizations. 'Computer support' is valuable insofar as it facilitates the

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9 There is a lot of controversy surrounding the COORDINATOR system, both in terms of its design philosophy and its success or failure in practice. While this debate is important, our purpose here is not to take sides, but simply to note one of the claims made about the system.

> 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 […] are as significant as the 'given.' […] The formal level is meaningless without interpretation, and the cultural level is vacuous without being grounded. (Robinson, 1991: 43)

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 problem with incorporating models of organizational procedures or structures in computer systems is not that organizational procedures and structures are fictitious. Rather, they serve a heuristic function in action by identifying constraints, pitfalls and strategic positions in the field of work. As observed by Suchman (1987) in her analysis of the role of plans in situated action, in order to serve this heuristic function "plans are inherently vague". Thus, in Suchman's conception,

> plans are resources for situated action, but do not in any strong sense determine its course. While plans presuppose the embodied practices and changing circumstances of situated action, the efficiency of plans as representations comes precisely from the fact that they do not represent those practices and circumstances in all of their concrete detail. (Suchman, 1987: 52)

The observation that "*plans are resources*" is generally valid. Organizational procedures may, of course, codify 'good practice,' recipes, proven methods, efficient ways of doing things, work routines. In flexible work organizations required to be able to cope with unanticipated contingencies procedures of this kind are of little value and may actually impede flexibility. However, a procedure may also convey information on the functional requirements to be met by the process as well as the product; it may highlight decisional criteria of crucial import; it may suggest a strategy for dealing with a specific type of problem (e.g., which questions to address first?); it may indicate pitfalls to avoid; or it may simply provide an *aide memoir* (such as a start procedure for a power plant or an airplane). Also, a procedure may express some statutory constraints where non-compliance may evoke severe organizational sanctions. More often than not, a particular procedure will express, in some way, all of these different functions. However, whatever the function, organizational procedures are not executable code but rather heuristic and vague statements to be interpreted, instantiated, and implemented, maybe even by means of intelligent improvisation.

Therefore, instead of pursuing the elusive aim of devising organizational models that are not limited abstractions and thus in principle brittle when confronted with the inexhaustible multiplicity of reality, organizational models in CSCW applications should be conceived of as *resources* for competent and responsible

workers. That is, the system should make the underlying model accessible to users and, indeed, support users in interpreting the procedure, evaluate its rationale and implications. It should support users in applying and adapting the model to the situation at hand. It should allow users to tamper with the way it is instantiated in the current situation, execute it or circumvent it, etc. The system should even support users in modifying the underlying model and creating new models in accordance with the changing organizational realities and needs. The system should support the documentation and communication of decisions to adapt, circumvent, execute, modify etc. the underlying model. In all this, the system should support the process of negotiating the interpretation of the underlying model, annotate the model or aspects of it, etc.

This set of issues is of vital importance for the future direction of CSCW research and development and raises many crucial questions which need to be investigated in future research programmes.

3.2. Supporting the management of a common information space

Another approach to the design of CSCW applications, other than the procedural or workflow approach described above, is to allow the members of a cooperating ensemble to interact freely, i.e. without being constrained by prescribed procedures or established conversational conventions, through the provision of facilities enabling them to cooperate via the joint construction of a *common information space*. Here, they perceive, access, and manipulate the same set of information, for example in a shared database, but further work is then required by the actors in order to arrive at an agreed interpretation concerning the meaning of these objects. Cooperative work is not facilitated simply by the provision of a shared database, but requires the active construction by the participants of a common information space where the meanings of the shared objects are debated and resolved, at least locally and temporarily. Objects must thus be interpreted and assigned meaning, meanings that are achieved by specific actors on specific occasions of use. Computer support for this aspect of cooperative work raises a host of interesting and difficult issues. In this section we discuss the difficulties involved in achieving a shared understanding of the meaning of objects among a group of people who are working in a distributed fashion, and what the implications are for computer support of such activities. Let us begin with problems of interpreting objects in a ‘shared’ system.

3.2.1. 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 artifact. The semantics of the information carried by the artifact, however, is, put crudely, 'in the mind' of the beholder, and the acquisition of information conveyed by the artifacts requires an interpretive activity on the part of the recipient. Thus, a common information space encompasses the artifacts that are accessible to a cooperative ensemble *as well as* the meaning attributed to these artifacts 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.

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: 6): "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.[10]

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

10 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." (Gerson, 1989).

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. Heath and Luff (1991) and Tang (1991)) 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 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.[11] 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 and 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., 1987).

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 a means of communicating 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

11 See Greenberg, (1990), for a concise and articulate overview of issues in this area.

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.

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 (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. (Engelbart and Lehtman, 1988: 249)

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.

3.2.2. 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. Here, a shared understanding cannot be negotiated on the spot and 'on the fly' and the distributed nature of cooperative work is thus 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 and so forth 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 and Star, 1986).

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 Originator 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 by Cyert and March in their classic study (1963: 77). Thus cooperative decision making involves a continuous process of assessing, and re-assessing, the validity of the information produced by the participants. For example, take the case of an "experienced and skeptical oncologist," cited by Strauss and associates (1985):

> I think you just learn to know who you can trust. Who overreads, who underreads. I have got X rays all over town, so I've the chance to do it. I know that when Schmidt at Palm Hospital says, 'There's a suspicion of a tumor in this chest,' it doesn't mean much because she, like I, sees tumors everywhere. She looks under her bed at night to make sure there's not some cancer there. When Jones at the same institution reads it and says, 'There's a suspicion of a tumor there,' I take it damn seriously because if he thinks it's there, by God it probably is. And you do this all over town. Who do you have confidence in and who none. (Strauss et al., 1985: 21-22)

As observed by Cicourel (1990: 222), the point is that "the source of a medical opinion remains a powerful determinant of its influence." That is, "physicians typically assess the adequacy of medical information on the basis of the perceived credibility of the source, whether the source is the patient or another physician." Thus "advice from physicians who are perceived as 'good doctors' is highly valued, whereas advice from sources perceived as less credible may be discounted."

In cooperative work settings involving discretionary decision making, the exercise of mutual critique of the decisions arrived at by colleagues is required for all participants. Therefore, 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. 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” (Storrs, 1989: 118). 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 inquiries 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, databases 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 (1980) 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 (see Nurminen (1988), though).

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.

4. Conclusion

This paper has outlined a number of important issues in the field of CSCW which come to the fore as a result of taking seriously the concept of cooperative work and its computer support. Emphasis has been placed on the distributed nature of cooperative work arrangements, and the additional requirements this places on the design of technological support. Our approach has thus broadened the scope of CSCW beyond support of small groups or teams, as this has been shown to be but one form of work arrangement, and indeed one that has special characteristics which does not generalize to the majority of work settings. The paper has attempted to turn the spotlight onto the nature of these different cooperative work forms, and discussed crucial aspects of how work is managed and effected. This discussion hinged on the concept of 'articulation work', a pervasive and ubiquitous aspect of work practices that is essential in the accomplishment of work. We have attempted to outline the problems and opportunities this re-orientation of the field provides for on-going CSCW work.

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