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Constructing CSCW: The First Quarter Century

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Abstract. As an established field of research, Computer Supported Cooperative Work or CSCW is now well beyond its first quarter century of existence. It is an appropriate time to take stock: What has been achieved, and what issues remain as challenges for the field?—This introductory article will assess what has become of the field, its position as a research field in the wider context of technology development, and its complex physiognomy.

Key words: CSCW, Computer-Supported Cooperative Work

As an established field of research, Computer Supported Cooperative Work or CSCW is now well beyond its first quarter century of existence. This Jubilee Issue of the *CSCW Journal* has been put together to mark this significant milestone in the development of CSCW. It is an appropriate time to take stock: What has been achieved, and what issues remain as challenges for the field? To address these questions, this special issue features seven articles that review a number of key threads of CSCW research, all written by scholars that have played a leading role in this research.

In this short introductory article we will abstain from attempting a comprehensive assessment of the achievements of CSCW; rather, we will restrict ourselves to briefly assessing what has become of the field, its position as a research field in the wider context of technology development, and its complex physiognomy: a mix of loosely interconnected research issues and programs *linked* to an unfolding program of cumulative research. In making this assessment, some observations on the origins and early development are made and an outline of achievements is sketched. However, what is intended here is not to give a historical account of the development of the CSCW field, but to characterize the makeup of the field.

1. The heterogeneity of CSCW

CSCW is, in many ways, a rather peculiar research area, and any assessment of its achievements must take its specific nature into account.

At first sight, CSCW is a remarkably heterogeneous research area with a diverse array of research problems. Where interdisciplinary research areas (e.g., climate research) typically involve different research disciplines and methods but derive their unity from the object of research (e.g., global warming), the problems addressed by

CSCW research are quite diverse, for the simple reason that they arise in and from the development and application of a wide range of different computing technologies. CSCW research does not address a specific family of technologies, whether existing or in the making; thus, whatever unity it has is not derived from specific technologies. We will attempt to explicate its unity below. Firstly, however, we will briefly examine the source of the field's heterogeneity. The origins of CSCW are an obvious place to begin.

The first event organized under the acronym 'CSCW', a workshop with invited participants, organized by Irene Greif and Paul Cashman, was held in 1984, and two years after that, in 1986, the first conference under the CSCW label convened in Austin, Texas (Krasner and Greif 1986), while the first European CSCW conference was held in London in 1989 (Wilson et al. 1989; Bowers and Benford 1991). And finally, the *CSCW Journal* began to appear in 1992. However, the research efforts that became, in a sense, institutionalized, i.e., acquired organizational form through these initiatives (and by subsequent conference organizations, editorial boards, funding programs, and teaching curricula), were formed in a protracted and distributed process, as researchers in seemingly unrelated research areas, concerned with an array of different collaborative computing technologies, realized that they were facing intransigent problems that somehow might be related to problems faced by researchers in other areas and then, often hesitantly, joined forces to investigate the potentials and problems of these technologies and to engage in their further development (Schmidt 2012).

In fact, collaborative computing technologies antedate CSCW as an organized field by several decades (Schmidt 2011, Ch. 11). What we today generally conceive of as computing technology (i.e., online, real-time transaction processing, in short 'interactive computing') was developed in the 1950s to facilitate cooperative work on a large scale, e.g., in air defense or airline reservation, by providing dispersed workers with access to a shared digital representation and thus with the ability to interact by inducing changes to the state of that representation (O'Neill 1992). Based on these technologies, researchers such as Murray Turoff (1972, 1973) built experimental 'computer conferencing' systems in the early 1970s that in fundamental respects, as technological paradigms, anticipated 'chat' and 'blogs' and other forms of 'social media' technologies. Similarly, early incarnations of electronic mail, and by implication distributed computing, were developed as early as 1965 by computer technicians for their own use while working on the development of time-sharing operating systems and were ported to network computing as soon as the first connections between host computers on the ARPANET became operational (Hardy 1996; Abbate 1999).

These practical but potent technical developments soon gave rise to studies of their use and possible impact, in the US typically under the label 'computer-mediated communication' (e.g., Kerr and Hiltz 1982; Kiesler et al. 1984), and in Europe mostly under the name 'teleinformatics' (e.g., Speth 1988). However, this line of research was a mere trickle compared to the vigorous and quite different stream of research that was conducted under the label of 'office information systems', at the time often simply called 'office automation' (e.g., Hammer and Sirbu 1980). A key issue in this research was the development of appropriate computational notations for

modelling and executing organizational procedures (Ellis 1979; Ellis and Nutt 1980; Kreifelts 1984; Sluizer and Cashman 1984), a line of research that over a short period of time morphed into research we would now consider classic CSCW (e.g., Malone 1983; Suchman 1983; Gasser 1986; Gerson and Star 1986; Greif and Sarin 1987; Malone et al. 1987; Stefik et al. 1987; Flores et al. 1988; Holt 1988). In a sense, then, CSCW's founding events of 1984, 1986, and 1989 were not the beginning of an entirely new research field, defined by a well-defined and focused research program. The steps through which CSCW became institutionalized were rather practical steps in a process of interlinking a range of research activities and communities that participants began to see as converging or in some other sense related.

CSCW emerged more as a bazaar than as a cathedral. In important ways, this remains the case. The technological matrix in which CSCW is embedded—the array of computing technologies that are or could be mobilized for the support of cooperative work—is in continual flux. The World Wide Web, initially launched in December 1989 to facilitate large-scale cooperative work in scientific research at CERN (Berners-Lee 1990; Gillies and Cailliau 2000), underwent explosive development over the following decade to become a cross-platform facility for communication and interaction for billions of people and now provides a global infrastructure for collaboration technologies (e.g., Bentley et al. 1997). Building on this infrastructure, a range of technologies have emerged, ranging from 'collaborative working environments' for organizational settings (e.g., Prinz 2006) to advanced forms of 'computer conferencing' such as 'social media' and free-form hypermedia technologies such as 'wikis' (e.g., Grasso and Convertino 2012). At the same time, the technological matrix of CSCW is rapidly evolving to also facilitate mobile communication and interaction as well as location-based and other forms of 'context-aware' computing (e.g., Schmidt et al. 2004). This process is ongoing and open-ended. New computing technologies with collaborative potentials or implications are continually coming to the fore, such as 'augmented' and 'mixed-reality' interfaces (e.g., Billinghurst and Kato 2002; Wagner 2012), 'the internet of things' (e.g., Atzori et al. 2010), and so on.

In other words, there is a sense in which CSCW is continually being formed. New technologies with collaborative potentials are emerging, developed for various purposes, and researchers engaged in their development or application may join the CSCW movement as they realize that their problems are related to problems already studied within CSCW or that they might benefit from building on what has been learned in CSCW, while researchers already engaged in CSCW research may explore the potentials of these new technologies.

In sum, CSCW did not emerge as a specialization of an established discipline or as a joint venture of such disciplines and was not formed with a defined and generally agreed-to research program. It emerged and continually emerges as researchers engaged with the development of different technologies or working with different application domains realize that they in their own work are faced with related problems and then seek to explore and articulate these problems. The fact that CSCW emerged as a loose association of different research efforts goes a long way to

explaining why CSCW for more than two decades has been the scene of seemingly endless discussions about its scope and focus. Moreover, the fact that the technological matrix within which CSCW research is enmeshed is continually changing, often in dramatic ways, again and again upsets whatever is understood as *bona fide* CSCW research and thus, repeatedly, throws the field into flux. Finally, the fact that CSCW is an *interdisciplinary* field of research and thus exposed to the centrifugal forces of the *disciplinary* demands of academic institutions and funding establishments has only aggravated its heterogeneous nature. Given these circumstances, one is surely entitled to say that the mere fact that CSCW exists at all today, some 25 years after it was institutionalized, is a major feat in itself.

2. The unity of CSCW: towards a CSCW research program

That the institutionalization of CSCW took place without a generally accepted research program is no accident. The researchers and technicians involved in the development and application of the various collaborative technologies prior to the establishment of CSCW as a research area did not, from the outset, have a clear and well-articulated understanding that the disparate problems they experienced in different ways were of the same kind. There was little more than a intuition that it might indeed be so and a commitment to explore this notion. Recognizing these problems as being in fact related, and especially articulating a systematic conceptualization of their interrelationships, has been an arduous task that can hardly be said to have been completed.

To examine this process we again have to go back to the period around 1988–92. By the end of the 1980s, key players in the emerging field began to realize that for collaborative computing technologies to advance, it would require a different approach to technology development than the one that had heretofore been the case.

First of all, it was quickly realized that systems cast in the mold of online transaction-processing computing (such as, e.g., airline reservation systems, database systems), while certainly facilitating cooperative work by providing actors with a shared digital representation of some kind, did not support actors in the 'articulation work' that is an essential aspect of any work activity, to use the now-classic term coined by Anselm Strauss and his colleagues (Strauss 1985; Gerson and Star 1986). In fact, such systems were carefully designed to hide the presence of other users. The realization of this fundamental limitation was actually already reached by the computer technicians who were engaged in the cooperative activity of building these systems and who in order to be able to coordinate and integrate their work activities developed primitive email systems for their own use. This practical insight, that transaction-oriented database systems might facilitate cooperative work (among travel agents, say) but did not support the articulation work required to deal with sundry contingencies, was a baseline insight for CSCW. In the words of Irene Greif, who played the key role in the formation and organization of CSCW as a research field in the 1980s, in her 'Overview' of CSCW (1988b), 'Transaction-oriented database systems rely on "coordination technologies"

for concurrency and access control and coordination' but the 'coordination tools are in the hands of a database administrator rather than of the end-user, and are used more to keep people from inadvertently corrupting data than for the positive goal of having a workgroup build something together' (Greif 1988b, p. 7). Consequently, in order to support cooperative work the 'assumed model of use' underlying these technologies had to be radically reconsidered (Rodden and Blair 1991; Rodden et al. 1992). This insight, itself 'informed by' early ethnographic studies (e.g., Harper et al. 1989a; Heath and Luff 1991), indicated that further focused studies of coordinative practices were required (Greif 1988b).

Secondly, by the mid-1980s the 'computer-mediated communications' research program had arrived at a critical juncture (cf., e.g., Bannon 1986). As pointed out by Greif, when the discourse model underlying 'computer conferencing' and other forms of message-handling technologies (email, instant messaging) is applied to typical work settings, 'the model breaks down': 'Designers who draw pictures, software developers who jointly write code, financial analysts who collaborate on a budget—they all need coordination capabilities as an integral part of their work tools' (Greif 1988b, pp. 7f.). A similar insight was expressed at the same time by European computer-mediated communication researchers (Bowers et al. 1988; Smith 1988; Pankoke-Babatz 1989). It was again immediately realized that systematic studies of actual cooperative work practices in real-world settings were required (Greif 1988b; Pankoke-Babatz 1989).

Thirdly, the attempts to computerize 'office procedures' under the banner of 'office automation' quickly turned out to be a flawed research program. Experimental systems were found to be inordinately rigid (e.g., Kreifelts et al. 1991), and from early workplace studies the realization emerged that the 'office automation' idea did not take into account the 'situated' character of working according to prescribed procedures (e.g., Suchman 1983; Suchman and Wynn 1984; Gerson and Star 1986; Suchman 1987). This experience not only indicated that ethnographic and other forms of in-depth studies of coordinative practices were required if significant progress were to be made in the development of collaborative technologies but also provided early exemplars of ethnographic studies playing this role.

What was slowly and hesitantly realized in this process was that this mix of technologies raised a set of fundamental issues that are all connected to the nature of *cooperative work practices*. For example, the challenge of designing computing systems that support the coordination of cooperative work activities is that the system not only has to support the execution of 'the theory' built into the model, but also 'the practice', that is, whatever needs to be done, under current conditions, to transform some normative construct ('plan', 'procedure', etc.) into contingent action. In other words, the model underlying coordination technologies (from 'office automation' to ERP systems) breaks down in view of the 'situated' nature of work. Consequently, in designing coordination technologies it is necessary to support practitioners in making coordination technologies work, that is, making them an integral part of their practices. Similarly, the model of message-handling technologies 'breaks down' when these technologies are used in professional work practices, for while they afford the ad-hoc interaction

characteristic of ordinary discourse, they cannot be integrated with ordinary work tools (e.g., CAD plans, programming environments) or with coordination technologies. The limitation is fundamental, in that the discourse model underlying message-handling technologies is predicated on a strict abstraction from the materiality of work practices (setting, equipment, tools, instruments) and from the organizational arrangement in which the practices are embedded. These insights prompted a surge of ethnographic and similar workplace studies, all committed to somehow 'informing' the development of collaborative computing by studying and analyzing 'situated action', 'articulation work', 'distributed cognition', 'activity systems', etc., and over time, researchers increasingly began to think of these notions as more or less related to the concept of *practice* as used in (especially) Wittgensteinian philosophy (e.g., Wittgenstein 1945-46) and in sections of sociology building on this (e.g., Bourdieu 1980).

That is, 'within the belly of the beast', in the middle of the heterogeneous aggregation of research interests that had become CSCW, a new—indigenous, as it were—research program was being articulated *from within CSCW*. The indigenous CSCW research program implies an approach to technology development radically different from that of the previous development of interactive and collaborative computing, namely, an approach to technology development in which ethnographic and other forms of in-depth workplace studies play an essential and proactive role. It is thus a program that differs in fundamental ways, for example, from studies of computer-mediated communication (from email to social media) that typically are 'reactive' (Bannon 1992) in that they focus on anticipating possible organizational and social advantages or disadvantages of some already existing technology.

In an attempt to reflect on and give voice to these early insights, two decades ago the editors of this Jubilee Issue wrote a couple of articles (Bannon and Schmidt 1989; Schmidt and Bannon 1992) in which we outlined a research program that took into account the lessons Irene Greif and the European 'telematics' researchers had spelled out, as well as the lessons learned from initial ethnographic work in CSCW. Briefly put, we argued 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' (Schmidt and Bannon 1992, p. 11). Some now argue that the program we sketched in those articles implied such a 'daunting task' that 'No serious effort to address their agenda materialized' (Grudin and Poltrock 2012). Well, not quite. Daunting task or not, the CSCW research program—for which our formulation was but one, albeit widely cited—has most certainly materialized. As this special issue amply demonstrates, the CSCW research program has fostered a wide range of serious and persistent research efforts in pursuance of a research program very much in tune with what was outlined by Greif, Pankoke-Babatz, Rodden, Hughes, Bannon, Schmidt, and many others at that important junction about 25 years ago.

All this makes CSCW a complicated research area. It is not just a bazaar, as are so many other interdisciplinary research areas, but a bazaar that is being reorganized and hesitantly but cumulatively systematized as the CSCW research program developed and unfolded. That is, CSCW is both an interdisciplinary research area in which

different research traditions join forces to explore and elucidate possibly shared problems but also an interdisciplinary research area in which its own indigenous research program is being pursued while it is being articulated.

However, in developing this research program, CSCW did not exist in a vacuum and could not start from scratch. To the contrary, the joining of forces in the formation of CSCW was conceived of in terms of pre-existing schools of thought. A range of conceptual frameworks originating in other research areas, for the purpose of addressing the problems of these areas, were imported as researchers from these areas became engaged in CSCW: distributed computing, distributed AI, human-factors engineering, software engineering, organization theory, industrial sociology, sociology of science, information systems design, psychology of learning, activity theory, distributed cognition, social psychology, cognitive science, ethnomethodology, etc. This of course gave rise to intense debates, but more importantly, it also initially restricted the effort of formulating CSCW's research program to conceptual schemes and languages borrowed from other intellectual traditions. It has, for example, been customary to conceive of CSCW's program in terms of quite specific forms of cooperative work (e.g., 'group work', 'team work', work over 'distance'), a specific moral disposition (e.g., 'team spirit'), or some presumptive 'shared' mental representations (e.g., 'shared understanding', 'shared goal').

A research strategy to overcome the problem of received conceptual schemes and languages and at the same time develop a conceptual framework under CSCW's auspices, was formulated in 1994 in a paper by John Hughes, Wes Sharrock, Tom Rodden, and others, that has become very influential (Hughes et al. 1994). 'The association, for example, of co-operation with synchronously, co-located persons working in a team, tends to ignore the pervasiveness of a variety of interdependencies within work settings which are immensely relevant to CSCW design' (p. 130). Therefore, the authors argue, 'studies of the social organisation of work will need to proceed in a manner which recognises this heterogeneity of domains and develops analytic tools which are capable of exhibiting the relevant scope of this variety' (p. 129). For these reasons, and thus harking back to what had been recognized already by Greif and the European 'telematics' researchers in the late 1980s, they accorded a central role to ethnographic studies in CSCW, suggesting that 'an analytic framework of some generality needs to be developed "from the ground up" as it were, and capable of retaining a sensitivity to the details and the variety of work domains'(*ibid.*).

Thus, in the effort to 'understand the nature and requirements of cooperative work with the objective of designing computer-based technologies for cooperative work arrangements', building a corpus of ethnographic and similar workplace studies would be a key strategic goal in the CSCW research program.

3. Gauging the depth and scope of CSCW

As the articles in this Jubilee Issue of the *CSCW Journal* demonstrate, CSCW researchers endeavoring to understand cooperative work and coordinative practices

by investigating the multifarious world of cooperative work 'from the ground up', have over the years been building a large and rich corpus of workplace studies in a wide range of settings. And in doing so, they have—ever so cautiously and tentatively—developed important elements of the conceptual framework that is required for CSCW to contribute constructively to the development of collaborative technologies.

As exemplars of this kind of CSCW research, the present special issue offers reviews of two threads of study targeting significant work domains. Cooperative work in the health care domain has been a classic area of CSCW study. In their article in this Jubilee Issue, Geraldine Fitzpatrick and Gunnar Ellingsen (2013) give an overview of CSCW research in the health-care domain, showing the richness of this research as well as the progress made here. Another thread of study targeting a significant work domain addresses cooperative work in scientific research. For many years, this domain did not attract special interest as a domain of CSCW studies (for early studies, cf., e.g., Kraut et al. 1986; Kraut et al. 1988), but in the last few years research devoted to the problem of computer-support for scientific collaboration has surged, as evidenced, for example, by the two recent special issues of the *CSCW Journal* devoted to this line of research (Jirotka et al. 2006; Lee et al. 2010). The article by Marina Jirotka, Charlotte Lee, and Gary Olson in this Jubilee Issue (2013) describes the advances made in this young but very active line of CSCW research.

However, the two bodies of domain-oriented study reviewed in these two articles in this Jubilee Issue are only examples of the wide range of ethnographic studies being carried out in CSCW. One of the work domains that has attracted significant attention in CSCW workplace studies is what can loosely be termed 'design work'. Early studies of cooperative work in professional design and engineering were published in a special issue of the *CSCW Journal* on 'Cooperative design' (Schmidt and Sharrock 1996). Within this category of work, software engineering as a cooperative endeavor has, not surprisingly, been studied intensively (e.g., Button and Sharrock 1996; Grinter 1996; Carstensen et al. 1997; Grinter 1997; Dittrich et al. 2009). Related domains of professional design work are architectural work (Schmidt and Wagner 2004) and construction (Christensen 2012). Recent attempts to advance our understanding of cooperative design work in general have focused on the role of representational artifacts in cooperative design (Boujut and Eckert 2003; Wagner et al. 2010).

A distinctly different body of domain-oriented studies has investigated cooperative work in what has been categorized as 'centers of coordination' (Suchman 1997). These studies encompass rapid-urban-transit control rooms (Heath and Luff 1992; Fillipi and Theureau 1993; Heath and Luff 1996); air-traffic control (Hughes et al. 1988; Harper et al. 1989a, b, 1991; Harper and Hughes 1993; Halverson 1995; Rognin 1996; Berndtsson and Normark 1999), airport ground operations (Goodwin and Goodwin 1996; Suchman 1997; Juhlin and Weilenmann 2001), ambulance dispatch centers (Bowers and Martin 1999; Normark and Randall 2005), call centers (Ackerman and Halverson 1998; Martin et al. 2007), etc..

In addition to these major lines of work-domain study, a vast spectrum of domains of cooperative work have been investigated, less intensely but nevertheless with

significant findings as a result. Take, for example, the studies of process control work: in space mission planning and control (Jones 1995; Watts et al. 1996; Shipman et al. 1999; Patterson and Woods 2001; Mark 2002), in waste water treatment (Bertelsen and Bødker 2001), in oil and gas production (Heyer 2009), as well as in vehicle control (Hutchins 1990, 1995; Hutchins and Klausen 1996; Carstensen and Nielsen 2000, 2001). Or take for example, at the other end of the spectrum, the many studies of cooperative work in financial institutions: in securities trading (Heath et al. 1995) and in retail banking (Harper et al. 2000; Martin and Rouncefield 2003).

Complementing these studies focusing on specific work domains, a number of workplace studies are undertaken to investigate more general aspects of cooperative work such as, for example, 'diagnostic work' (Orr 1986, 1996; Büscher et al. 2009), 'invisible work' (Nardi and Engeström 1998), and 'mobility work' (e.g., Luff and Heath 1998; Bardram and Bossen 2005a). On the other hand, there is a strand of workplace studies devoted to systematic examination of types of technology in a range of settings that have certain classes of technology in common, such as field studies of the evolutionary development and use of 'groupware' systems (Kahler et al. 2000; Andriessen et al. 2003).

It should be noted, however, that the development of a corpus of studies of cooperative work practices across the wide variety of domains can hardly be considered to have proceeded in a systematic manner. Some complex work domains have been studied intensively while other, equally complex, cooperative work domains have attracted but little attention. Advanced (i.e., 'order-driven' or 'flexible') manufacturing is a case in point; the same applies to administrative work. As pointed out in the article in this Jubilee Issue by Monteiro et al. (2013), this bias is also reflected in the scarcity of CSCW investigations into the uses of large-scale coordination technologies such as 'enterprise resource management' systems (MRP II, ERP), CAD and CAD/CAM systems, document management systems, etc.

Orthogonal to studies focusing on work domains or types of work, but building on the evolving corpus of workplace studies, CSCW researchers have, very tentatively, developed conceptualizations of key aspects of cooperative work practices. Researchers have worked to explore generic features of cooperative work such as *temporal* aspects (e.g., Egger and Wagner 1993; Decortis 1994; Andersen et al. 2000; Bardram 2000; Reddy et al. 2001; Seebeck et al. 2005) or *spatial* aspects (e.g., Fitzpatrick et al. 1996; Harrison and Dourish 1996; Hinds and Kiesler 2002; Dourish 2006; Ciolfi et al. 2008).

Another general finding from ethnographic studies is that practices such as asking and giving advice, giving and receiving instruction, making experiences available to others, etc., in short, 'didactic practices', are essential for the sustainability of any professional cooperative work setting (Simone et al. 2012). Much of this research is of course carried out in neighboring research areas such as 'knowledge management' and 'computer-supported collaborative learning' (CSCL). However, this kind of research as a rule investigates learning and instruction in abstraction from the context of cooperative work practices, but a significant strand of research into such practices has developed under CSCW auspices, such as studies of practices of learning in

communities (Carroll 2007) and in work settings (Koschmann 2008). In their article in this Jubilee Issue on didactic practices such as that of 'sharing knowledge', Ackerman et al. (2013) provide a critical review of the CSCW contribution to the research on 'knowledge management'.

More central to understanding cooperative work practices, CSCW researchers are exploring classes of coordinative practices that are specific to cooperative work. One such continual research strand is that of 'mutual awareness' among cooperating actors which was identified very early as a key issue in CSCW research. Initial ethnographic studies demonstrated that the performance of competent workers in their routine cooperative activities is characterized by 'effortless' coordination, i.e., the phenomenon that practitioners in conducting their own work routinely heed the ongoing activities of their colleagues. The implications of these findings were quickly understood as having radical implications not only for collaborative technologies but for computing technologies in general. The article in this Jubilee Issue by Tom Gross (2013) on 'effortless coordination' provides a much needed survey of this research, with special emphasis on the enormous amount of technical research that has been done over the years.

Also driven by ethnographic and similar studies, a substantive strand of persistent CSCW research has been devoted to the problem of normative regulation of coordinative practices by means of 'plans', 'procedures', etc. The article in this Jubilee Issue by Federico Cabitza and Carla Simone (2013) gives an overview of the long-term research effort in CSCW that has been developing collaborative technologies that aim to make practitioners able to express and control the rules of their coordinative practices in computational protocols. In a convergent argument and from a position informed by STS, the above-mentioned article in this Jubilee Issue by Eric Monteiro et al. (2013) provides a timely critical discussion of the relatively minimal interest paid by CSCW research to date to coordination technologies and other forms of 'information infrastructures' such as ERP systems and document management systems.

At another level of abstraction, CSCW research is beginning to achieve an understanding of the essential role of representational and coordinative artifacts in cooperative work (e.g., Harper et al. 1989b; Yates 1989; Bowker et al. 1991; Norman 1991; Suchman 1993; Schmidt 1994; Schmidt and Simone 1996; Bowker and Star 1999; Sellen and Harper 2001; Fitzpatrick 2004; Schmidt and Wagner 2004; Bardram and Bossen 2005b; Ackerman et al. 2007).

Finally, there have been several attempts to summarize the insights of CSCW, first in the form of compilations (Greif 1988a; Baecker 1993) and broadly-thematic collections (e.g., Galegher et al. 1990; Bowker et al. 1997), later in the form of more systematic attempts to expound a general conceptual framework (e.g., Heath and Luff 2000; Dourish 2001; Olson et al. 2001; Ackerman et al. 2007; Schmidt 2011). The work of 'generalization' that is required for CSCW to truly contribute to the

development of collaborative technologies is on-going. Thus, where CSCW, initially, was obliged to formulate its research problems in languages developed under the auspices of other fields, CSCW research has now, for several years, been unfolding under CSCW's own auspices, in step with the development and formulation of the CSCW research program.

The key role assigned by the CSCW research program to ethnography in the development of collaborative technology is quite exceptional compared to other technological research areas and it is, unsurprisingly, an issue that has been the subject of intense deliberation over the years (e.g., Luff et al. 2000; Randall et al. 2007). In these methodological debates a key issue has been to understand the relationship between the highly local nature of ethnographic findings and the generalizations and conceptualizations that form an essential part of the development of technology (e.g., Plowman et al. 1995; Anderson 1997, 2000; Schmidt 2000; Sharrock and Randall 2004). Reviewing this vast body of work, the article in this Jubilee Issue by Blomberg and Karasti (2013) reflects on the pivotal role of ethnographic studies in CSCW research.

Finally, of course, not all CSCW research is explicitly inspired and informed by the findings of ethnographic studies. Obviously, important lines of research, perhaps only indirectly motivated by abstracted renditions of ethnographic findings, strive to understand the nature of various new technologies, and their possible benefits and limitations compared to other technologies. This is the order of things and fully in tune with the nature of CSCW as a diverse research area under continual formation. But of course, such technology development efforts may at some point become exposed to different kinds of workplace study such as evaluation studies, naturalistic experiments, etc. The research on organizational calendar systems (Grudin 1994), video-mediated communication (Finn et al. 1997), 'media spaces' (Harrison 2009), and 'collaborative virtual environments' (Benford et al. 2001) can be seen as fine examples of such research. The spectrum of technical CSCW research, that is, studies oriented towards 'internal issues' in technology, reaches from such explorative studies to research into enabling technologies (Greenberg 1991; Bentley et al. 1997; Beaudouin-Lafon 1999; Grasso and Convertino 2012) to studies of adaptive workflows (Klein et al. 2000), context-aware computing (Schmidt et al. 2004), and consistency management (Dewan 2008).

The scope of the research undertaken within CSCW over the last 25 years or so speaks volumes, and the articles published here review only a selection of this research, albeit a selection of important strands of cumulative research. The list of special issues or themes published in the *CSCW Journal* since its inception in 1992 (in the Appendix Table 1 at the end of this article) can be seen as a complementary cross section of CSCW research over the years. It is reasonably representative in that it itemizes what guest editors and authors over the years have deemed research themes sufficiently important to merit the toil of producing a special issue. The many special issues listed in this inventory also represent as many cautious attempts to derive general categories and

build a conceptual framework, for instance by offering occasions for comparative analysis, by juxtaposing empirical findings and technical paradigms, etc.

In sum, the CSCW research program is obviously being realized. A conceptual framework is being built from the ground up, not in anything like a linear and swift fashion, but painstakingly, falteringly. But the required cumulative progression *can* be discerned.

4. Assessing the influence of CSCW

Due to the conditions of its very existence, CSCW research intersects with and therefore also influences a range of areas of research in computing technologies and their application. But CSCW's influence runs deeper. By virtue of CSCW's commitment to technology development, the ethnographic and other forms of in-depth studies of work practices conducted under CSCW auspices have attained a high level of rigor. CSCW therefore has achieved significant influence beyond its own dominion. This is obvious in the now widespread use of ethnographic studies for technological purposes in HCI and Ubicomp, just as CSCW has had manifest feedback effects on the research areas that provided essential scaffolding for CSCW's early development, such as ethnomethodology (cf., e.g., Lynch and Sharrock 2011, Section 7), information systems research (Pipek et al. 2009), participatory design (Blomberg and Kensing 1998), and activity theory and distributed cognition (Nardi 1997; Halverson 2002; Ackerman et al. 2007).

A telling indication of the reach of the gravitational field of CSCW's effort to develop 'an analytic framework from the ground up' can be found in an article by Stephen Barley and Gideon Kunda published in *Organization Science* (2001), in which they point out that 'the most extensive body of research on collaborative work is presently to be found in [[CSCW]'. Citing a range of CSCW studies (e.g., Heath and Luff 1992; Harper and Hughes 1993; Suchman 1993; Hutchins 1995; Hutchins and Klausen 1996; Suchman 1997), Barley and Kunda report that CSCW research is developing 'concepts for describing situated decision making and mutual adjustment to the rapidly changing microcontingencies that seem to characterize [cooperative work] settings', such as 'centers of coordination', 'working division of labor', 'articulation work', etc.:

> What sets these studies apart from most research on teamwork [in organization science] is their attention to the moment-by-moment flow of activity and their emphasis on the situated integration of tools, documents, action, and interaction. In contrast to studies of decision making in organization behavior where decisions seem to be deliberate, distinct acts, in the CSCW studies one encounters flows of choreographed attending, prescient anticipation, mutual adjustment, and entwined action, out of which routinely emerge without remark a stream of decisions that often have life-or-death implications. Team work is shown to be a process of continual structuring and restructuring done through, to, and with both technology

> and people in an unselfconsciously conscious manner. In short, the CSCW literature offers insights into processes of organizing that Weick and Roberts (1993) have called mindful heeding. What the CSCW literature reveals is that such organizing depends heavily on tools, technologies, and environments as integrating mechanisms for the social production of action (Barley and Kunda 2001, pp. 88f.).

In other words, because of CSCW's commitment to understand cooperative work practices for the purpose of influencing the development of appropriate collaborative technologies, CSCW research has to take seriously actual work practices in their contingent materiality. It is thus probably not unfair to say that CSCW has become the prime locus of practice studies.

5. Epilogue

We have seen that CSCW was formed as researchers—in academia, in governmental and business research labs, and in practical software engineering—began to realize that the problems they were trying to come to grips with might be similar to the problems other researchers were facing. This process of convergence is ongoing, as researchers faced with related problems arising from the design, implementation, and use of new technologies or types of system realize that their problems are already addressed in some relevant way or could benefit from being approached from a CSCW perspective. That is, driven by the introduction of new technologies, by innovative uses of known technologies, or by the application of collaborative technologies in new domains, *CSCW is continually being formed* as an interdisciplinary research field endeavoring to understand cooperative work practices with a view to developing adequate computational technologies to facilitate cooperative work, mediate communication, and support the regulation of coordinative practices.

This is a source of intellectual energy, but certainly also a source of fragmentation. The interdisciplinary endeavor that is CSCW is, if not daunting then surely challenging. Bridging from ethnographic studies to experimental design of collaborative applications to evaluation of infrastructures and interfaces requires serious intellectual commitment. A continued commitment to some form of cumulative research is required for CSCW to be able to contribute to the development of computing technologies.

Now, this challenge is not a challenge for CSCW alone. While CSCW, in its continual formation and reformation, is a rather peculiar research area, its interdisciplinary character is a continuation of centuries of scientific collaboration across disciplines and programs, from the Encyclopedists of the 18th century (Diderot and d'Alembert 1750; 1751; Académie Royale des Sciences 1761) to the International Encyclopedia of Unified Science movement around the middle of the 20th century (Neurath 1938). Seen in this perspective, CSCW's shortcomings as a research area are

not (or not necessarily) a sign of weakness but perhaps rather a sign that CSCW takes scientific collaboration seriously.

In the 1930s and 1940s, the social scientist and philosopher of science Otto Neurath, a leading figure of the Vienna Circle (until it was disbanded due to the rise of Fascism), spearheaded an international movement aiming at systematic scientific collaboration across disciplines (involving, among others, Niels Bohr, Rudolf Carnap, John Dewey, Albert Einstein, Kurt Gödel, Charles Morris, and Bertrand Russell). In Neurath's view, the unity of science does not require the construction of a overarching conceptual edifice, nor is such an edifice possible. The issue, on this view, is one of practical scientific cooperation. No scientific insight can be applied in isolation from other scientific and practical knowledge. In the course of intervention in our everyday lives, in medicine, in navigation, in technology, or, in Neurath's example of fighting a forest fire, any disunity among the sciences, any discord over conceptualizations, laws, models, terminology, and so on, must be overcome, at the point of action at the very least (Neurath 1931, p. 59). And that is, he argued, quite sufficient. We do not need to build conceptual 'pyramids', and indeed should avoid doing so (Neurath 1939-40). In fact, '"*The" system* is a great scientific lie' (Neurath 1935, p. 116). Arguing against reductionist attempts to build unified conceptual systems, he advocated a pragmatic approach in which unity is seen as *unity in action.* There is no ultimate arbiter, he pointed out, no final court of appeal—neither philosophy nor mathematics—to pass judgment on the different contributions. For unity in action 'local systematization' is sufficient. What is required is merely 'orchestration of the sciences': the 'democracy of cooperation' among sciences (Neurath 1946).

To express this deeply pragmatic and democratic concept of scientific cooperation, Neurath often depicted scientific collaboration as akin to sailors rebuilding their boat while at sea, without being able to start from scratch and without having recourse to an overarching plan:

> Imagine sailors who, far out at sea. transform the shape of their clumsy vessel from a more circular to a more fishlike one. They make use of some drifting timber, besides the timber of the old structure, to modify the skeleton and the hull of their vessel. But they cannot put the ship in dock in order to start from scratch. During their work they stay on the old structure and deal with heavy gales and thundering waves. In transforming their ship they take care that dangerous leakages do not occur. A new ship grows out of the old one, step by step—and while they are still building, the sailors may already be thinking of a new structure, and they will not always agree with one another. The whole business will go on in a way we cannot even anticipate today. [¶] That is our fate (Neurath 1944, p. 47).

Continually emerging, in a state of recurrent flux due to new collaborative technologies and the migration of such technologies into new application domains, and at the same time striving to build technologically useful conceptualizations, we suggest that CSCW is very much in a similar situation. The construction of CSCW is ongoing.

1. Appendix

Table 1. Special issues published in the CSCW Journal 1992–2013.

Special issue title or theme	Editor(s) and citation
NetWORKing	Ina Wagner and Andrew Clement (1994)
Do Categories Have Politics? [Suchman-Winograd debate]	Liam Bannon (1994; 1995)
Computer-Supported Collaborative Writing	Bertram C. Bruce & Mike Sharples (1994)
Time, Technology, and Groups: Development, Interaction, and Task Performance over Time in Computer-Mediated vs Face-to-Face Groups	Joseph E. Mcgrath & Holly Arrow (1995)
The Design of Cooperative Systems	The COOP Group [Manuel Zacklad et al.] (1996)
Studies of Cooperative Design	Kjeld Schmidt & Wes Sharrock (1996)
The World Wide Web as Enabling Technology for CSCW	Richard Bentley, Uwe Busbach & David Kerr (1997)
Interaction and Collaboration in MUDs	Paul Dourish (1998)
Participatory Design	Jeanette Blomberg & Finn Kensing (1998)
A Web on the Wind: The Structure of Invisble Work	Bonnie A. Nardi & Yrjö Engeström (1998)
Tailorable Systems and Cooperative Work	Helge Kahler, Anders Mørch, Oliver Stiemerling & Volker Wulf (2000)
Adaptive Workflow Systems	Mark Klein, Chrysanthos Dellarocas, & Abraham Bernstein (2000)
IT Infrastructures	Ole Hanseth & Kristin Braa (2001)
Activity Theory and the Practice of Design	Bonnie Nardi & David Redmiles (2001)
Awareness in CSCW	Kjeld Schmidt, Christian Heath & Tom Rodden (2002)
The Role of Objects in Design Co-Operation: Communication through Physical or Virtual Objects	Jean-François Boujut & Claudia Eckert (2003)
Evolving Use of Groupware	J.H. Erik Andriessen, Marike Hettinga & Volker Wulf (2003)

(*continued on next page*)

Table 1. (continued)

Special issue title or theme	Editor(s) and citation
Context-Aware Computing in CSCW	Albrecht Schmidt, Tom Gross & Mark Billinghurst (2004)
Heterogeneous Facets of CSCW	Carla Simone & Marilyn Tremaine (2004)
Information Infrastructures for Distributed Collective Practices	William Turner, Geoffrey Bowker, Les Gasser & Manuel Zacklad (2004)
Supporting Scientific Collaboration: Methods, tools and concepts	Marina Jirotka, Rob Procter, Tom Rodden & Geoffrey C. Bowker (2006)
Computer Supported Cooperative Work and Dependable Healthcare Systems	Rob Procter, Mark Rouncefield, Ellen Balka & Marc Berg (2006)
Leisure Technologies	Barry Brown & Louise Barkhuus (2007)
Learning in Communities	Jack Carroll (2007)
Learning and Work	Timothy Koschmann (2008)
Settings for Collaboration: The Role of Place	Luigina Ciolfi, Geraldine Fitzpatrick & Liam Bannon (2008)
Consistency Management in Synchronous Collaboration	Prasun Dewan (2008)
Diagnostic Work	Monika Büscher, Jacki O'Neill & John Rooksby (2009)
Software Development as Cooperative Work	Yvonne Dittrich, Dave W. Randall & Janice Singer (2009)
Sociotechnical Studies of Cyberinfrastructure and e-Research: Supporting Collaborative Research	Charlotte P. Lee, David Ribes, Matthew J. Bietz, Helena Karasti & Marina Jirotka (2010)
Information Infrastructures for Healthcare	Jørgen P. Bansler & Finn Kensing (2010)
Project Management in E-Science: Challenges and Opportunities	Dimitrina Spencer, Ann Zimmerman & David Abramson (2011)
Socially Embedded Collaborative Practice	Myriam Lewkowicz & Markus Rohde (2011)
Knowledge Management in Action	Carla Simone, Mark Ackerman & Volker Wulf (2012)
Collective Intelligence in Organizations: Tools and Studies	Antonietta Grasso & Gregorio Convertino (2012)
Differentiated Awareness-Support in Computer Supported Collaborative Work	Gwendolyn L. Kolfschoten, Thomas Herrmann & Stephan Lukosch (2013)

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