

Cognition and Collaboration: Trends, problems and challenges from academia and design practice

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Introduction

The current workshop, Cognition and Collaboration - Distributed Cognition in Complex Processes, is the second workshop in a series of research discussions. The first workshop, Analyzing Collaborative Activity, was held at CSCW 2002 and focused on analyzing collaborative work and representation of collaboration in the context of Computer-Supported Cooperative Work technologies. Both workshops relate the use of multi-method and multi-theory approaches from field research and ethnographic studies of collaborative process. Contributions range from empirical questions of field research to theoretical integration. The “middle ground” of inquiry has been developed, with field researchers inquiring into design issues, designers considering theory, and theoretical investigators looking at applications. See papers and information: www.redesignresearch.com/cscw/ .

Following the more general findings of the first workshop, the second workshop aimed at a more specific target, developing the conceptual framework of Distributed Cognition for analyzing and understanding collaborative work.

Analyzing Collaborative Activity – General Issues

The discussions of the first workshop elicited several broad perspectives or themes relevant for analyzing collaborative work:

- **CSCW?** As we continue to explore this domain of inquiry, some find it artificially limiting to articulate research problems specifically about cooperative *work*. A trend toward broadening interest in intellectual cooperative activity extends the to Learning (CSCL), Play (CSCP?), and more generally, “practice.” Although the roots of CSCW draw from the original interest in group technologies and enhancing cooperation in organizational settings, many researchers have pushed beyond these bounds. Since this topic has been circulating across other discussions, this topic should gain momentum in future workshops. As cooperative technology extends beyond the conventional descriptions of computing, we might also call for an extension of the field into *cooperative technology for collaborative practices*.
- **CSCW for** : Design, Products, Organization, Community, Work Practice. Participants disclosed various target domains for the application of collaborative technology. Opening up the space for cooperative activity and opening up the technology also opens up the possible applications space. Some articulated this “designing for” as *intervention*. Any design activity oriented toward collaboration support might be understood as an intervention in the social space, and treated as such by researchers and managers.
- **Adoption of interpretive frameworks.** Many of us reported from experience with interpreting field research through theory or integrating theories to generate broader understanding or applicability from findings. Our common ground was the theoretical orientation of distributed cognition, with several reporting findings interpreted from the lens of distributed cognition or activity theory. We further articulated the use of theoretical frameworks as such as “Lens,” a way of viewing the domain that focuses on some aspects clearly, while necessarily relegating other aspects to the periphery. This choice of lens specifies explanatory power; disclosing this feature of theorizing allows us to work across theories by choice, agnostically.

- **Beyond Contextual Design.** Over half of the projects reported on work integrating at least some CD representations, with several utilizing much of the complete Contextual Design (CD) toolkit. To some extent, the use and effectiveness of the models were taken for granted, as though CD now afforded a canonical approach. One distinction of the workshop was to not take representations for granted, but to explore their uptake in our research and design projects. While this was an intention of the workshop, due to our focus on issues and not specific models per se, little discourse emerged on the CD toolkit.

An interesting sidebar should be noted that it seems CD models are now widely used across both ethnographically informed research and design-oriented research. Perhaps researchers may find little to share on the specifics of its use due to its acceptance; we found little sharing on any downsides of reliance on this popular toolkit. Due to the wide uptake of CD, as responsible researchers we might further explore, critique, and evolve its representations.

- **Multidisciplinary researchers and practitioners.** An obvious and pervasive theme was the disciplinary variance among workshop participants. Ranging from anthropologists to social scientists to design researchers, and using methods ranging from ethnography through organizational modeling to prototyping, we found differences in method and interpretation. Although all participants might be considered interdisciplinary to some extent, we still found need to smooth out variations of understanding, which takes time. We might attempt to build more bridges of background in advance of future workshops.

Emergent Issues and Challenges

In collaborative work analysis, both designers and academics reported significant issues and challenges. The workshop identified the following salient issues, among others.

1. Ethnography and Design Research - How do we integrate ethnography into design and research contexts?

With an emphasis on field data analysis, most projects reported use of ethnographic methodology. Ethnographic methods are often used as part of a multi-method research approach, with more or less applicability and validity based on the experience and articulation of the individual researcher. Rather than invalidating the strength of ethnography, the multiple methods keep teams honest by providing multiple interpretations of field data.

One of the attractions of toolkits such as CD is their support for filling in the gaps of researcher method – ethnographers unfamiliar with design process may use CD and its models as a communicative bridge to create value for the intended designers, even though they may lack in design experience. Likewise, design professionals with limited field research experience may bridge their own way into deeper understanding of user practice through the scaffold of models, as part of a multidisciplinary design team.

A continuum of issues (similar to that of disciplinary focus) ranged from ethnography as a social research process to using ethnography as a method for understanding users in design projects. These extreme ends of the spectrum may require different representations, levels of skill, and degrees of engagement.

We also noted how ethnographic studies often represent a “*situational slice*,” leaving us with the issues of authentic representation of practice when our studies necessarily encompass a specific time slice. One issue that warrants much further discussion is the notion of studying activity and collaboration *over time*. Temporality remains a major factor not effectively addressed by CD or other models; observations of any unstructured (non workflow) activity show patterns of activity that are only partially revealed through the situational slice of the current study. While longer studies (as advocated by experienced ethnomethodologists) may reveal much more of the

structure or relationship in activity over time, we find a paucity of representations for interpreting the temporal dimensions of collaboration.

The workshop discussed the *evaluation of research method effectiveness*. How do researchers assess the effectiveness of specific methods and multi-method hybrid approaches? How do we know which approaches offer the sensitivity to specific research questions? How do we improve skill and practice to better validate our own field research? While experimental and quantitative research methodologies enjoy well-established standards of effectiveness, field research remains a researcher-centric skill, developed by practice, feedback, and self-reflection. While experiments are designed to be replicable, each field study remains its own unique case, and is subject to influences of the researcher, the organizational unit of analysis, the type of intervention, the specific time chosen, and many other factors. Traditional controls include analysis and disclosure of possible effects, multiple brief studies, using different researchers and informants, and so on. However, when ethnography becomes widely used for design research, and Contextual Design becomes used as part of a team design process, some types of simple and practiced research controls might be considered valuable to share and document.

Ethnography was discussed *as a “method” and also as a way of approaching research*. Relating this to the uses of ethnography discussed above, we find ethnography integrated into larger research projects as one of several methods for engaging the field. This does not in and of itself “reduce” ethnography to a method – effective use of ethnography requires a mindset and understanding of ethnomethodology. As a way of approaching a research effort, the ethnographer starts with good tools for ethnography and expands the toolkit from there to include various interpretive approaches, models (such as CD), and process-specific representations.

2. Theoretical Issues, and Uses of Theory

A distinct difference was found between theoretical approaches to field research in collaborative work and empirical studies focusing on findings in a defined field setting. Although these approaches can also be described as deductive (top-down) and inductive (bottom-up) in contrast to each other, theoretical frameworks are by design deductive approaches. In one issue session, theoretical papers raised questions of appropriate theories and frameworks. We acknowledge a field where one set of theories may be useful for understanding social systems, another set may be appropriate for relating practices to design, and yet another for selecting and implementing interventions in organizational practices.

Theories are not being left to themselves – many of us are integrating theory to build a better framework for explanation and interpretation. One paper (Andriessen) brings together four major theoretical frameworks to propose a Dynamic Group Interaction Model. Chisalita adds organizational culture theory to the well-documented design process models. Activity Theory is extended with temporal lifecycle models to describe collaborative information behavior. Value analysis is brought into an urban planning simulation environment. And so we find bricolage of theory taking place in deliberate attempts to improve the explanatory power of an adopted framework, or to extend that which has already been used in prior work.

In the final analysis, design goals and research goals differ, theories are not necessary for successful field research of collaboration. In many cases, the object may be to evaluate the effectiveness of a design intervention, through introducing and evaluating prototypes or early product designs. In these cases, the designer can be theory agnostic and effective. In other cases, we might find a successful design or social system having reached a peak or stasis. We turn to theory to explain the situation and to articulate innovations that offer possible breakthroughs to the community of use. We see we should “try on” theory, that theory should serve the research or design problem, not the other way around.

3. Values in Design

Finally, we found a trend toward developing means of understanding values in the domains of study. There were raised some specific research questions for studying values in the context of field research for design. Values of interest can be defined across a range of individual and social contexts – values of the users and designers, universal and particular human values, organizational and cultural values. Discourse revealed the requirement for developing models for values in different research settings. While values studies may be more typical in sociological studies, product design, and even business research, they are still an emerging issue in CSCW and field research in collaborative work. It remains to be tried whether traditional values measures and models (e.g., Rokeach, Quinn, Maslow) may even be applicable to the complex social and work domains of the research projects covered within the workshop. What frameworks afford sensitivity to both individual and group values? At this point we remain aware of the trend and open to sharing from experience and effective approaches used across the wider community of researchers.

Analyzing Collaborative Work – A Distributed Cognition Framework

Although several theoretical frameworks were raised in the first workshop, we considered it useful to explore the contribution of Distributed Cognition to understanding collaborative analysis issues. Distributed Cognition has emerged as a significant theoretical framework for analyzing and understanding collaboration, and sheds light on the issues of analysis of holistic team interaction, multiple actors and artifacts, temporality and the organizational context of individual activity. We invited discussions about how this framework is used in practice of research and design, what problems or challenges it raises.

Distributed Cognition (DC) offers a theoretical and methodological framework with a broadened cognitive perspective, emphasizing the integrated cognitive system formed by people and their artifacts. DC analysis analyzes two relevant functions in particular:

- Representations of internal and external knowledge
- Propagation of knowledge between the individuals, artifacts and the environment as well as the transformations of information and knowledge resources during the activities.

A distributed cognition analysis identifies the shared cognitive components and artifacts, and describes explicit and implicit coordination among people in collective practices. DC analysis also specifies breakdowns and critical events occurring within processes and cognitive systems distributed among multiple participants. The outcome of analysis formulates proposals (recommendations) for functions to be preserved and identifies design and redesign of tools and practices in order to improve collaborative work. Distributed cognition approaches are considered useful for describing interactions among conscious actors and interactive systems in complex processes, and accounting for the effects of distributed action, awareness, and decision-making.

Theoretical issues

In the workshop contributions we find DC accommodating related theories, conceptual frameworks, and the extension of previous models which intend to explain collaborative work. Among these are Activity Theory, Collective Mind theory, and conceptual frameworks of extended cognition and cognitive economy.

As a developing framework, Distributed Cognition shares much in its approach with Activity Theory, both supporting the research and design of distributed systems. The primary differences can be considered minimal – DC analyzes artifacts and tools as integral to a cognitive system shared by all participants in the analysis. Activity Theory separates mediating artifacts as specific types of functional instruments, but accommodates the distribution of cognition across common

activities. The DC unit of analysis embraces the cognitive system, which includes activity. Activity Theory focuses on a specific domain of activity, which includes distributed internal and external cognition. Both frameworks have support in the workshop's research agenda. The analysis of the workshop contributions did not reveal so many problems or challenges (related either with the theory or the methods) as trends and applications.

Distributed Cognition accommodates Weick's collective mind theory in one paper, integrating principles of collective action and communication from organizational studies. The concept of "collaborative elasticity" drawn from this integration of DC and organizational systems presents a proposal for understanding the effective organizational resilience desired in high-reliability and critical missions. Collaborative elasticity draws from six dimensions of individual and team/organizational behavior that support flexible coordination among multiple stakeholders. Failures to support these dimensions explain breakdowns in collective awareness and action, as analyses from procedural collapse or mission disasters have shown.

By combining DC with the "joint activity" concept, another proposal extends the cognitive engineering (CE) model to support the redesign of social behavior, with a special focus on coordination mechanisms for shared values and goals. Drawing on Speech Act Theory, this approach analyzes the coordination mechanisms used in the process of driving and managing traffic systems, proposing coordination of individuals in traffic as a complex social activity. A game theory approach was also considered as a model for promoting common goals among individuals engaged in the traffic system, as a means of coordinating desired social behavior, minimizing conflict, and avoiding accidents.

Another contribution introduces *extended cognition*, analyzing the social and individual spatial relationships of the socio-technical cognitive system. Extended cognition considers properties of intelligent behavior and information distributed over physical space and over time, elaborating beyond and supporting the individual, and extending the social. Four social science research traditions have contributed to extended cognition, a concept that has reappeared with significant support after its submergence during the individual cognitive and behavioral traditions of the 20th century.

Extended cognition is presented in this case as enabling collaboration in physical and virtual space, and analyzes artifacts as referents for understanding coordinated activity. For example, some theoretical contributions place importance on the artifact or "external representations" of the socio-technical system defining three types of collaborative work spaces: physically centered space, virtually maintained space and a locally distributed space. As such, we find in these workshop contributions both naturalistic observation and theoretical analyses of physical and cognitive space, and of time-based analyses of activity.

Applications

The workshop contributions demonstrate a variety of domains for applications of distributed cognition in collaborative or coordinated activity. While these papers to some extent share a similar unit of analysis - the socio-technical system - the compelling applicability and flexibility of the DC conceptual framework shows its range from small systems (team) to large (a whole organization) and even continuous systems (traffic). The papers suggested widely differing applications for DC analysis:

- Computer product design and design team organization
- Scientific research, and intellectual collaboration for knowledge production
- Driving in high-volume traffic and intelligent highway systems (ITS)
- High reliability systems (aircraft crews), missions (firefighting), and organizations

We should note the significant application challenges ensuing from these analyses and from the broadened understanding gained from discussion. The primary challenge may be *adapting*

appropriate design approaches and methods that can be shown to afford the identified performance, usability, and safety benefits realized in the analysis of distributed cognition. A major challenge includes learning from DC to extend application to the *analysis and design of social systems*, from high-performance teams to elastic organizations, and perhaps to large-scale and continuous social systems such as government and travel systems.

We might address the trend toward designing applications and tools (such as mobile technologies) that enhance awareness of social interactions with distributed communities, artifacts, and communication systems. Think of Smart Mobs in large urban spaces, for example, a phenomenon that emerged from the adoption of mobile phone and text tools for coordinating the spontaneous emergence of crowds at a designated target location. One contributor identifies Common Information Space (CIS), a CSCW concept addressing the orientation of multiple participants toward a common view of multiple and interacting channels of information. The use of status monitors in instant messaging services also addresses the ability to organize multiple channels and multiple participants in a distributed information environment.

However, we encounter significant gaps in applying knowledge of collaborative activity to complex systems and technology design. The dynamic complexity of collaboration remains inaccessible to traditional structures of task and individual analysis. Analytical representations (such as task and process analysis) fail to capture the possibilities of intent, contingency, and action among multiple participants interacting in shared information space. Even the commonly accepted toolkits of Contextual Design have been noted (in the first workshop) as useful for some analyses, but ineffective for others, not having been intended as a methodology for designing tools for collaboration. Numerous CSCW projects demonstrate this gap by reporting ethnographic studies that make a conceptual leap to prototypes or tool adoption without offering an analytical method for identifying the intentions and functions within the collaborative domain. Therefore, we claim the requirement to continue testing and reporting new analysis and design methods specifically for these types of ill-structured socio-technical systems.

Conclusions

We should recognize that the theories and frameworks drawing on distributed cognition represent a significant break from past models of individual cognition and information processing. The field can be seen as in transition, where in the last decade CSCW has developed from interdisciplinary niche to a source of influential research and theoretical directions (e.g., the rise and acceptance of DC and Activity Theory). CSCW research has even been successful in predicting many of the key trends in the post-Internet information ecology (always-on coordination, work ecologies integrating IM and email, integrated video and computer communication, spam). While many CSCW technologies have not proven successful, we should appreciate the wide adoption and influence of the theories and research approaches fostered by CSCW.

Research methods continue to show development, as we find continuing advancement of multi-method approaches integrating ethnography, field research and field experiments, design research, Contextual Design, and lead user research models. Where multi-method studies were uncommon in practice and the literature even 5 years ago, they now appear to be the norm in collaboration research. We expect this trend to continue, and will continue to share learning and advances in the current workshop format.

However, the methodological toolkit requires continual reflection and improvement. The reliance on triangulating multiple methods, while getting the job done, also highlights the weakness of current methods to study the complex social phenomena of collaborative work. The analysis of distributed cognition in collaborative work is inherently complicated with multiple participants and their motivations, contingencies of situation, and technology use. We cannot yet consider the analysis and design toolkit sufficient to our domains and the quest to understand.

Finally, we find advantages as well as disadvantages in the inter- and multi-disciplinarity of the field. Learning and adopting methods from multiple disciplines contributes greatly to the breadth of the research agenda, and offers broad support for the creative research approaches required

to investigate collaborative activity and technologies. However, such continued interdisciplinarity shows up in some lack of influence in academic research agendas, traditional scholarly journals, and related funding. Promising projects investigating collaboration may be squeezed into a narrower technology focus, or find publication by narrowing the scope of findings. Given that this workshop has found hosts in both CSCW and CSAPC conferences, and similar workshops are sponsored at other international conferences, we are encouraged by the broadening appeal of the DC research stream into domains beyond CSCW.