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CSCW Research Shift Analysis using a 3-dimensional Model View

Toshihiko Yamakami†

It is an interesting topic to trace the major research trends in CSCW from a long-term perspective. The word CSCW was coined in the middle of 1980's from the awareness of technology/social convergence in multi-user/organizational computing studies. First the author discusses a retrospective view on the last 2-decade CSCW research from the birth to the development. Second, the author discusses new challenges to be uncovered in order to consider the framework for the future. Third, the author discusses the past CSCW frameworks and perspectives to set up a measure to classify each CSCW research. The author examines the causes of the decaying legacy frameworks. Then, the author provides a 3-dimensional model for CSCW study framework, consisting group, task, and technology fitting. With the proposed model, the author uncovers the research field to be explored in the next decade and give some implications in the framework shift in the technology-organization relations.

1. Introduction

Grudin mentioned *collaboration is a sign of maturation*[1]. We will see some kind of maturation in CSCW with implies the deeper penetration of research topics into the complicated human society. It is an interesting topic to trace the major research trends in CSCW from a long-term perspective. Olson et al summarized CSCW research issues in 1990[2]. Even with the fact that the society and organizations are never-ending challenges for CSCW research, we can think about the research shifts after this busy decade with emerging technologies. The technology-driven conquer did not succeed well, then the social factors were emphasized to coin a new word: computer-supported cooperative work in order to focus work, not the technologies. Do we continue to chase the running away mirage with the poorly crafted technologies? In the fundamental bottom layer, the answer is yes. However, the periodical review of the research frameworks will be beneficial for driving long-term research. This paper aims at identifying the long-term evolution analysis on the CSCW research.

2. A retrospective view on CSCW research

The groupware was coined in the middle of 1980's. The three technologies: multimedia networks, hypertext systems, and multi-user interfaces pursued the identical target: group work support. After coined in the middle of 1980's, the CSCW research enters the third decade of its history. CSCW reflected the need to focus on *work* and *organization*, in addition to the *technologies* at that time. At the time of birth in the 1980's, CSCW had the roots in technologies and social sciences. In the technology side, there were three different aspects to enable CSCW: the multimedia network, hypertext and database, and multi-user interfaces. The underlying technologies continue to advances.

The higher-level CSCW research concepts: participatory design[4], awareness[5][6], informal communication[7], social network, organizational memory[8], affordance[9][10], ethnographic approach[11][12], ecology[13], technosocial situation[14] were step-by-step analyzed in the approximiately-2-decade history of CSCW. There are many social research perspectives brought into this research domain. The first successful one was the participatory design from the Scandinavian approach. It was highlighted in early 1990's, gradually leading to the participatory design research projects. After that, awareness was one of the most cited categories. The ethnographic approach was another successfully introduced methodology throughout the 1990's. Grudin viewed the CSCW evolution from the viewpoint of the organization size in[15], which is one of the most insightful observations on the CSCW research evolution.

The advances are not expected to stop in the near future, like *ubiquitous computing*. Klem-

† ACCESS, 2-8-16 Sarugaku-cho, Chiyoda-ku, Tokyo, JAPAN, e-mail:yam@access.co.jp

mer mentioned in his invited talk that one of the major challenges in the computer science in the next 15 years would be confluence of bits and atoms[16]. Advances in wireless technology bring the closer integration with tasks and environment with RFID, sensor technology and wireless connections. The real-world integration is within the research reach, which sometimes covers multiple research topics like physical interface, environment computing, tangible user interface, augmented reality, and multimodal interface.

From a retrospective view, we witness diversity rather than convergence. We did not see any grand theory in the last decade. The 200-year history of social science is hardly to beat. To make the matter worse, the emerging technologies make the social contexts more complicated and more difficult to analyze.

3. Challenges for the next decade

There are many variations of underlying technology use and focusing social aspects. First, the research started to make technology-augmented meeting rooms. Next, people started to use Internet for sharing information or virtual realities. Third, they started to use mobile technologies. In recent years, we witness many research utilizing RFID technologies. The author considers that the research focus in the past decade was biased to the particular type of office interactions, especially in 1985-1995. First, it was generally restricted to the office tasks. The non-office tasks and issues were generally uncovered. They include cross-gender interactions, cross-generation interactions, multi-generation interaction and non-profit activity interactions. Mechanical part of the work like scheduling, reservation, workflow and conferencing were mainly studied. On the contrary, creative part of collaboration was not focused in 80's. An Upstream stage of creative work was not well captured. This bias was counter-adjusted recently like research for Designer Outpost by Klemmer[17]. Advances in the network technologies now challenge some of the underlying assumptions of the past research. The 24-hour collaboration using time difference is getting common from the globalization trend these days. There is a social need that requires more and more technologies in the large framework like totally technology-augmented environment like intelligent transportation system or technology-augmented town-place or in the micro framework like chip-embedded environment.

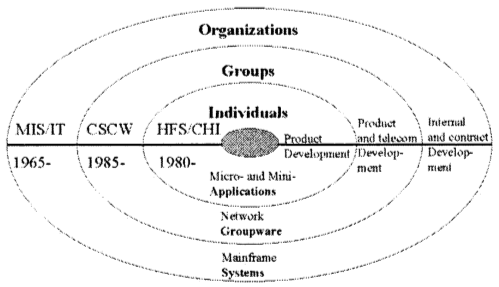


Fig. 1 Development and Research Context[18]

There are several interaction paradigms to be explored:

- Cross-generation interactions,
- Collaboration over time differences,
- Heterogeneous interactions,
- Interactions in Non-profit activities,
- Parallel context interactions,
- 24-hour work,
- Global time shift,
- Technology-translated interactions.

4. Existing Frameworks

Size of group is one of the critical factors in the group work support. Grudin[3] highlighted the evolutional dimension with size from the following transitions:

- MIS/IT: Mainframe with internal and contract development for organizations
- HFS/CHI: Micro- and mini-applications with product development for individuals
- CSCW: Network groupware with product and telecom development for groups

The framework is depicted in **Fig. 1**. It is a unique grand framework to give perspectives in CHI and MIS domains.

The first popular research dimension model coined in the CSCW research was 2 dimensional taxonomy with the synchronous/asynchronous and space-shared/remote dimensions in the late 80's. After that, multiple dimensions have been considered to capture the CSCW characteristics as follows:

- size: personal, team, organization, society
- granularity

Collaboration
Communication
Awareness
Co-presence

Fig. 2 A Hierarchical Layered View on Groupware[19)]

	collocated	remote
synchronous	meeting support, et al	distributed meeting, et al
asynchronous	workplace memory, et al	messaging, workflow, et al

Fig. 3 A 2-dimensional model with sync/async and collocated/remote dimensions

- geographical: co-located, remote
- interaction-type: spontaneous, planned
- interaction-type: synchronous, asynchronous
- interaction-type: formal, informal
- collaboration-type: collaboration, cooperation, competition
- architecture-type: centralized, decentralized
- support-type: new channel, activation of existing channel
- support-type: autonomous, controlled
- culture-type: monoculture, diverse-culture

Okada et al presented a dimension model for CSCW with the following layers[19)] depicted in **Fig. 2**.

He discussed the groupware functions and issues from this layered view model in order to design successful groupware.

In the early days, the 2-dimensional model depicted in **Fig. 3** was commonly used to classify the groupware systems. When the model was discussed, the collocated/asynchronous domain was not clear. The author puts workplace memory, which indicates a time-transparent organizational knowledge sharing in a particular place. It is a still arguable domain.

Grudin described the shift from "Here and Now" to "Everywhere and Forever" from the ubiquitous computing perspective[18)]. The author discussed the hybrid workplace computing in the ubiquitous environment[20)]. The technology enhancement of memory, bandwidth, and availability gradually obscures the once-popular dimensions.

We see the gradual decay in the interaction type related dimensions. It is partly because the legacy studies put too much emphasis on the interaction types. In the early days, the technology was so handicapped that the different interaction types made a significant difference. Good user interface, especially multi-user case, is still a significant challenge. However, the research naturally shits toward the bigger framework expecting the coming technology achievements in the micro-component level, like network interfaces and user interfaces.

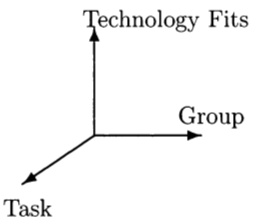


Fig. 4 A 3-dimensional view on CSCW research shift

5. Research framework shift in a 3-dimensional view

Considering the framework shift, the author considers that there are three framework shifts visible in the coming research field:

- new view on *group*: multi-generation, multi-culture, ...
- new view on *task*: family interaction, technology-augmented task, ...
- new view on technology-organization relation: fits, ...

There are many technology-organization relations like adoption process, interactions between them, and so on. The author comes to the concept of technology fits in the mobile internet evolution study[21)]. The relations between technologies and organizations are one of the uncovered research directions. From the above mentioned focus list, the author proposes a 3-dimensional view on the CSCW research shifts depicted in **Fig. 4**.

5.1 Shift in group perspective

There are two shit trends in group dimension:

- shift in targets, and
- shift in cross-group or group boundaries.

The former examples include the new type of group target. Multi-generation family is one of examples. A nation-wide decision making system is now in the reach of computer systems.

The whole environment can be empowered by embedded intelligence. This technology extension includes a new group target within reach of CSCW research. The latter examples include the boundary-less group. Multi-culture collaboration is global-scale cooperative work. When the intelligence penetrates the every-day environment, the multi-faceted nature of human beings will be further highlighted.

Cross-generation interactions deal with interactions across generation borders. Cross-generation interactions are one of the most uncovered research topics. It is influences by various social factors like different communities, different norms and conventions, and different interests. It is also impacted by different technology literacy and different technology availability. It also relates to aging, awareness, high-level social norms, and cognitive differences in time.

5.2 Shift in task perspective

It is notable that we witness the transitions of the *work*. Even from the last decade, various different work contexts, e.g. ambulance or cockpit, were popular target for the CSCW analysis using e.g. ethonomethodologies. The emerging new work includes:

- 24-hour work like three-shift work around the globe: asynchronous continued work
- volunteer work: work in the autonomous norm-build-up
- family interactions: featuring inter-generation interactions

24-hour continuation of work is an emerging task field especially augmented by technologies. It contains the 24-hour shift work in trouble shooting and user claims, or close-less shopping site. Virtual stores are also included in this work category. Another sub-category in this work is the global time shift. The global companies can continue the software manufacturing or industrial design work using task relays in multiple continent work forces. This type of collaboration is still to be explored.

Heterogeneous interactions are interactions with heterogeneous communication media. Technology-augmentation best fits in a single media. It is difficult to analyze fundamentally heterogeneous communications. The multi-user multi-modal interactions need to address this issue. Interactions in non-profit activities are interactions based on non-profit motivation. The motivation analysis is different. The evaluation needs to be based on user satisfaction not based on efficiency nor cost. Devotion and commitment need to be addressed in this topic. Parallel context interactions are interactions with multiple contexts. This type of interaction is augmented by the advances in wireless technology. The mobile multimedia communication brings the duality of the communication context into a real life. People can maintain multiple contexts during one's activity. For example, during the university lecture, students can exchange email messages and text chats using mobile handsets. This is a typical case of dual contexts, switching by order of seconds.

The shift from supporting technologies to the diversified work will be a new trend in the CSCW studies. In the past days, the computer supported cooperative work relatively depended on the routine, every-day life work which could be observable on the common offices. The research targets were meeting-support, calendar-support, project-support and knowledge sharing support. The ethnographic research covered after this first trend the specialized work area like cockpit or ambulance. The third stage is the new definition of work. The driving force comes from the three aspects: family, non-profit-organization, and global enterprises. The family brings the new aspects of over-the-generations interactions. The past human factor research relatively focuses on the coherent group interactions. The non-profit-organization brings the new aspects of semi-social interactions. They are not business-based, but not just a community because they pursue some organizational goals.

Originally, the work focus highlights the clear definition of the context and restricts the target boundary. The today's work area poses the two new challenges:

- New works beyond the past work-task boundaries
- New works beyond the past work vs. non-work boundaries

The examples in the former case include h24-hour continuous work around the globe with 8-hour * 3 shifts demonstrates such a new perspective. People continue to work in remote sites, but never work together in a synchronized

manner. The examples in the latter case include family interaction task. A family interaction can be augmented by technologies including cross-generation interaction. The family tie is lost and the technology is now augmenting the family world in many senses. This type of non-work group behavior encounters new challenges like inter-generation interactions.

In the past study, researchers fixed the task domain first for design and evaluation. Then it is a natural approach to classify the tasks and technologies with task and technology matrix. In the unexplored domains listed above does not fit this technology and task matrix perspectives. It is a domain that needs a new methodology.

5.3 Shifts in Technology and Social Context Relations

There remain areas where a component based approach is not appropriate. The social context in the relation of technologies needs further investigations. Examples include the followings:

- organization culture
- knowledge management, tacit knowledge
- social power game, conflict resolutions
- cognitive aspects: awareness, commitment, breakdown, affordance, ecology, ..
- technosocial situations

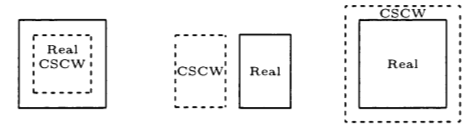
There are three different technology and social context relations in the emerging CSCW applications.

- closed technology context
- parallel social context itemclosed social context

The technology augmentation leads to a stage where we have to consider a wide diversity in the technology and society relations in time and space scales. The mobile communication creates a new research arena where the social contexts coexist and change dynamically in seconds-scale order. This new social context will create a new challenge for CSCW research.

The typical 3 cases are depicted in **Fig. 5**. The time dimension makes the issues more complicated. It is a challenge to bring a new theory framework to deal with these emerging contexts. Each context needs to be measured by technology fits in such cases.

The complexity and dynamism in the social context augmented by the technology is expected to lead to the bridging theories and paradigms in the coming CSCW research.



a) CSCW < Real b) CSCW : Real c) Real < CSCW

Fig. 5 3 different positioning between the real world and CSCW world

6. Conclusion

It is an interesting topic to trace the major research trends in CSCW from a long-term perspective. The word CSCW was coined in the middle of 1980's from the awareness of technology/social convergence in multi-user/organizational computing studies. First the author discusses the past CSCW framework models to set up a measure to classify each CSCW research. Second, the author provides a 3-dimensional model for CSCW study framework, consisting group, task, and technology fits. From the framework, the author summarizes the last 2 decades trend in CSCW research and highlights the technology evolution and technology focus shift. Using the proposed model, the author uncovers the research field to be explored in the next decade from the lack of the past focus. With the proposed model view, the author categorizes the ongoing CSCW hot research domains. In addition, the author discusses the impact and implication of the research focus shift in the 3-dimensional model view. Finally, the author provides some implications for next decade CSCW research trends with the research focus shift using the momentum shift in the 3-dimentional-model view.

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