Research Article

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Computer-Supported Cooperative Work – Revisited

https://doi.org/10.1515/icom-2021-0028

Abstract: Due to the COVID-19 lockdowns and the related mandated work for home, we have seen a massive increase of the use of collaboration tools in various work settings in the last 18 months. Whereas this might have been a new terrain for some, IT-supported work and the related research domain Computer-Supported Cooperative Work (CSCW) have been around for decades. In this article we briefly review what CSCW has to offer for the currently increasing demand in setting up remote collaboration – and share our own observations about what happened when collaboration tools have been introduced in the pandemic. As a summary, we present some learnings from the experience – both for the current state of CSCW research and for future work.

Keywords: Computer-Supported Cooperative Work, CSCW, COVID-19, collaboration tools, remote work, awareness, boundary management

1 Introduction

In March 2020 measures to reduce the further spread of COVID-19 mandated the temporary closure of 'non-essential' businesses and forced millions worldwide to work from home. From an academic perspective, it has been fascinating to see how the so-called lockdowns have made many office workers fully embrace digital work tools like collaboration platforms and video conferencing tools which allowed them to keep working remotely and to interact in new ways.

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These rather dramatic developments reinforced a new way of organizing work which is known under many names: work from home, flexiwork, hybrid work, mobile work, remote work, distributed work (to name but a few), and can be described by a simple denominator: a person is not working within a pre-defined space questioning the concept of a 'workplace' or of 'going to work'. Work, now more than ever, happens in private homes, shared spaces or during transit. With this variability of work location often come more flexible work arrangements which allow employees also greater control over time and schedule of work.

As a consequence, support for remote collaboration never has been so much in the focus of organizations as in the last 18 months.

Now, there is a research field that has been dealing with collaboration support for almost 40 years – Computer-Supported Cooperative Work (CSCW) [4, 17, 30, 59]. Already in 2000 two of the authors of this article contributed to an overview article on CSCW in this journal [58]. Since then, the field has grown by several orders of magnitude [36]. As CSCW researchers we asked ourselves in the past months: how has CSCW helped to deal with the changes set in place due to the pandemic? And what we can learn from this unprecedented number of office workers[1] that have been finding themselves requested (and finally allowed) to work remotely and do so by massive application of remote collaboration previously unheard of?

In this article, we look at both, the social practices that have been developed or have emerged and the theories and concepts of CSCW. We start with theories and concepts in the following section, and then we present some observations we made during the COVID-19 pandemic (in the form of case vignettes). We conclude with a discussion of what research in CSCW should address in the future and how transfer of research results may need to change to allow for better use by practitioners.

1 In Germany, in April 2020, the proportion of employees across occupations working partly or entirely from home rose to as much as 34 % [8].

2 CSCW – State of the Art

2.1 History

The origins of Computer-Supported Cooperative Work (CSCW) as a research area can be traced back to a workshop organized by Irene Greif and Paul Cashman in 1984, where researchers from different disciplines met to exchange ideas, share results, and to join forces to better understand how IT could be used to improve and enhance group outcomes.[2]

First ideas of CSCW appeared much earlier in 1945 in Bush's classic paper "As We May Think" [9]. Inspired by the work of Busch in 1968 Douglas Engelbart and his team developed the ideas further and implemented them. In their ideas on augmentation of human's intellect, Engelbart and English [24] proposed that computers and people must evolve together, and that computers and software should be seen as tools that augment, rather than replace human capabilities. A demonstration of a prototype of a collaborative application (often referred to as "The Mother of All Demos") was given by Engelbart and his team at the Fall Joint Computer Conference in San Francisco in 1968 [37, p. 42].

At the same time the basic idea of remote interaction and virtual communities turned up. Joseph Carl Robnett Licklider, who significantly influenced the development of the Internet, already wrote in the year 1968: *"... life will be happier for the on-line individual because the people with whom one interacts most strongly will be selected more by commonality of interests and goals than by accidents of proximity."* [38]

2.2 CSCW Concepts and Theories

Sure, there have been a lot of technical developments in CSCW – starting from synchronous group editors and the famous Grove algorithm for optimistically handling concurrent access [20] and full platforms for supporting communication, workflow management and yellow pages like IBM Connections. But the real achievement and contribution of CSCW is in uncovering the basic workings of cooperative work, and to develop a foundation of theory and methods for designing support of cooperative work.

By studying work practices, and by developing and testing tools to support them, numerous technologies have been developed and tested, and groundbreaking insights into understanding what collaboration is, how it can be supported, and how tools for supporting communication and collaboration can be introduced.

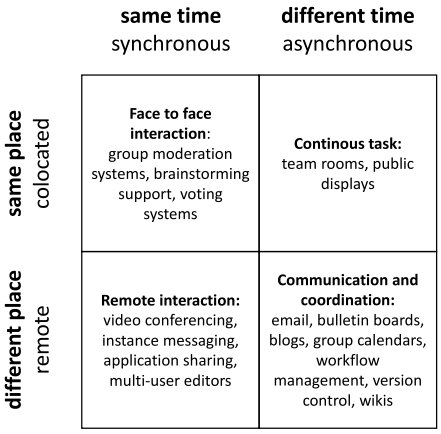

Figure 1: Time/Space matrix (adapted from [48]).

Collaboration situations initially have been classified by time and space – see Figure 1 [7, 28, 52, 58]. This classification already offers an interesting overview of types of tools for supporting cooperation and types of situations that appear in cooperative work.

Another result of CSCW research is the characterization of the nature of group interactions and the sociotechnical foundation of the organizational concept of telecooperation. The following five forms of interaction among individuals in groups are often mentioned in CSCW literature: *coexistence*, *communication*, *coordination*, *consensus* and finally *collaboration* [35].

The utility of coexistence and awareness for some kinds of cooperative work is now well understood, and technological support for those items has been prototyped, tested, and diffused into the field [19, 35]. A variety of models for understanding the role of communication have been advanced, e. g. the context-oriented communication model by Misch [45] or the Cooperative Work Framework by Dix et al. [16, p. 465f], and each provides valuable insights for practitioners and researchers. The concept of coordination has been researched, and support for coordination is now ubiquitous in the workplace [41].

But CSCW contributes more. First is the learning that work systems are sociotechnical systems – and the research into different methods and topics for developing or evolving such sociotechnical systems.

In the following subsections we will first describe further what CSCW has learned about awareness and communication and about coordination (Sections 2.3 and 2.4).

2 See https://dl.eusset.eu/handle/20.500.12015/4097 for more information about this initial CSCW workshop.

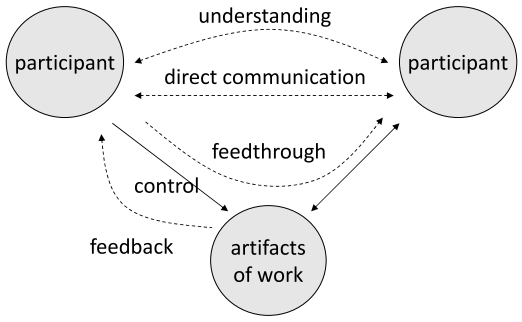

Figure 2: People/Artifact Framework (adapted from [16]).

Then we will address what CSCW has discovered about the work system and about how to make technical solutions work in the work system (Sections 2.5 to 2.7). We cannot cover every relevant topic for implementing remote collaboration here – e. g. motivation theory, but will try to focus on the most CSCW specific topics.

2.3 Awareness and Communication

Awareness as "*an understanding of the activities of others, which provides a context for your own activities*" [19] is a concept that is widely used in CSCW to describe how tools can and should support remote collaboration. Increased awareness facilitates the digitally supported establishment of a "common ground" that is necessary for meaningful conversations and relationships [10]. Awareness reduces uncertainty and enables spontaneous coordination. Uncertainty often arises in cooperative work with mutual dependencies. For example, the participants may ask themselves whether the cooperation partners will be able to finish their parts of the work in time, whether the planned results can actually be achieved, or whether the collaborators will be available for queries.

Due to the frequent lack of implicit ways to resolve these uncertainties when collaboration is geographically distant, effective and efficient coordination of activities over distance becomes a challenge [14]. Therefore, especially in distributed teams, it is necessary for team members to be explicitly informed about each other's activities.

Awareness is closely related to communication. One theory in this area is the people/artifact framework that addresses the functional relationship between members and the tools to support cooperation [16, p. 465f]. Figure 2 shows the core of this framework. The directional and bidirectional arrows indicate channels of communication either between participants or between a participant and the artifact.

Other contributions to better understand communication concentrate on the context of communication. Communication can only succeed, if the senders' expressions are completed by the context, which can be perceived by them and the recipients.

In the field of human-machine-communication context is defined as "*any information that can be used to characterize the situation of entities* (*i.e. whether a person, place or object*) *that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context is typically the location, identity and state of people, groups and computational and physical object*" [15].

Examples for context in communication are

- What has been said before
- What can be seen, felt be the communicating parties
- Culture
- Common knowledge, content of mass media

Communicative acts are always and necessarily embedded in a specific context. The communication situations, as well as the cultural [66] or organizational [61] context, influence the communication itself.

Figure 3 shows the combination of context and communication tasks of the communication partners A(lice) and B(ob) as proposed by Misch [45]: The mutual context of the communication partners consists of parts of the individual communication partners' contexts (context of A, context of B). By processes of perception the outer context of the communication partners becomes part of their inner context, but only partially. If one person A(lice) wants to inform another person B(ob) for aspects of her thoughts or feelings, she has to produce an expression which can be perceived by B. The production of this expression is part of the communicative behavior of A. As soon as an expression is uttered, it is part of the environment and therefore also a part of the outer context of the communicators. The extra-communicative behavior includes all behavior of the communication partners. It is also part of the outer context and can be used for checking the success of understanding. If B´s behavior does not comply with the reaction A might expect in relation to her expression, she will become unsure about the success of communication. The communicator cannot explicate all context information in the expression.

Because of the incomplete context information, the recipient has to reconstruct the not communicated context himself. In the case of computer-mediated communication, the extent of the context, which has to be made explicit increases. This is caused by the different time and place, which makes direct perception of mutual context

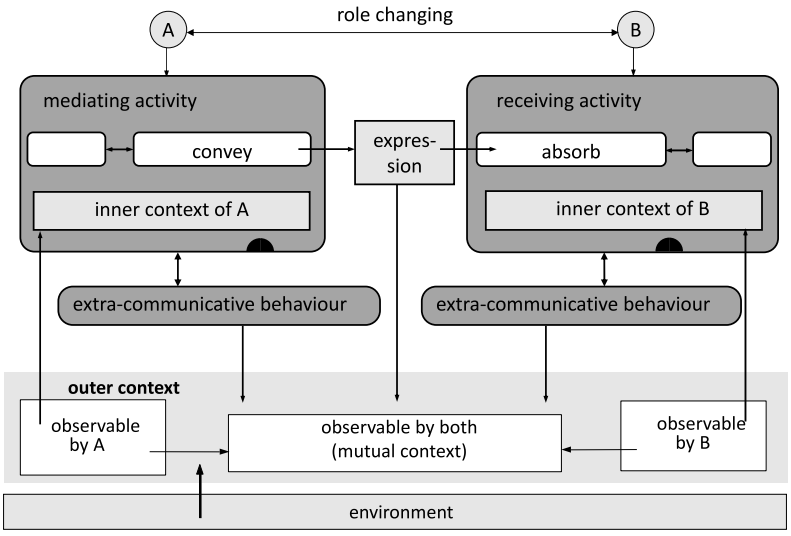

Figure 3: The relevance of context (adapted from Misch [45]).

impossible. Awareness communication via communication artefacts has to help here.

2.4 Coordination Support

Coordination is one of the main mechanisms observed in cooperation. It allows not only cooperation to happen, but also to be efficient and reliable, through ensuring the consistency and the appropriate sequences of sub-tasks. Therefore, coordination support always has been an important domain in CSCW. Additionally, a general understanding and knowledge of coordination and the mechanisms that can be used to support coordination can inform CSCW systems design in general.

At the end of the 1980th Malone and Crowston started to bring concepts about coordination from the different disciplines together to a new research field, which they labeled "Coordination Theory" [40–42].

Crowston and Malone define coordination as "*the act of managing interdependencies between activities performed to achieve a goal*" [42]. They highlight the following basic concepts and relationships:

- Actors performing activities which are directed toward some ends (= goals)
- Activities are not independent. They must be performed in a way that helps create "pleasing" outcomes and avoids "displeasing" outcomes.
- Interdependencies are the goal-relevant relationships between the activities.

So, the context of coordination is one or several actors performing interdependent activities or tasks to achieve certain goals. These tasks might require or create resources of various types, and the actors face coordination problems arising from dependencies that constrain how tasks can be performed.

Building on this motivation one can identify different generic types of interdependences:

- prerequisite: output of one activity which is required by the next activity (ordering activities, moving information from one activity to the next) – examples are producer/consumer dependencies, task/subtask relations
- shared resource: resource required by multiple activities (allocating resources)
- simultaneity: time at which more than one activity must occur (synchronizing activities)

In the first case, an activity requires results or prior activities, in the second case, several activities use a shared resource, and the last type describes interdependencies between activities, which are performed in parallel.

To overcome these coordination problems, actors must perform additional work, which Malone and Crowston called coordination mechanisms. For example, if particular expertise is necessary to perform a particular task (a task-actor dependency), then an actor with that expertise must be identified and the task assigned to him or her. Crowston et al. [11] detail that there are often several coordination mechanisms that can be used to manage a dependency. For example, mechanisms to manage the dependency between an activity and an actor include (among others): 1) having a manager pick a subordinate to perform the task, 2) assigning the task to the first available actor and 3) a labor market in which actors bid on jobs.

Coordination support then was split into

- Explicit coordination support: workflow management, conversation systems ... the machine does the coordination
- Implicit coordination support by providing awareness – desktop based or via more sophisticated/ubiquitous displays

Especially the second issue highlights the basic importance of coordination in context to coexistence and awareness. Supporting coordination via shared artifacts is the most commonly found way for supporting coordination while workflow management addresses the domain of automating coordination for a smaller set of application domains.

2.5 Practice Orientation/CSCW and the Work System

As already stated, CSCW is not so much about building tools, but more about understanding work and life practices and supporting those with innovative IT artefacts. Practice-based CSCW research is an "*orientation towards empirically-grounded research embracing particular methodological approaches with the aim of creating new theory about work, collaboration, and cooperative technologies*" [5].

This can be seen a lot in CSCW research: First there is a large bunch of ethnographical studies. One of the CSCW key figures, Jonathan Grudin told in an interview [36]: "*sources of trouble arose from insufficient understanding of organizational processes and team process*". Grudin already wrote about it in late 1980s [27] and himself thought that CSCW will overcome these problems quickly. But the discipline did not. Reason (according to Grudin): As time goes by, we try to support work in more and more detailed ways and in different kinds of work environments, work contexts, and we do not understand the nuanced activities we are hoping to support. So, there are the same problems in new context. And there are new challenges: more time pressure for developers, technology must fit into more complex existing practices, including systems that people are using outside their work that they have developed habits around.

To address the problem of hard to capture and changing requirements iterative or evolutionary development has been introduced early (in CSCW and other areas that are dealing with similar challenges). The basic idea behind evolutionary system development methods is not to go through the process of requirements capture, design and implementation once but several times [34].

In addition to evolving the system design, involving users and other stakeholders is important in all phases – first by watching them, and later by actively requesting their input. This strong user participation is both important for getting the requirements right and for planting a positive attitude towards the new system in the users (in the context of successful change management).

In this context it is important to note that "implementing a system" in CSCW always means designing a whole sociotechnical system, including organizational and social aspects and not the technology only. The term "sociotechnical system" has been coined in the 1950ies by Trist and Bamforth [63] at Tavistock Institute London in the context of a number of studies of work organization in British coal mining and textile industries (also see [22]). In these studies, the researchers found very different results emerging from the introduction of identical technology into different groups (social systems). The central lesson from analyzing the observations was that the technical system and the social system must be co-optimized for the whole system to be successful. If a technical system is created or introduced at the expense of a social system, the results obtained will be sub-optimal. While rooted in classical workplace studies the concept was later also adapted to the usage of computer-based information systems to support social groups [47]. Here the technical system is the IT-system introduced to help the people to communicate and collaborate, the social system is constituted of the organization and the relationships between the group members.

In workplace psychology the term "work system" is used for a sociotechnical system representing clearly identifiable and separable subsystems in an organization or company. Work systems are systems in the sense of system theory, i. e. they transform input to output. According to models from workplace psychology they can be seen as consisting of the following parts (see for example [62]):

- people (with qualifications, interests and requirements)
- technology (machines, IT-systems, work resources, special conditions)
- organization, structure (work processes, decision making structures, communication structures)
- the primary task of the work system

The primary task/goal is of core importance for the sociotechnical system because it provides a source for motivation and for holding the system together.

CSCW research has adapted these insights to shaping systems for collaboration support. In summary, the main messages from the sociotechnical systems discussion for CSCW are

- technical systems (CSCW support technology) are highly embedded in social systems
- there is more than just the technical system – and it is worth looking at this "more" (for designing and introducing CSCW systems)
- the social and the technical subsystems should be optimized (designed) in parallel, because they influence each other
- the goal/task of the overall system should not be forgotten – it usually is a main source for the coherence of the system
- social systems and interaction in social systems (via the technical systems) are highly complex – this has to be considered when designing for collaboration support (e. g. by not assuming to get the solution right at the first attempt)

The sociotechnical system approach highlights the alternating dependency between social systems and technical components. Social processes are the basis for the development of technology and vice versa the technology structures the possibilities for social exchange. Giving equal weight to social and technical issues when designing new work systems is of core importance for success [49].

For actively involving users (in building or evolving sociotechnical systems) different participatory design methods have been developed [46, 60]. Participatory design is a complementary method to ethnography in which the users and other stakeholders of the software are involved in the design from a very early stage and throughout the design and development process. One example for a participatory design method is the Sociotechnical Walkthrough [31]. This method includes different moderated workshop settings in which the whole sociotechnical system is discussed or developed with the users. For describing sociotechnical systems a special modeling approach has been developed that adds special constructs for sociotechnical systems to standard systems modeling approaches like UML [39].

2.6 Appropriation, Malleability

Computer systems for supporting collaboration are often labelled as Groupware. Marca and Bock [43, p. 60] state that the development of Groupware was not merely another evolutionary step in the history of computer science, but *"a conceptual shift; a shift in our understanding. The traditional computing paradigm sees the computer as a tool for manipulating and exchanging data. The Groupware paradigm, on the other hand, views the computer as a shared space in which people collaborate; a clear shift in the relationship between people and information*."

This conceptual shift has far-reaching consequences. Indeed, the statement implies that Groupware is not characterized by single isolated applications, which have some cooperative aspects, nor should the computer only be seen as a means of information processing. Instead, computers are a medium for communication and collaboration. These important aspects of computers already were anticipated by visionaries like Vannevar Bush, Douglas Engelbart and Joseph Carl Robnett Licklider decades ago [9, 23, 38].

Since "implementing a system" in CSCW always means designing a sociotechnical system, including organizational and social aspects, it is even quite common today that for the technical component of the system no completely new system is implemented, but "just" off-the-shelf tools are selected, integrated, and configured. After setting up the (sociotechnical) system, the next step is the appropriation of the system.

Appropriation can generally be understood as "*the way in which technologies are adopted, adapted and incorporated into working practice*. [...] *Appropriation relies on flexibility in both practice and technology*" [18]. Appropriation needs to be treated as a process, because the users must gain practical experience with the software and over time find a place for it within their own practice. This process is always a social process, because the work practices are by definition social practices that are shared and socially negotiated [54, 57]. Therefore, any employment of a new software must be socially negotiated as well. The term appropriation stresses that the users have to collectively adopt the software and make it "their own" [56]. Hence it is necessary to develop new process theories regarding technology acceptance that are suited to grasp the phenomenon of appropriation of malleable end-user software. Besides a good understanding of technological developments this requires methods that can capture and examine social practices, which calls for an interdisciplinary approach.

Another important concept of collaboration support software is its malleability [54]. The main characteristic of malleable end-user software is its inherent flexibility and openness in enabling and supporting a wide variety of work practices without the need for technical customization. Instead of focusing on a particular purpose or providing a solution to a problem, MEUS aim to create potentials and new opportunities for organizational innovation. The main aim is to support existing or enable new work and communication practices. Typical MEUS examples are communication and cooperation systems (e. g. Skype, Lotus Notes etc.), office software (word processing

and spreadsheets), as well as a wide range of new Internet-based tools for information storage and editing (e. g. DropBox or Evernote).

Malleability as a characteristic of end-user software challenges the applicability of existing theories such as the widely known adoption theories Technology Acceptance Model (TAM) [12] and Unified Theory of Acceptance and Use of Technology (UTAUT) [65]. In essence, these theories model the adoption of new workplace technologies as a decision made by individuals regarding use or non-use of a new IT artifact [3]. In doing so, they focus on the "if" of adoption (does it occur?) not the "how" (what happens during adoption?). The decision regarding usage or non-usage is, among other variables, dependent on the perception of the usefulness of the software for the individual's tasks. Data in corresponding studies is typically collected before adoption takes place and the dependent variable is modeled as the intention to use.

However, the problem arises that the usefulness and potential role of MEUS for one's work practice cannot easily be determined and anticipated a priori due to its flexibility and lack of in-built purpose. In essence, these existing theories do not account for this fact, which violates a core assumption. Consequently, such theories are not applicable for explaining user adoption of malleable end-user software. At the same time, this challenges the validity of existing studies built over these theories, such as studies investigating the adoption of social software in the workplace.

To develop a better understanding for the adoption of malleable end-user software new approaches are needed. User acceptance should not be modeled as an individual decision made for a well-understood artifact, but rather as a social process of appropriation in which the software is interpreted and "placed" within the context of existing work practices [55].

2.7 Benefit-Orientation

Several authors in the field have been analyzing CSCW projects and have been identifying core challenges of collaborative system design compared to software design in general. See for example the early work from Ellis or Grudin [21, 27]. One of the conclusions of Grudin was:

– For making a collaborative system a success all (or at least a large part) of the co-workers have to use the system actively (network effects, critical mass). This requires mainly a clear balance between effort and benefits for all of the users (no disparity between effort and benefits), which has to be communicated to the users, and includes the need for easy-to-use user interfaces and for a good integration.

Working on this very important issue in designing work systems means that it is important to watch that everyone that is needed to participate has more benefit than effort. However, we have seen a lot of systems that failed even while offering benefit – just because they failed in communicating this benefit. So, in addition to offer benefit, CSCW system also must work on communicating the benefit to the potential users.

In practice this often means that one must work on how the system is documented and presented to potential users. Documentation must focus on how the user can benefit from the system – and not on how particular features can be used. Different possibilities of a benefit-oriented documentation are e. g.

– Reports on possible uses of the platform (in online or offline publications). Mechanisms such as word-of-mouth propaganda or viral marketing as well as the credibility and authenticity of promoters and key users also play a major role here.
– Collection of concrete examples of use in the form of reports in which users tell of their own successes with the platform, e. g., in articles in the employee newsletter, as part of online documentation, in user blogs, or even as a simple post by an employee marked with a hashtag (e. g., #bestpractice).

Both can be implemented either in text form, as a podcast, or even in the form of scenario posters or comics. Both types of rules were particularly well received when they were developed either with employees or directly by them (participatory creation and decision-making process). A tried-and-tested approach in larger organizations has been to first collect a broad range of ideas and suggestions relating to the set of rules through a survey and to refine these results in workshops with small groups.

3 Learnings from the Last 18 Months

So how did the field of CSCW do in the last 18 month (at the time of this writing)? Did the theories and experiences help in dealing with the situation raised by the pandemic? The answer is yes and no.

Now, what happened at the beginning of the COVID-19 pandemic?

Remote collaboration tools were introduced broadly without analysis of practices, without identifying and designing processes (whole work systems). Tools were set up and people started to use the tools without plan or proper introduction or training.

Not everything went well, but things happened in this largest practical CSCW experiment that should be documented and mentioned. In the following paragraphs we try to collect some anecdotes about effects. Thereby, we will not address what worked technically and what not (how the tools were implemented), but how they have been used, how the usage influenced work life and private live – and what this shows about collaboration support in general.

3.1 Locked-Down Digital Work

The lockdowns have created new social norms around digital work. In many adoption scenarios before the lockdown, leaders would give their teams and themselves time to make sense of digital work, before they tried to align uses and cooperatively establish norms and rules, for example, how they expect their team members to check-in. Due to the necessarily high adoption speed, this was not possible in many companies. Thus, the newly gained autonomy backfired for many employees, who felt they had to justify more often how they spent their workdays. Already in 2013 Mazmanian et al. [44] showed how an increasing amount of autonomy can have counter-intuitive effects: employees that were allowed to work mobile (hence increasing their autonomy) checked their emails more often, reducing their ability to disconnect from work and reducing their autonomy. Experiences from the lockdown seem to confirm that; Feldman and Mazmanian [26] note on locked-down digital work: "*Because they're not as visible, employees look for ways to demonstrate that they're engaged and available. They might assume that they need to make themselves more reachable and responsive than before the move to virtual work, perhaps by working longer hours and replying more quickly to emails. [...] Employees spend more time online, proving they are "there" and less time working productively, which makes coping with their individual needs and circumstances even harder*."

However, studies showed that not only were most employees as productive as in the office (or even more) but also that most leaders perceived their employees similarly (or more) productive (e. g. [53]). Thus, the problem was not productivity, but missing social norms which gave employees the feeling they needed to make up for the reduced amount of visibility by communicating more than before.

Yang et al. [67] present another interesting very large dataset from Microsoft from which they conclude that work from home resulted in less collaboration hours and more focus hours – and caused people to shift from scheduled meetings (including online meetings) to more messaging.

Similar observations have been made in other studies. In [6] the authors conclude from a Web based survey conducted from May to July 2020 that in the home office workers communicate significantly less. Hofmann et al. [32] concludes that the "biggest shortcomings not to be fixed simply by buying things". The basic set of IT equipment – designed for working on the go, falls short of the mark for a more permanent home office. Additionally, the home office situation presented a "management boot camp" with lots of challenges for management.

3.2 Boundary Management in Practice

When working from home employees gain flexibility, but common spatial and temporal markers, so called boundaries, cease to exist. Boundaries are the socially constructed lines of demarcation that define a role (e. g. 'employee') as well as the times and places where the role is performed (e. g. 'in an office') [2].

When working mostly or completely remotely (as it was the case during the pandemic), individuals are confronted with blurring boundaries. In a situation with no defined workplaces, flexible working hours and the increasing spread of boundary-dissolving communication and collaboration tools, the gains of increased autonomy go along with increased pressure for integration, and work intensification [1, 50, 51, 64]. Thus, individuals have to manage their boundaries, i. e. they need to consider, establish and work with new social, spatial and temporal boundaries [25].

Studies have discussed the increasingly blurred boundaries between the public and private spheres of our everyday life [33] and the so-called "constant connectivity" [13] before COVID-19. Due to the lockdowns, the line between private and work became thinner for many individuals who were not able to differentiate anymore between calls with the customers and family obligations like checking on kids' homeschooling [53]. Individuals have coped in many different ways with the increased level of working from home – which came with consequences for wellbeing and productivity.

To give an insight how this pans out in every-day remote work, we present highlights of a recent study on boundary management. The study is based on screening/questionnaire with 23 participants (13 female/10 male, age M = 33 (SD = 3,73)) and 9 semi-structured interviews (4 female/5 male, age M = 34 (SD = 2,61). Results showed that boundary management is different for every person. Subjective perceptions of demands originating from work, family and other life domains define the perceived boundary management and boundary tactics of individuals. Inductive and deductive analysis of internal and external factors impacting boundary management of knowledge worker working from home revealed two themes: (i) Prevalence of boundary management types and boundary tactics and (ii) organizational influences on boundary management when working from home. Not surprisingly, there was a higher number of integrators who work two or more days from home. Nevertheless, it was exclusively segmenters who work at home for at least one day (50 % have kids). A closer look at the data sets revealed that all of these respondents have children.

The segmenters' arguments ranged from a fundamental separation of work and life, as otherwise both domains would be neglected, to the reference to the natural separation because of the family, to the emphasis on the time needed to switch off. The integrators most often mentioned the advantage of more flexibility through integration. Accordingly, the integrating and segmenting tactics were each classified according to the four specific boundary tactics: communicative, physical, temporal and behavioral.

Surprisingly, all of the physical boundary tactics reported had a segmenting background. Temporal boundary tactics regard time as a strategic instrument for connecting or separating domains. One integrating practice mentioned was taking advantage of the flexibility in the different domains, for example, by working less on one day to give priority to private matters. Nevertheless, it was important for the employee to use compensatory periods for private matters. Behaviour-based boundary tactics received by far the most frequent mentions.

Only a small minority stated that they avoid sending emails on private devices to avoid such delimitations. Nevertheless, the case of answering work-related messages when sick or on vacation had already occurred among this minority as well.

Nevertheless, limitations of these integrating tactics were also used, such as separate mail accounts for private and work-related mails or the targeted retrieval of mails on the smartphone. But employees, meanwhile, admitted to not consistently following through with these approaches. The goal of all participants was the harmony of private and professional life. This raises an important question: how can CSCW research and practice support boundary management for both, integraters and segmenters, in order for these users to successfully balance private and professional life?

3.3 Current University Innovation & Transformation

"Who led the digital transformation in your organization? Your CEO, your CIO or COVID-19?" – is already a famous joke in the current time of the pandemics. Almost all types of organizations world-wide experienced major digital transformations of their cooperative work: routinized and ad-hoc cooperation both changed substantially. In this vignette we will look at two very concrete mini-cases of digitally driven university innovation and transformation: the case of Friedrich-Alexander University Erlangen-Nuremberg (FAU)[3] as an example of a large public European Research University in Germany and the case of the European University EELISA[4] as an example of a successful and highly dynamic university alliance as part of the European Universities Initiative of the EU.[5]

FAU is seen as innovation leader among the universities in Germany (#1) and Europe (#2).[6] Founded in 1743, it also has strong historic roots, covers the full disciplinary spectrum, and is famous for its research strengths and patent portfolio in engineering and computer science. Research in the digital domain has been strong since the early days of digitization. University processes, administrative routines and committee schedules, however, have been typical for a large public university before the start of the pandemic. A lot has changed since: meetings of the president's core team that used to happen in long weekly face-to-face meetings have changed to short daily online team updates, meetings of the broader leadership team including all deans of FAU's faculties and schools changed from bi-weekly or monthly face-to-face meetings to online meetings on a weekly basis complemented by short ad-hoc meetings as needed. This change happened as early as March 2020, driven by the sheer need to act quickly and protect the FAU community. However, what started as a

3 www.fau.eu

4 www.eelisa.eu

5 https://ec.europa.eu/education/education-in-the-eu/european-education-area/european-universities-initiative_en

6 Reuters (2019): https://graphics.reuters.com/EUROPE-UNIVERSITY-INNOVATION/010091N02HR/index.html

reaction, developed into highly flexible modes of coordination and cooperation within a traditional university setting. What is known as agile work and scrum type meetings in industry has proven highly fruitful to transform a university that already had a track record as innovation leader but did not have equally innovative work practices in the university leadership and coordination. In this case, the answer to the question "Who led this digital transformation?" is clear: COVID-19 has been the trigger, the CIO the enabler, the president the driver who took responsibility and acted as a role model for the FAU community that ultimately made the transformation happen. For sure, what we have seen so far is just a first step towards a new normal of "computer-supported cooperative work" across the broad range of university activities and processes. The journey will continue, and each step can profit from the early learnings and evidence from CSCW research.

The second mini case covers the "digital transformation" of the ambitions of the European University EELISA. EELISA is the European Engineering Innovation & Science Alliance – an alliance of nine innovation-oriented universities across Europe covering partners in Madrid, Paris, Pisa, Erlangen-Nuremberg, Budapest, Bukarest and Istanbul. On the 9th of July 2020 the consortium proposal EELISA was accepted and announced by the EU as European University. The proposal that has been developed before the pandemic put a strong focus on reaching the ambitious goals of innovation, engineering, science and sustainability by connecting the different stakeholder groups of all partner universities by means of mutual visits, exchanges, meetings and quality time jointly spent to develop the innovations needed. On the day of the announcement of the European University EELISA all partners had already spent four months in video conferences, digital collaborations, online teaching and learning, platform-based research or distributed innovation and entrepreneurship initiatives. Thus, from day one, the new European University started as a virtual innovation alliance. Equally the cooperation and coordination across the different European University alliances started in online meetings with high degrees of participation due to easy and equal access, seamless collaboration and impressive engagement of all partners involved. Also in this case, the answer to the question "Who led this digital transformation?" is clear: COVID-19 has been the trigger, the ubiquitous availability of simple online tools for synchronous and asynchronous the enabler. Only where strong leadership as a driver also supported the adoption of new forms of work more dynamic and flexible forms of cooperation and collaboration were successfully implemented. For sure, what we have seen so far is again just a first step towards a new normal of "computer-supported cooperative work" in and between universities. The journey will continue. Now, the next challenges will be to implement powerful platform-based cross-university communities, to find the right balance of synchronous and asynchronous collaboration as well as wise decisions about where "same place" matters and where "different place" might not only be a possibility, but a powerful feature. The overarching question that fascinates all partners and stakeholder groups is about the right look and feel of an attractive distributed European University Campus. Solving this CSCW puzzle and providing a "one campus" feeling will prove fruitful for all research and education institutions that span across time, place and space.

4 What We Should Remember

In the previous sections we have presented results from research in the context of CSCW and findings of what has happened in the "large-scale CSCW experiments" during the massive move to working from home in the pandemic during the last 18 months.

In this section we will extract learnings from the cases presented in the previous section – and relate these learnings to the CSCW concepts presented before.

The first thing that can be seen is, that the research results in CSCW have not been used a lot to address the challenges of getting collaborative work done during the pandemic. The results (especially academic papers – but also publications for practitioners) have been used like operation manual: they have not been read, but one started experimenting with the collaboration tools on the market, failed and iterated until it worked more or less.

Luckily, the collaboration tools on the market already contain a lot of the wisdom, CSCW has discovered in the past decades. For instance, there are synchronous group editors like Google Docs or Etherpad that build on the Grove algorithm, and there are very potent enterprise social networking platforms like IBM Connections or Confluence that implement a lot of awareness features and coordination mechanisms. So, most of the technological learnings from CSCW are regarded by selecting well designed tools. But what about learnings about introduction and appropriation? It clearly would have been beneficial for some developments to focus on benefit and on usage in the documentation from the beginning.

What we should ask ourselves as researchers is which research results are useful for which audience. While ethnographic studies and design case studies are impor-

tant to base research upon, their results are not useful for practitioners in itself. We also still do not know organizational behavior well enough, to design from theory. But our knowledge can and should inform design, introduction and appropriation.

Another learning from looking into the developments is that supporting remote collaboration was mainly about digital transformation and (designing or evolving processes and practices) – and not so much about selecting the best tool. However, CSCW did not provide clear advice here (nor did it in selecting tools).

What also has been learned in the deployment is, that the tools made available from CSCW work should be self-explanatory – both in its handling (how to achieve what in the tool) and its usage (how to use the tool and its features to support work practices). Particularly in the latter, there is still a lot to do. Regarding support for practices, the tools should lead and provide examples – but at the same time support different practices.

What we also could and should remember are the challenges in implementing and introducing collaboration support, first collected by Grudin in 1994 [29] and presented in the CSCW overview 20 years ago [58]:

1. disparity between costs and benefits when using the CSCW system, i. e., who gains an advantage and for whom the effort is increased.
2. need for a critical mass of users for a CSCW system to be useful.
3. violation of social taboos and threat to organizational structures.
4. handling of exceptions.
5. complexity of the user interface due to the integration of CSCW functionality in addition to application-oriented functionality.
6. difficulty in evaluating and analyzing CSCW systems.
7. lack of experience in designing multi-user applications.
8. difficulty in introducing CSCW systems into organizations.

All these issues all are still valid. As Grudin himself stated in an interview [36] this does not mean that we have not made any progress in CSCW, but we have broadened the application area.

Looking at the experiences from implementing collaboration support during the pandemic, one recommendation for how to implement collaboration support routed both in theory and practical experiences is:

– Look at benefit for users (both in selecting and explaining/documenting)
– Look at whole work system – and not single tasks only

Even when lessons learned about the importance of awareness and the working of the Dix and Misch models of indirect communication and communication of context are implemented in some collaboration tools as written before, one could see a disregarding of these findings in practice. When tools are used, these features are regarded as non-essential – and what we found even more intriguing, when tool usage is analyzed as in some of the studies presented in Section 3.1, indirect communication is not regarded at all. Statements like that home office workers communicate significantly less only focus on direct communication – which is misleading. So, there is still a need for better communicating the models provided by CSCW research – both for designing and for analyzing solutions.

5 Conclusion – What Is Next?

In the paper we looked at learnings from CSCW research and at learnings from the (large-scale) application of CSCW tools during the pandemic.

What can be seen is that due to the massive need for remote collaboration during the pandemic several technical barriers have been removed – it now is possible to collaborate remotely – even across boundaries of organizations – across all kinds of technical and organizational firewalls. The tools and infrastructures for supporting remote collaboration have shown some flaws, but basically worked.

However, some companies managed to benefit from the possibilities to collaborate remotely – others did not.

One reason for this is in the nature of sociotechnical systems. It just is not only about providing technology, but about respecting and designing practices and processes. And there was little guidance in how to do this – how to use the tools for successfully collaborating.

CSCW has traditionally studied interdependencies among collaborating human actors and computer systems. New CSCW systems like Shared Workspace Systems or (Enterprise) Social Networks enable completely new divisions of labor between collaborating actors and computer systems in an organizational setting. Particular examples are crowdsourcing, open innovation or the inclusion of external experts in internal processes. This has important implications for organizational structures, management and motivation.

In our opinion CSCW research in the future should more concentrate on what can be enabled with the collaboration tools. Documenting this from case studies in short lessons and advice – and benefit oriented case studies could really be helpful for practitioners.

What CSCW guidebooks could and should do is to give people ideas/imagination of what could be done and how it can be done. Then CSCW could be helpful in cases where quickly something has to be changed (like during the pandemic) but also in "normal operation mode".

All this can be summarized nicely in one brief statement: **Digitization is implemented with far too little imagination and far too little consideration for the user and practices**. This should be worked on in CSCW.

Funding: We acknowledge financial support by Universität der Bundeswehr München.

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