From The Matrix to a Model of Coordinated Action (MoCA): A Conceptual Framework of and for CSCW

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ABSTRACT
The CSCW community is reliant upon technology-centric models of groupware and collaboration that frame how we examine and design for cooperative work. This paper both reviews the CSCW literature to examine existing models of collaborative work and proposes a new, expanded conceptual model: the Model of Coordinated Action (MoCA). MoCA is a broader framework for describing complex collaborative situations and environments including, but not limited to, collaborations that have diverse, high-turnover memberships or emerging practices. We introduce MoCA's seven dimensions of coordinative action and illustrate their connection to past and current CSCW research. Finally, we discuss some ramifications of MoCA for our understanding of CSCW as a sociotechnical design space.

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CSCW; Conceptual Frameworks; Theory

ACM Classification Keywords
H.5.3 [Group and Organization Interfaces]: CSCW

General Terms
Theory

INTRODUCTION
What is the phenomenon of study in CSCW? As computerized technologies and the practices they support continue to grow in diversity, ubiquity, complexity, and scale, the number and type of research topics related to the study of collaborative systems have simultaneously continued to proliferate within CSCW and the larger umbrella of HCI. It has become increasingly urgent to find ways to describe the problem space in which CSCW researchers work. Focusing on name changes for our field is to inspect bandages without attending to the wound itself. A conceptual grounding—e.g. theoretical framework—is needed to help us define and describe what it is that the field of CSCW actually studies. In order to further discussions in our field, this article first reviews models of CSCW and then turns to positing a new conceptual model, the Model of Coordinated Action (MoCA).

Technology-centric models of groupware and CSCW have influenced and continue to influence how we think about cooperative work. Existing frameworks continue to be useful, yet we need a larger conceptual model that allows us to be explicit so that when we are modeling work we might hold these models up for inspection, rather than letting our models of work linger in the shadows, designed for but unarticulated. When we design systems to support collaboration, we are modeling sociality. Popular conceptual frameworks for explaining what it means to design for collaboration, or icons like the time-space matrix that models teams, have a bias towards individuals and small groups. These frameworks thus ensure that we have a model for only a very small subset of sociality.

Instead of trying to map an infinite variety of types of work on to a relatively smaller number of technologies that are rapidly changing and proliferating—we instead propose mapping technologies on to a more comprehensive model of work, such as the one proposed here. Doing so is sensible for understanding whole "ecosystems" of technologies that may be used in concert, whether or not they were designed at the outset to be used together. Sociotechnical coordinated actions may require the combined use of mundane technologies such as MS Excel and Access in conjunction with bespoke business process-specific applications [21].

A new conceptual model is needed that can help us to understand CSCW as a *comprehensive and coherent* design field that is neither overly constrained by an allegiance to "work" per se, nor is so open that any description of any computational technology used by two or more people is considered relevant. The theoretical development of our field has struggled to keep up with the rapidly increasing diversity of sociotechnical configurations, therefore landing us in an exciting era of research, but also one in dire need of conceptual grounding.

Below we present an overview of existing models of collaborative work within CSCW that are helpful for understanding how the field historically frames its design space. These technology-centric models of groupware and CSCW continue to influence how we think about cooperative work. We next present our elaborated model of collaborative work, the Model of Coordinated Action (MoCA). MoCA is our attempt to better map the larger design space that reflects today's CSCW challenges of supporting not only small, homogeneous groups, but also larger, heterogeneous groups coming from different communities of practice [56]. We then apply MoCA to two examples from the CSCW literature to illustrate the potential our model affords the community. Finally, we discuss directions for further development of the theoretical bases for the design space around collaborative work.

BACKGROUND

The call for a broader conceptualization of the design of systems for collaborative work is far from new. In 1992, Schmidt and Bannon [46] had already pointed to the need to expand the scope of research to settings that are unstable, large, open, and diverse. They state:

> *Also, we do not want to restrict the scope of CSCW to those special settings where the responsibility of accomplishing a task has been allocated to or assumed by a relatively closed and stable collective. The concepts of 'group' and 'group work', however, invariably connote special types of cooperative relations characterized by shared responsibilities. This conceptualization of CSCW will tend to ignore or even dismiss the major challenges posed by the design of systems that support cooperative work arrangements that are characterized by a large and maybe indeterminate number of participants, incommensurate conceptualizations, incompatible strategies, conflicting goals and motives, etc. (p.17)*

While European CSCW has, overall, had a more organizational bent, including more investigations of heterogeneous organizations [19,20,45], the field of CSCW in the United States, has emphasized to a greater degree developing technologies to support relatively homogeneous, small groups [19]. The historical bias in the US towards the study of small, homogeneous groups has contributed to a lack of necessary theories of the larger, "woolier" collaborations to which Schmidt and Bannon [46] refer. Despite progress internationally, the theoretical foundation of CSCW has been "patchy and incoherent" [49]. Here we posit a conceptual framework that is by, for, and of CSCW research—a theory native to CSCW and HCI.

The growth of studies of "new" social media and large-scale and long-term infrastructures are putting pressure on extant models of collaborative work in CSCW. Social media is increasingly used for organizing [1,52], bringing US CSCW research back to the table of organizational work. It should be noted here that throughout this work we are referring to models of CSCW that are either used or posited as being comprehensive models of the field. There are myriad fine models on various subtopics of the field that we do not elaborate on here, for example the work of Olson et al. [40] on the five factors that contribute to the success of a collaboratory (computer-mediated science, usually at a distance): the nature of the work, common ground, collaboration, readiness, management, and technical readiness; and the work of Chudoba et al. [8] modeling distance workers, "virtual teams", collaborating through computer-mediated communication and facing the "discontinuities" of team distribution, workplace mobility, and variety of workplaces.

MODELS OF CSCW

In this paper when we discuss "models" of CSCW we refer to conceptual models that posit the elements that compose Computer Supported Cooperative Work. The models we have had of CSCW thus far have been largely descriptive and the model proposed below is not yet different.

Historically groupware-ware centric models, of which there is much work in HCI, are still held up by the larger HCI community as the typical way to model collaborative technologies. The field of CSCW formally began in 1984 and initially focused on developing software to support the work of small groups [19]. The HCI community has long used taxonomies of cooperative systems to better understand how to design for people working together. Grudin posits one such conceptual model, see Figure 1, where each ring shows the link between "*one focus of computer systems development and the principal customer or user of the resulting technology*" [19, p.20]. The outermost ring (Organization) is described as emerging originally as the research province primarily of Information Studies while the innermost ring (Individual) emerged soon after as the focus of HCI research. The diagram notes CSCW's emphasis on the "Small group" level with occasional efforts at the "Project" level noted.

At the same time, Grudin acknowledged that CSCW as a field need not restrict itself to the level of small groups and the associated groupware, but that it draws from more than one ring of his model: "*People study, for example, the use, in group and organizational settings, of applications developed for individual users: the ways in which software, developed to support groups, affects individuals and is adapted to different organizational contexts: and systems developed to support organizational goals as they act through individuals, groups, and projects" [19, p.21].* CSCW was posited as "residing" at the small group level but also venturing to other levels. Our point here is not to dwell on the fact that development and technology have changed over the past 20 years, nor on the fact that CSCW is no longer limited to groupware, rather our point here is to *draw attention to the ways in which we think about collaboration and collaborative technology*.

Our conceptual frameworks for what it means to design collaborative technologies have changed remarkably little since Grudin's discussion in 1994. The HCI community has long used taxonomies of cooperative systems, such as Johansen's [24] matrix, to better understand how to design for people working together.

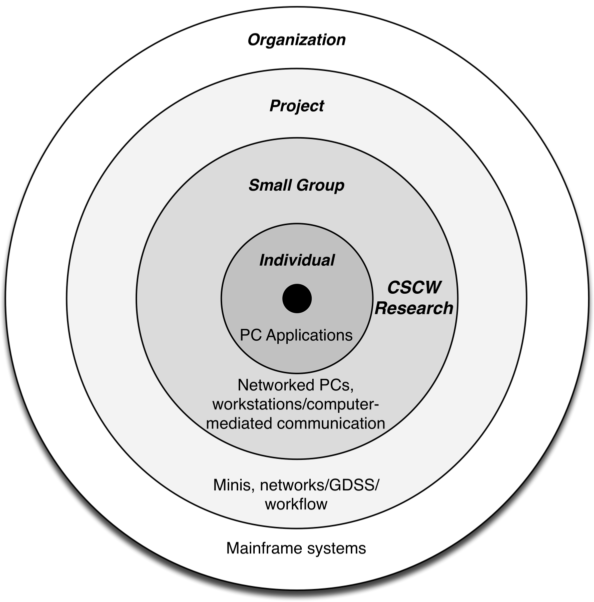

Figure 1. A recreation of Grudin's (1994) model for the design space of CSCW with the technological systems and associated principal customers or users in each ring. For simplicity we do not list the software development and research areas included on the original, although we do note the indication of CSCW research on the Small Group ring.

Johansen's taxonomy of groupware tools [24] is such a storied, long-standing element of HCI research that it is a requisite part of the education of anyone stepping foot into the HCI community attempting to support groups, and certainly for the CSCW community whose historical core has been in the research and design of groupware tools. Johansen's matrix may even be considered an icon within CSCW: "*This matrix has become a common language amongst the CSCW community*" [12, p.692].

Latour [26] makes a distinction between future science where what is known is still being debated (for example in recent publications) and established science which is taught as factual and known in textbooks. In the field of HCI, textbooks continue to discuss Johansen's matrix, itself derived from an earlier typology of group support systems [11], as a known fact. Shneiderman et al. [50] cites Ellis [14] in a brief discussion of Johansen's matrix, describing the matrix as the "*the traditional way to decompose cooperative systems.*" Johansen's matrix is not merely a way to decompose cooperative systems but is "the" way. Dix et al. [12] discusses Johansen's matrix in terms of systems to support groups and states that while groupware can be classified by function (e.g. meeting support or group authoring), the matrix is considered "*a very useful shorthand to refer to the particular circumstances a groupware system aims to address.*"

Below we see the original Matrix from p. 44 of [24], Figure 2. We see the familiar axis of time, which is broken down in to synchronous and asynchronous and also the axis of place (unlabeled but described in the text), which is broken down into co-located and remote meetings). We also see the familiar dichotomy between. However, we also see something quite interesting: the other axis concerning place is labeled face-to-face vs. electronic *meetings*. Closer inspection of the book's chapter reveals that this table is part of an extended discussion focused quite clearly and explicitly on, and only on, supporting team meetings.

	Time	
	Synchronous	*Asynchronous*
Face-to-face meetings	1. Facilitation services 2. Decision support 8. Beyond white board 17. Nonhuman participants	4. Presentation software 5. Project management 14. Memory management 16. Comprehensive support
Electronic meetings	3. Telephone extension 9. Screen sharing 12. Teleconference aid 15. Spontaneous interaction	6. Calendaring 7. Group writing 10. Computer conferencing 11. Text filtering 13. Conversation structuring

Figure 2. Johansen's (1988) time-space matrix.

Furthermore, Johansen presents an adjacent table contrasting small group work versus large group work (Table 3 on p.43 in [24]). While he does not explicitly theorize the small group/large group division, the table is presented as no more or less important than the divisions presented in the time vs. location matrix. The matrix was originally created to understand only electronic meetings and was also originally presented along with another typology that presented small vs. large group work as conceptually and practically distinct. The textbook discussions of CSCW only present the electronic meeting matrix and do not present Johansen's adjacent table contrasting small vs. large group work [12,50]. In other words, *the matrix has been taken out of context and half of Johansen's conceptual model—which includes large group work—has been ignored.*

HCI researchers have extended the electronic meeting portion of Johansen's model in the intervening years since 1988. However, the extensions have largely been focused on issues surrounding the dichotomous division of synchronous vs. asynchronous. Dix et al. [12] critique and extend the matrix by pointing out that the distinction between synchronous and asynchronous work is overly simplistic. For example work can be *concurrent synchronized* (e.g. videoconferences), *serial* (e.g. argumentation tools), *mixed* (able to be synchronized or serial for example through locking), or *unsynchronized* (e.g. email). Grudin's [19] iteration of Johansen's matrix divides place into same place, predictable different place, and unpredictable different place vs. same time, predictable different time, and unpredictable different time (p.25). Despite the many useful iterations of Johansen's matrix [2,3,19,20], this conceptual model does not and was not designed to be able to grapple with the variety and complexity of the systems that we are attempting to design today nor the great variety in the types of work in contemporary societies. Are the elements of place and time really all that are salient in the composition of cooperative work systems? Previous work suggests no [14,24], and yet also continues to only incrementally build on the Matrix [2,19].

The notion of groupware as an organizing concept for collaborative systems is further problematized by Andriessen [2] in his own iteration of the matrix. Andriessen notes that although the matrix suggests a sharp distinction between systems, many advanced systems are "*sets of more or less integrated modules and functionalities, that can be tailored to specific usage,*" or in other words, he highlights that actual work often requires the use of many applications together.

When discussing the Johansen taxonomy, we often consider it to be a taxonomy of tools, but the Johansen taxonomy is also a framework that implicitly describes work itself. In the matrix, the salient elements of work are considered to be whether or not it is asynchronous or synchronous and whether or not it is local vs. distributed (alternately described as same place vs. different place). While it seems specious to suggest that many actual CSCW researchers today consider the matrix to be representative of our understanding of work and of technologies that help people to work together, the model is considered, as noted above, to be not only part of a common lexicon but also as a traditional way to decompose cooperative systems (i.e. break them into their constituent parts).

Finally, while not a model of CSCW per se, in the field of Human Factors and Ergonomics, Patel et al. [41] posit the CoSpaces Collaborative Working Model (CCWM) of collaboration that lists "various factors that make up or influence collaboration at work." This framework is a useful tool for providing guidance to systems developers structuring iterative development, evaluation, and implementation and is therefore relevant to CSCW. However, despite a purported dual focus on both factors that "make up" or influence collaboration, the model focuses on factors that *influence* collaboration and on collaborative engineering in particular. The CCWM model does not take on the task of defining collaboration itself.

For the field of CSCW, which is increasingly grappling with a proliferation of types of collaboration including non-engineering work and even non-work, a nuanced model of collaboration itself is important. In CSCW, we not only lack models to put in our textbooks, but we also lack a contemporary, comprehensive model for decomposing cooperative systems in their great variety.

ARTICULATION WORK AND THE EDGES OF CSCW

The model we introduce later builds on some existing comprehensive models of CSCW and collaborative technologies. However, as we discuss in this section, there are some "edge cases" which are cases of collaboration that are not technically "collaborative" yet are now falling within the purview of current research in our field. Here we discuss notions of articulation work and non-routine work in order to show how the field is changing and is now embracing types of activities that might not traditionally be considered cooperative or collaborative.

While the models of Johansen's matrix and later iterations implicitly model fairly constrained types of collaborative work, additional work in Sociology and CSCW has grappled with more complex forms of collaboration and organization through the concept of articulation work as posited by Strauss [54] in Sociology, and later built upon on by Schmidt and Simone [48] and Gerson [18]. Articulation work is about making sure all the various resources needed to accomplish something are in place and functioning where and when they're needed in the local situation [54]. Key concepts worth interrogating here are the spectra posited by Strauss of collaborative work projects falling on a continuum from simple to complex and also the notion of the "common field of work."

Articulation work is implicitly reliant upon the notion of the *common field of work* that Schmidt and Simone [48] posit. Schmidt and Simone note that the common field of work is the site of action for coordinative work:

> *constituted by the interdependence of multiple actors who, in their individual activities, in changing the state of their individual field of work, also change the state of the field of work of others and who thus interact through changing the state of a common field of work.* [48, p.158]

Interaction *through* a common field of work is considered a fundamental distinction of cooperative work. Articulation work as a result is necessary to help to restrain the distributed nature of the "complexly interdependent activities" that are taking place. Schmidt and Simone also note that cooperative work and articulation work are recursively related, leading to re-arrangements of the work at hand before further articulation work and so on.

Later work by Gerson [18] takes on much more diffuse, networked types of collaborations where he coins the term "metawork" to discuss the subset of Strauss's articulation work conceptualization that consists of aligning tasks and subprojects. The notion of metawork accounts for non-local arrangements of different "kinds of activity" that may be larger and more abstract. Despite these differences, both metawork and local articulation focus on modifying a "common field of work."

Might there be room for less direct interdependence where the relationship between the person and the common field of work is slightly more distant? To take a mundane example: a Person who drops off canned food at a shopping mall that will later be taken to a food bank. The common field of work is the food bank where people in need come to pick up food. But the Person is only interacting directly with the shopping mall. The reader might object here that the common field of work is actually at the shopping mall where the food is exchanged, but then a conceptual gap arises between the shopping mall and the actual, situated, goal-centered work whose state the actors want changed. This is not so different from what Friedman et al. [16] argued when they noted that system stakeholders are not just those who have their hands on a system. And in fact, Schmidt and Simone [48] foreshadow this when they note that one person's work is another person's articulation work.

The point here is not to argue that a common field of work is no longer important for CSCW—to the contrary—rather we are simply arguing for greater recognition that for complex endeavors there may be more distance between relevant participants and the "common field of work" than in simpler endeavors. There may be multiple overlapping common fields of work; people may be working in a concerted and coordinated fashion and yet might have slightly different, but compatible, goals.

Strauss' Work Spectra: The Need for More Detail

In his discussion of articulation work, Strauss introduces spectra from routine to non-routine work and from simple to complex [54]. The contention that projects range from simple to complex and from routine to non-routine still holds, however, as we will discuss below, there are many ways in which a collaboration can be simple or complex, or new or old. For example, a project can be complex because it is has many people, or involves many communities of practice, or has no communities of practice. A project can also be complex because there is a high turnover of participants, or because it is highly physically distributed, or is highly asynchronous, or because of the extremes of being temporary, or of being very long term.

Any of these things could make a collaboration more complex. Similarly for the notion of routine, elements of a collaboration can be routine while other elements may stay the same. For example a team may be stable, but their artifacts (e.g. tools or systems) may be changing rapidly, or the type of problem being solved may be routine, but an organization may have become geographically distributed requiring new collaboration practices. The question then becomes not only whether a project is simple or complex, and not only whether a collaboration is routine or non-routine, but how is it simple or complex? How is it routine or non-routine? In what ways?

It should be noted that even supposedly routine work must confront unexpected change from time to time either from within the collaboration [22,33] (e.g. a key team member gets sick) or without (e.g. organizational restructuring or economic pressures). To some extent, then, all work is developing, progressing, materializing. While this is the case, there is still a range from more established to more emergent, or developing, collaborations.

In order to sufficiently understand collaborative technology, we need a more sophisticated understanding of collaborative work itself and to develop models that are in line with the variety and complexity of the systems that we are designing and using today. However, as the "groups" supported by HCI research grow increasingly large, diverse and distributed, so does our focus. We have expanded our conceptualization of collaborative technologies to not just tools, but whole systems or aggregates of tools and systems, which exist outside of currently employed taxonomies. In the following section we examine well-known dimensions of models of collaborative work in greater detail while also positing additional lesser-known dimensions relevant in today's research, development, and practice landscape.

MODEL OF COORDINATED ACTION (MOCA)

In this section we introduce the Model of Coordinated Action (MoCA). The conceptual models of CSCW discussed above have been largely descriptive, as mentioned earlier, and the model that we propose here is currently descriptive as well. However, with additional investigation, MOCA could be further developed to document even more fully the relationship between the dimensions of the model.

As per the previous section about the need for room for less direct interdependence between the person and the common field of work, we call our new model a model of "coordinated action" rather than one of "collaborative work." We chose the word "action" to emphasize the importance of goal-directedness implied by the word "work" while also being inclusive of goal-directed action that may not traditionally be considered work (e.g. serious leisure [53] or relationship work [55]).

MoCA shows us that there are many ways for coordinated action to be diffuse (well beyond physical distribution and asynchronous work) and this requires us to broaden our notions of interdependence that require individuals to interact through changing a common field of work. Rather we posit that individuals may have a shared goal (even if in name only) and that while interdependence remains key, individuals may actually be working to support others in changing a field of work. Therefore we suggest a slight change to the wording but a marked change in perspective. We suggest that coordinated action is the core of our modern field of CSCW and that it is constituted by the interdependence of two or more actors who, in their individual activities, are *working towards a particular goal through one or more overlapping fields of action*.

What this shift does is make room in how we conceptualize CSCW for action that supports, feeds into, and is necessary for accomplishing goal-directed actions—but may not be taking place through a common field of work itself. In other words, tying ourselves to conservative notions of what "common" means in the notion of a "common field of work" actually prevents us from studying a whole variety of collaborative and organizational forms where interests and tasks might be aligned only partially (e.g., slightly, temporarily, hastily, or even poorly). Rather than this being considered a problem, we might consider this to be a rather normal state for endeavors that are at all complex.

MoCA consists of seven dimensions of coordinated action. While the time-space matrix implies a binary division between local and distributed and synchronous vs. asynchronous, in our model we describe each of these "dimensions" as falling on a continuum. Again, we are describing actual collaborative work arrangements in all their great variety, as opposed to collaborative technologies per se. This new conceptual mapping of types of collaborative work enables a fuller representation of the design space for collaborative systems. By focusing this model on collaboration per se, we open up more room to investigate how multiple technologies can be mapped to a single collaborative action—a sociotechnical aggregation of actors and technologies. The figure below, Figure 3, demonstrates one way of depicting a full range of coordinated action.

We introduce below all seven dimensions and illustrate their connections to CSCW literature. The characteristics of each these seven dimensions have already been described in some way in the CSCW literature, MoCA provides a way to tie together these many "loose threads." More specifically, the model provides conceptual parity to dimensions of coordinated action that are particularly salient for mapping profoundly socially dispersed and frequently changing coordinated actions. As discussed in the previous section, the first two dimensions represent concerns that are well acknowledged within HCI and are captured by Johansen's matrix as well as any number of iterations of that matrix. Therefore we spend less time discussing these two dimensions. Building off of our community's decades of work and elaborating further upon these dimensions as part of our model, we are not suggesting dismissing the traditional model itself, rather we are setting up the traditional model to be incorporated into a larger, more elaborated model.

Dimension One: Synchronicity

The first dimension, taken from Johansen's original matrix about electronic meetings, is one of the two "typical concerns" or considerations [47] within extant CSCW models. Here it is slightly renamed as *synchronicity*. To iterate for the sake of setting up a parallel discussion for the third through seventh dimensions to be introduced later: the first dimension of *synchronicity* concerns a continuum of coordinated action ranging from being conducted synchronously, or at the same time, to asynchronously, or at different times. In deference to earlier work [12], the continuum of this dimension allows for coordinated actions to be a mix of asynchronous and synchronous. We do, however, give up some of the nuance of all the historical discussions [19,20] in that this dimension does not account for predictability of time. However, appreciation for predictability, or lack thereof, is implied in dimensions described later.

Dimension Two: Physical Distribution

The second dimension, also taken from Johansen's original matrix, is *physical distribution*: a continuum which concerns whether coordinated actions are taking place in the same geographic location at one end of the continuum or at completely different geographic locations at the other end. As this dimension is on a continuum, a collaborative undertaking can be more or less synchronous or physically distributed, including being mixed as per Dix et al. [12]. As with synchronicity, this dimension does not account for predictably of place. However, appreciation for predictability, or lack thereof, is implied in dimensions described later. Finally, as Olson and Olson [39] note, "*Collaborative work at a distance will be difficult to do for a long time, if not forever,*" and furthermore distance will continue to matter; the nature of some kinds of work (e.g., tight vs. loose coupling) are affected by distance even despite technological advances.

Dimension Three: Scale

The third dimension is *scale*, or the number of participants involved in the collaboration. The dimension of scale is often an afterthought in the discussions on synchronicity and physical distribution. On the other hand, large scale is often taken as a given for studies of infrastructure or social media. Coordination theory tells us that when "*multiple actors pursue goals together, they have to do things to organize themselves that a single actor pursuing the same goals would not have to do*" [34, p. 5]. Even when technologies are modular and easily extensible, an increase in participants requires more complicated social arrangements and new practices. In large-scale collaborations it has been found that mechanisms for coordination need to scale dramatically to adequately support large-scale distributed work [9]. In other words, scale matters.

Dimension Four: Number of Communities of Practice

The fourth dimension is *Number of Communities of Practice (NCoP)*. The Communities of Practice framework is itself a complex multidimensional theory; for this dimension we focus specifically on the *number* of communities of practice *represented* in the coordinated action.

Wenger's Community of Practice framework, built on the notion of legitimate peripheral participation [27], is a theory of learning whereby newcomers are exposed to experienced members of a community. Over time, newcomers learn and adopt the values, norms, practices, and artifacts (e.g. tools) of an expert community. A community of practice, however, takes time to form. Individuals must have repeated and enduring exposure to each other to form a community and to teach and learn from each other. Notions of teams and groups tend to assume the existence of a community of practice. Recent research in HCI, however, has increasingly explored collaboration where communities of practice are far less developed and where the notion of "community" (already a stretch beyond the idea of a team) becomes increasingly hard to pinpoint. The CoP framework is useful for understanding learning and socialization to a given social world but oftentimes in our field we must investigate coordinated actions where multiple communities of practice are *represented* by individuals, groups, or networks and where a social group may yet need to be created. Having briefly described CoP, we note that the dimension here is not meant to capture the whole, complex theory of socialization but merely the number of CoP.

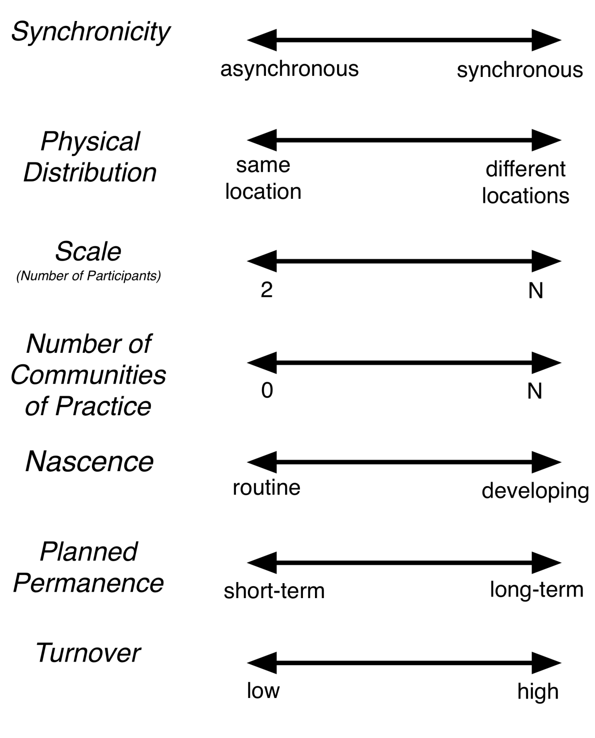

Figure 3. The Model of Coordinated Action (MoCA) and its seven dimensions with the end points of each continuum.

One way to look at the dimension of NCoP is through the lens of interdisciplinarity. When collaborators come together to work from different disciplines—science, design, or another background—there is a lot of thrash. There is confusion about roles, about how and why artifacts and tools have been created and should be used, and there is confusion about terminology [28,57]. In other words, there is not a lot of group cohesion. It is a team or community-in-the forming that is trying to develop practices, artifacts, and nomenclature. This mish mash of background, perspectives, artifacts, and tools is a natural occurrence when trying to foment creativity and innovation by putting together a diversity of skills and perspectives.

The dimension of NCoP then pertains to a type of cultural diversity including diversity in norms, practices, tools, and language. Towards one end of the dimension are small, homogeneous teams comprised of people with similar backgrounds and training. However, there is a more extreme possibility: in theory, it should be possible for people to come together who belong to no relevant community of practice. Examples of this include children with no previous experience trying to form a theater group, or novice adults trying to accomplish something in which none of them have significant relevant experience—e.g. building a deck together when none has such experience, in which case no CoP are involved. We expect that this case of 0 might be relatively rare, however.

A more common scenario would be a very culturally diverse team, and we indeed pass that waypoint as we travel to the endpoint of the continuum, but in fact if we go to the far end of the dimension we find diversity bounded only by the vast mélange of people who have access to computational systems and the Internet. At a very high N, we may see a scenario we have seen in studies of smaller collaborations of design teams [28,57], where there are several people involved, and while the coordinated action itself is still forming its own community of practice, the individuals involved bring the expectations, norms, and practices of their own relevant community of practice very much to bear on the work of the coordinated action.

Also, individual project members may belong to existing communities of practice and have access to those practices. A newly formed, very small team comprising four team members from different disciplines, for example, can be said to have an NCoP of 4. In these two latter cases the coordinated action cannot truly be considered to be 0 on the dimension of communities of practice.

Dimension Five: Nascence

The fifth dimension of MoCA is *nascence*, which discusses un-established (e.g. new) versus established (e.g. old) coordinated actions. Nascence, it should be noted is not merely a simple synonym for "newness" rather it implies a "coming in to being"—a special kind of instability rife with future potentialities. Thus we might see nascence in a reformed and rebooted coordinated action. Rather than posit one end of the spectrum as simply the opposite of routine, we describe it as developing. It is well understood that even routine work has developing characteristics. As previously mentioned, even seemingly routine work may confront unexpected change either from within the collaboration [22,33] (e.g. a key team member take a prolonged leave) or without (e.g. new market demands).

A relevant concept for nascence is the notion of *boundary negotiating artifacts,* which, while not exclusive to this dimension, might be found most commonly in un-established coordinated actions. The term *boundary negotiating artifacts* (BNAs) [28] has been used to describe the creation and use of temporary, unstandardized artifacts to support collaboration. The related notion of boundary objects as originally conceived is reliant on the existence of standardized practices [28]. The notion of BNAs posits that artifacts can be unstandardized yet functionally useful but also suggests that the organization of collaborative work itself can be in flux and yet functionally useful. It is not just nascence that characterizes these collaborations that are highly in flux, however. Some collaborations are not just new, but they are also, by design, temporary.

Dimensions Six: Planned Permanence

The sixth dimension is the *planned permanence* of the collaborative arrangement. *Planned permanence* refers to the intended permanence of a coordinated action. Relatively little research in CSCW has focused explicitly on notions related to this dimension. The dimension of planned permanence refers to planned or intended permanence, because it often cannot be predicted how long a coordinated action will actually last, nor is it straightforward to decide at what point something is actually "permanent." Another way to think about this is whether the collaboration is intended to be short-term or long-term. Works by Lee [28] and Yasuoka [57] studied small teams doing non-routine, nascent, and short-term collaborative work involving people from different communities of practice or "knowledge backgrounds."

Research has studied the special character of collaborations that were not intentionally created to be long term or global by assigning them a name: *local and temporary alignment of practices* (LTAP) [57]. A characteristic of LTAP is the creation of project jargon to create local and temporary alignment of practices during the early design period of short-term projects. While some modes of communication were learned during participants' professional education, others were invented during the project period. Within nascent and short-term teams, where participants belong to different communities, the creation of practices, artifacts, and special shared terms, i.e. jargon, is necessary if not crucial for success.

Whether a coordinated action is temporary or permanent, the participants need to create shared practices, artifacts, and terms; however, with strong *planned permanence*, participants may endeavor to create not just temporary artifacts, but in fact the standardized artifacts and practices that are requisite for stable boundary objects. The coordinated action, then is substantively different—the difference between a family setting up tents and a campsite for a weeklong stay vs. the same family building a home meant to last for decades. Again, we are referring to planned and not actual permanence, because the plan is to what people are orienting their actions.

It should be noted however, that a temporary collaboration is not necessarily "easier" than a more permanent one. While a more permanent one has high overhead in the planning and creation of administrative and coordinative practices and tools required for long-term collaborations, temporary collaborations can struggle due to a lack of common jargon, methods, practices, and understanding.

Dimension Seven: Turnover

The seventh dimension of MoCA is *turnover*. The turnover dimension refers to the stability of the participant makeup of a given collaboration. More specifically, this refers to the rapidity with which participants enter and leave. Implicit within this dimension are collaborations that range from closed, private collaborations where participants leave slowly, if at all, to collaborations that are fully open and public where "the masses" may participate. While nascence and turnover may seem to be overlapping, it is important to note that they can be independent. For example a long-standing coordinated action can suddenly undergo a significant amount of turnover due to internal events (e.g. a favorite manager being fired) or external (e.g. the advent of a favorable job market).

Instances of mass participation serve as examples of collaborations that are high on the dimension of turnover. For example, recent work on mass participation explores not the work of teams or organizations, but of the "crowd". The crowd is a very different animal where anyone can participate or stop participating at any time. We see loose collaborations ranging from individuals writing and editing articles for public wikis [25,35,36], websites that allow collaborative editing, to tweeters sharing information about disasters through microblogging [51,52].

EXAMINING THE LAST THREE DIMENSIONS: NASCENCE, PLANNED PERMANENCE AND TURNOVER

The seven dimensions of MoCA include two dimensions, synchronicity and physical distribution, that have been explicitly recognized in CSCW for quite some time; and two more dimensions, scale and number of communities of practice, that have been explicitly and implicitly recognized. We examine the last three dimensions of MoCA in more depth here using two examples drawn from previous CSCW literature since they are relatively less explored in the field.

The three dimensions of *nascence*, *planned permanence*, and *turnover* are dimensions that are necessary for understanding the more diffuse coordinated actions that are of increasing interest in CSCW. These diffuse coordinated actions are often characterized by emergent ways of organizing and a complex ecosystem of fields of work. We are not suggesting that for emergent collaborations and organizations the other dimensions are not salient; they are. Rather we wish to explicitly draw attention to how these more abstract, dimensions play out in actual practice.

We use these two examples to illustrate how MoCA can help us understand sites of study that are of interest to CSCW researchers. The first example is an emergent disaster relief virtual organization from Starbird and Palen [52]. The second is work to develop and sustain the CAMERA metagenomics cyberinfrastructure from Bietz, Ferro, and Lee [5]. Since these projects were not undertaken to explicitly gather data to address these seven dimensions, interpretation of the data presented in the articles is necessary. *Thus, this analysis is undertaken for demonstration purposes and is not intended to represent an empirical contribution.*

Example One: Humanity Road (HR)

Our first example uses Starbird and Palen's [52] examination of a disaster relief virtual organization, Humanity Road (HR), to explore what the dimensions look like in a coordinated action. Starbird and Palen describe how Humanity Road arose as an emergent organization in the aftermath of the 2010 Haiti earthquake. Humanity Road started as a group of people affiliated through social media and eventually morphed into a non-profit organization. The authors emphasize that since its inception and evolution in 2010, HR is, and always has been, a virtual organization comprised of a global network of volunteers in support of humanitarian relief.

Humanity Road used various social and collaborative media, including Twitter, Skype, and Google Docs. Twitter was the primary mechanism through which active disaster information was collected and disseminated while Skype and Google Docs were used to coordinate volunteers' participation. Work in this realm was episodic and dependent upon volunteers' ability to obtain information, sort through it to ascertain its correctness and utility to emergency management groups, and to disseminate information determined to be correct and useful.

Key to the process of collecting and disseminating information were "episodic" and long-term volunteers. Serving as a volunteer in HR ranged from retweeting tweets to disseminating current information about the disaster, to helping create and coordinate event diaries (later renamed situation reports) that helped track the knowledge being tweeted. Participation was open to people around the globe. "Long-term volunteers" were persons who contributed both during and in-between disasters, and as of 2011 included six "seasoned" participants.

While Starbird and Palen refer to these persons as "long term" or "now seasoned" this by no means indicates that there was a stable core of participants over time. Some of these seasoned participants were with the organization since a year prior to it's 2010 inception as a formal non-profit and some joined afterwards. Episodic volunteers on the other hand contributed during a single disaster event and could be entirely new to the collaboration with no previous experience or understanding of the emerging norms for disseminating disaster information through social media. The collection of members who volunteered over the long-term was not entirely stable and could turn over in less than a year's time. Still others came and went over a longer period of time.

During an unfolding crisis the high turnover in participants from event to event led to a muddled information collection and dissemination process. New long term or episodic volunteers could jump into the middle of ongoing work at any time during a disaster, leading to confusion regarding the state of verified and disseminated information. The high turnover led the long-term volunteers to take charge and develop a structured set of documents for the information collection and dissemination process. This process and associated artifacts enabled new participants to contribute to the disaster relief effort without disseminating incorrect information. The development of such artifacts and processes, however, took time and only emerged over the course of multiple disaster events as long-term volunteers adapted their work to the situations at hand.

The ability of anyone who was invited and willing to undergo a minimal amount of training to participate in Humanity Road's efforts reduced the virtual organization's ability to form a community of practice due to a constantly changing stream of participants. Humanity Road therefore found it necessary to "*bake in mechanisms into their work*" (e.g. the structured set of documents to organize work tasks) to make their larger overall strategy and goals possible. Starbird and Palen point out, however, that the development of these mechanisms did, over time, allow episodic volunteers to more freely enter and exit the collaboration while freeing long term volunteers to focus on other organizational goals.

In applying MoCA to the briefly discussed example above, it enables us to make sense of the coordinated action itself. Rather than looking at "collaboration" or "cooperative work" or even "coordinated action" as unchartable territory, perhaps we can begin to look for patterns and similarity. In the following discussion, we use the ordinal rankings of low, medium, and high, as crude placeholders for potential future empirically derived measures. In essence, we are "kicking the tires" a bit to demonstrate the potentiality of having such a framework such as MoCA. Indeed the only way to be sure about this data would be to have collected this data at the time that the study was undertaken.

Working primarily through Twitter and Skype, we see that volunteers are widely distributed, with participants scattered around the globe. While the potential number of people participating in the coordinated action is quite large, in actuality there is a small group of longer-term volunteers along with a somewhat larger group of episodic volunteers. The example of Humanity Road shows that high *turnover* for collaborations involving the "crowd" confounds the formation of a community of practice since participants may enter or exit at any time. Yet at the same time there are some stable members over time so there is also evidence of medium turnover. Thus, in the MoCA dimensions, we might say that Humanity Road covers a range on the continuum rather than simply being high or medium.

We also see that Humanity Road changes with regards to *planned permanence* over time. It starts out as a group of interested people and then eventually becomes a non-profit organization. However, our data for planned permanence is incomplete based on the above example. We know that once HR became a formal organization, we consider the planned permanence to be much higher than none, but still to be less than some ecological science infrastructures for example that are planned to last several decades if not a century. On the dimension of *nascence*, HR is mixed because during the course of the study it is truly brand new with many new practices needing to be established, whereas after a core group is established, the nascence is less. Thus on the dimension of nascence, HR is both medium and high. Given that coordinated actions change over time, it is sensible that how a coordinated action looks on the dimensions of MoCA changes over time as well.

Example Two: Development of the CAMERA Cyberinfrastructure (CI)

Research in CSCW has also looked at the transforming nature of collaborations for developing scientific cyberinfrastructures (CIs). In the following example, we examine the development of a cyberinfrastructure in more detail to further illustrate an emergent sociotechnical system from the literature. We are using the example of an ethnographic study of a marine metagenomics CI from Bietz, Ferro, and Lee [5]. Cyberinfrastructures are virtual organizations comprised of people and large-scale scientific computational infrastructures. Cyberinfrastructures have been described as being fundamentally emergent [43] and as being iteratively developed over time in response to a climate of constant scientific and technological change [6].

Bietz, Ferro, and Lee studied scientists who are collaborating to create a new database-centric system that will support new scientific methods, specifically metagenomic or environmental genomic methods. This project is the Community Cyberinfrastructure for Advanced Marine Microbial Ecology Research and Analysis (CAMERA). CAMERA is the collaborative endeavor of multiple organizations. The authors studied the project over a three-year period. In CAMERA participants were designing new collaborative practices and organizational structures in order to create new infrastructures to support new ways of doing science. Below we briefly describe findings from that original study, Bietz et al. [5], before launching in to our own analysis of it using MoCA.

In Bietz, Ferro, and Lee [5] the author's examine how "*the developers of CAMERA understand, manage, and respond to change*" in the course of their work to accomplish an infrastructure for marine metagenomics research. The author's especially focus on the strategies the individuals use to sustain the development and maintenance of CAMERA through changing organizational and scientific contexts. Bietz et al. discuss studying the CAMERA project in two phases, with the first phase begun around two years after the first. This enabled them to capture "*two snapshots in the life of the project*" for their analysis.

Between the first and second round of data collection Bietz et al. found that the human infrastructure [31] of the CAMERA project had changed substantially. Originally, CAMERA was a partnership of two US research institutes: the J. Craig Venter Institute (JCVI) and Calit2. JCVI is an independent genomic sciences institute in Maryland, while Calit2 is a research institute of the University of California, San Diego (UCSD). During their first round of data collection Bietz et al. ascertained that JCVI was leaving the CAMERA project. This was significant since JCVI provided both technological and biological expertise to the project. The authors note that CAMERA's leadership therefore quickly sought to partner with another organization to fill this gap and enable them to sustain the project and its stated goals.

At the end of the author's first round of data collection the CAMERA leadership selected a new organizational partner, the Center for Research on Biological Systems (CRBS). The CRBS had previous experience with other similar cyberinfrastructure projects and importantly was also located at UCSD. By the second round of data collection, the organizational leadership had also shifted from Calit2, even though it was still part of the project, to CRBS. CRBS members occupied "key leadership positions" and were leading the development work for the CI.

The author's note that the CAMERA project's transition from the JCVI to the CRBS organization was "easier than it might have been" thanks to CRBS and Calit2 being embedded in many of the same structures at UCSD. Mechanisms for moving money between the organizations and the purchase and use of common computing systems were more easily accomplished thanks to these structures. Bietz et al. note that the shared structures readily enable the CI developers to leverage existing infrastructural relationships to enact productive new relationships. In addition, the transition from JCVI to CRBS was "managed in phases so as to minimize disruption to the infrastructure." Members from each organization were therefore able to enact productive relationships over the course of these phases and key members who stayed on were able to take on larger roles that helped to keep historical information within the project. This relationship work sustained the development of CAMERA through changes in the organizations, technology, and scientific goals as it grew from a nascent to a more established entity.

The CAMERA project's organizational changes led to significant turnover in the project development staff. However, as Bietz et al. note the larger human infrastructure of CI projects is more expansive. This motivated the authors' examination of other stakeholder groups who found that the composition of the executive committee, the program officer, and the 10-person scientific advisory board did not change significantly between their two rounds of data collection. This provided stability to the project since these entities helped keep the project funding stable and its vision and goals aligned in the same direction.

Turning now to briefly apply MoCA to the CAMERA example, we see that as with many infrastructure efforts, CAMERA stays consistently high on the continuum of *planned permanence* as it is meant to be a lasting research infrastructure for many researchers who can, in turn, create their own sets of tools to work with that infrastructure. Across the author's two rounds of data collection one of the key organizations on the project changes, yet the overarching goal of accomplishing an infrastructure is sustained and enacted due to the human infrastructure.

Nascence is ranked on the high end of medium or the low end of high over the course of Bietz, Ferro, and Lee's study as the coordinative action of CAMERA is not entirely brand new during most of the course of the study, and thus cannot be said to be high, yet at the same time the project does reach an identifiably stable and established state. Certainly it does not rank low in nascence where there would be a clear "business as usual" feeling.

Finally, the example discusses *turnover* at great length showing that while there is some stability in the form of continuity in executive and advisory members and a few members of the project staff, overall the project staff had a great deal of turnover. Therefore we can consider the coordinated action of CAMERA on the dimension of *turnover* to be both medium and high.

We take the discussion of these two examples as a neonate thought exercise. Each of the two examples is distinct from early CSCW studies of electronic team meetings, being among the coordinated actions that are less centralized and exhibit a lot of change. We drew on already-published research to show that highly emergent organizations are already being studied within CSCW and furthermore that they, and their emergent qualities, can be at least partially understood and profiled by grappling with their relationships to the dimensions of nascence, planned permanence, and turnover. While the other dimensions of MoCA, too, are necessary to help us chart the realm of coordinated action, these three dimensions in particular are useful for us to be able to identifying and talk about emergent ways of organizing and also complex ecosystems of work.

DISCUSSION

Having discussed how three particular dimensions might help us to index and talk about emergent collaborations, we now take a step back to look at the "big picture": the larger context of MoCA. In particular, we elaborate on the utility of the shift from traditional notions of cooperation to the notion of coordinated action. This shift is helpful for assisting with investigations of more complex forms of multi-person action. We then go on to discuss how emergent coordinated actions have been of enduring interest to our field. Growing interest in emergent types of action such as infrastructural work to support "big data" and social media that support mass participation are exerting pressure on our field to redefine its scope more broadly. In the final subsection of this discussion, we list some of the theoretical and practical implications of MoCA.

Coordinated Action

Coordinated action can still be conceived of as people working together toward a shared goal. But shared goals can be very diffuse and ill-defined and we also see that "working together" may sometimes feel more like a series of fleeting microblog exchanges or people working rather separately on different systems that still need to interoperate with a larger, sprawling infrastructure. Research on information infrastructures has explored the idea that not only are infrastructures virtual organizations [10], but they are also systems of systems [13] comprised of a shifting patchwork of stakeholders who have different but overlapping interests [4,6]. The easiest way to describe this is to note that many organizations and computing systems are partially but not completely interoperable, and have overlapping but non-congruent interests and priorities.

Research has shown that people developing parts of infrastructures are usually spending a lot of their time on other projects as well [4,7,29]. The people involved in these infrastructure efforts, like most people, participate in many communities of practice. And yet these infrastructure efforts often do not feel like communities of practice: when people are working together *and productively* on a funded infrastructure project they may not agree on the target audience and the precise goals of the component of work that they are working on. For example in one study of infrastructure developers, participants had a few different ideas about who the "community" was that they were serving and therefore also different ideas about what their design priorities should be [30].

Collaborations that are low on planned permanence overall and high on the dimensions of turnover and communities of practice (including zero CoP) may also have another interesting quality however, which is that with a lack of routine practices and artifacts, the nature of work is rather special. Wenger's notion of a community of practice requires enduring participation, yet with very little enduring participation, we have coordinated actions bringing together people from many communities of practice. As mentioned earlier, it is possible for people to come together who belong to no community of practice, relevant to the coordinated action in which case none are involved.

Alternatively, there could be a coordinated action where many different people hail from many different communities of practice. In such a situation it is not hard to believe that there may not be a well defined, shared goal. Perhaps we are both interested in helping with disaster relief. You tweet from where the disaster happens and I re-tweet your tweet, exchanges that have been documented in the literature [51]. We may never otherwise interact although we may be following some of the same microblogging feeds. This is a very, very lightweight coordinated action where there is little interdependence. It is arguable whether the Twitter feed itself is "the common field of work" or if it is the disaster area where participants want help to be rendered, but it still represents people working on a shared goal of some kind: helping disaster victims.

The notion of coordinated action frees us from having to decide on only one common field of work and one clear-cut goal. Removing the bias towards smaller, tightly knit cooperation allows room for our field to continue studying not only those cooperations, but also larger, more loosely knit coordinated actions.

Emergence

How can we make sense of the types of coordinated action that are making a new model such as MoCA necessary? We posit here the notion of *emergent coordinated action* as a way of describing some of the edge cases that are pressuring CSCW to reconsider what is indeed the phenomenon of study. The model presented above might provide a tool for discussing how to support and design for collaborations that exhibit emergence, particularly *social emergence* [44] (the processes whereby the actions and interactions of agents result in the global behavior of a system). All social systems, and thus all sociotechnical systems, are emergent to some degree. Innovative types of work, such as design or scientific work, seem to exhibit more emergence. Coordinated actions that have high turnover, are low on planned permanence, are high on nascence (or some combination of those) could be considered highly emergent.

In research on intensional networks from more than a decade ago, Nardi et al. [37] found that actors deliberately formed intensional networks and that furthermore these networks had two properties: history (shared knowledge) and emergence (described by the authors as characterized by rapid formation to accomplish particular tasks). In their more recent work on complex and multiply-determined systems, Edwards et al. [13] describe a challenge of "navigating processes of planned vs. emergent change."

In research also from more than a decade ago, Furnas [17] discusses a framework for the context for designing IT as a mosaic of responsive adaptive systems (MoRAS) in the context of future HCI (denoted by Furnas as ++HCI):

> *The framework views the world relevant to ++HCI design as being composed of a whole set of systems, ranging from parts of the human mind to workgroups, communities, markets, and societies. The dominant considerations that shape the structure and dynamics of this set of systems arise by noting that they individually respond to their environments and adapt to remain viable* over *time. Further, they are coupled with one another in a kind of multiscale mosaic, influencing each other in a variety of ways. [17, p.208]*

In the extended example on cyberinfrastructure development described earlier [5], we see more recent research describing similar ways that collaborations can be emergent: different groups form at different times and different actors are working to reshape their collaborations and technical arrangements depending on their needs of the moment. The collaboration is described as a complex and rapidly shifting kaleidoscope of interactions, technologies, and collaborations from teams to multiple organizations.

Additional research in CSCW has investigated design in emergent sociotechnical systems. In research on complex collaborations around organizational software, Pollock et al. [42] investigate the seeming contradiction in design contexts where there exist standardized software solutions and, simultaneously, a great diversity of organizational settings to which those solutions are to be applied. Looking at "generification work" with organizational software packages, they describe a process of extending and morphing that enable software packages to move from place to place and in to new settings. The extensions of software packages, however, also enable organizations to align themselves with the software. Individuals and larger social structures, such as organizations, exist and coevolve in relation to one another.

Our investigations of coordinated action and how to model it has pushed us far beyond our starting point of looking at synchronous and asynchronous and co-located vs. distributed work. Our journey here has also taken us past another waypoint that looked at routine and non-routine and simple vs. complex coordinated action. We have now gone far beyond simple binaries to looking at a very multi-dimensional design space.

While the notion of emergence is not new to CSCW and related literatures [38,44], coordinated actions that exhibit social emergence are becoming ever more ubiquitous in our research, and increasingly relevant to everyday life given the extended reach of social media and information technologies more generally. Having emergent qualities is a fundamental reality of many contemporary coordinated actions. As we start to consider more types of coordinated action that are "complex," or more extreme, on any number of the seven dimensions of MoCA (i.e., synchronicity, physical distribution, scale, nascence, NCoP, planned permanence, turnover), the challenge of designing to support emergence will become increasingly important. Exploring the design space of emergent collaborations and emergent organizations is timely and deserves more attention.

Conceptual Frameworks for CSCW: A Way Forward

The Model of Coordinated Action represents but one way forward. While it touches upon many years of empirical research in CSCW, it is yet an early step in a larger project to contribute to theory that originates from the CSCW community and that is for the CSCW community—and perhaps beyond. We propose here a particular kind of theoretically driven empirical program. It is our hope, however, given the continued prominence of historical models such as Johansen's matrix, that the community is ready to consider an expanded model. Should MoCA stimulate or contribute to conversations about what the phenomenon of study is within CSCW or should MoCA inspire the development of other conceptual frameworks that put all manner of research and technologies that support coordinated action in dialog with each other, then this model will have served an extremely useful purpose and our time here will already have been well spent. However, we do not wish to stop there.

The future practical implications of MoCA are that it may provide *a shared way* to find and talk about what we study in CSCW despite its electrifying and daunting diversity. We are not recommending that everyone adopt this wholesale and make this the object of their research, rather we suggest that this model could provide a useful common reference similar to GPS coordinates. Further exploration of models like this, whether or not they are MoCA, could assist with finding some of our own common ground for talking about and comparing:

- Change within one coordinated action over time
- Differences and similarities within particular domains (e.g. health, science, education)
- Differences and similarities within particular types of activity (e.g. mass participation, infrastructure development)
- Differences *across* domains and spheres of activity (e.g., Wikipedia scholars in CSCW might find similarities with scientific collaboration scholars in CSCW whereas they might not have before)
- The development of a way to index different coordinated actions *at the time of data collection* so that we may search for similar coordinated actions that may not be in our sub-disciplinary area
- Identification of the equivalent of personas for different types of coordinated action: profiles of coordinated actions
- Identification of technologies that have proven relevant or useful to coordinated action that fits certain profiles
- Identification of constellations of technologies that are relevant to coordinated actions that fit certain profiles

Related to the last point of identification of constellations, we note that research has already usefully taken notice that groups of individuals are combining different types of technologies in different ways [15,21]. However we still need to know more about when, how, or why. We suspect given the examples already in the CSCW literature that the technical needs of more emergent systems are somewhat different from those that are less emergent—for example what constitutes agile and modular ways of working? We already see that people are using ecologies of tools and technologies to collaborate [21,23], therefore we can perhaps start to get a sense of what classes of tools and systems, and what clusters of those same classes, are useful for what sorts of collaborations.

The seven dimensions of MoCA (i.e. synchronicity, distribution, scale, number of communities of practice, nascence, planned permanence, and turnover) provide researchers, developers, and designers with a vocabulary and range of concepts that can be used to tease apart the aspects of a coordinated action that make them easy or hard to design for. If we are sensitized to the notions of planned permanence, turnover, and number of communities of practice, etc. we then have standardized tools (concepts in this case), with which to read, recognize, compare and talk about the unique features of each design space.

MoCA starts to reveal some of its power when a design or research team is provided with this conceptual framework for comparing one design or research project with another. If we become aware that while our previous projects involved few communities of practice, extreme distribution, high planned permanence and low turnover and our new project entails extreme distribution, low planned permanence, and high turnover, we can be proactive about anticipating new challenges for research and design pertaining to those dimensions which are different from our earlier work. Furthermore, we can document and learn from the differences.

MoCA's major implications for design, however, as per the bullet list above, are twofold: 1) to more precisely, yet with appropriate flexibility, describe the CSCW design space and 2) to provide fine-grained ways to understand and locate related work such that we do not forever relegate ourselves to domain silos (e.g. health informatics, Wikipedia, science, ubiquitous computing for the home) or methodological silos. Coordinated actions that are similar in terms of synchronicity, distribution, nascence, turnover, and scale in, for example, health informatics and ubiquitous computing for the home, might have more in common with each other than coordinated actions in the same domain that rate very differently on those same dimensions. To reduce this to a simple example: designing for a small, nascent undistributed coordinated action in medical research informatics (e.g. a tablet app to support wet lab activities) might have more in common with another small, nascent, undistributed coordinated action in, say, ubiquitous computing for the home (e.g. a tablet app to support family chores) than it would with a large, established highly distributed coordinated action (e.g. a legacy system for electronic medical research records). With frameworks like MoCA it could become much easier to locate and explain such "cross-silo" comparisons than it is currently. The implication of this work for design is to help CSCW by mapping our new, larger and more complex design space and by maximizing our use of existing research.

CONCLUSION

Rather than seeing this model as a foray in to turning CSCW into a "pure" social science, to the contrary we see this work as taking seriously the notion that CSCW is, in fact, a design field. If we are designing to support coordinated action we should know more about what coordinated action is, and furthermore, we should have better ways to talk about the variations among them. In this way, we might get closer to understanding what it means to design for sociotechnical systems that can be simultaneously socially and technically complex and are subject to frequent changes from both within and without.

For systems that are very large and complex "design" almost feels like a misnomer. The developers of these systems are somewhat powerless in the schema of very diffuse organizations that do not have central control, but might be seen more accurately as facilitators. While CSCW has sought to investigate the political ramifications and methodological challenges of involving users in processes of change, the field still suffers from the lack of a understanding of how people involve themselves, in larger, more complex sociotechnical systems.

More recent work in HCI, particularly in CSCW, investigates very different types of coordinated actions such as Wikipedia communities, crowd working, and infrastructural development [4,35,36,42,51,52]. Of course smaller, changeable collaborations have been under our nose all along but have received less attention [28,57]. These collaborations, where the cast of characters and the work practices and artifacts are often necessarily changing, and changing frequently, are likely to continue yielding interesting questions, insights, and design opportunities.

For historical reasons we do not actually object to adherence to the use of the words "collaboration" or "cooperation," but we chose to use the words coordinated action in this paper and for this model in order to be consistent and technically correct about what we consider to be the focus of CSCW research and development. What we propose here is a simple and straightforward extension of existing models of CSCW that also represents a bold shift. The shift lies in giving up on narrow idealized notions of goal-directedness, which suggest that goals are clear and well-defined and that people working in concert necessarily have the exact same goals. The shift also lies in opening our conceptual roadmap to include the notion that very loosely knit ways of doing things together (whether it be for work or leisure or enrichment) are now part of the landscape. What we hold on to from our theoretical past is the notion that a keystone of our field of CSCW is not "Computer Supported Cooperative Work" per se, but investigating goal-directed coordinated action to better inform technology design research and practice.

Löwgren and Stolterman [32] note that design theory is "*knowledge focused on creating new conditions for design, different patterns of thinking and acting, new design examples, and a general understanding of the conditions for creative and innovative work.*" If, in the future, we succeed in coming up with values for the dimensions described above, we open up the possibility for CSCW researchers to retrieve research on similar types of collaborations. That would be immensely valuable.

Individual intrepid researchers in HCI have already been venturing into the frontiers of accepting and exploring these ways of coordinating action together—we do not argue otherwise. However, our theory and conceptual frameworks should follow suit. This work represents an effort to stimulate more dialog about what the phenomenon of study of CSCW really is and how we might represent it so that we can understand our work and ourselves better and—at the very least—have a model to put in our HCI textbooks that are more reflective of advances in our field.

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